Salem/ Hope Creek Environmental Audit – Post-Audit Information

Question #: ECO-7 **Category:** Ecology

Statement of Question: Please provide the following documents that were made available during the Salem and HCGS License Renewal Environmental Audit in response to Pre-Audit Question # ECO-7.

Attachment #1 – USFWS letter dated 9-9-09

Response: The document requested is being provided.

List Attachments Provided:

Letter from U.S. Fish and Wildlife Service to PSEG Nuclear, LLC (E. Keating) regarding March 4, 2009 request for information on the presence of federally listed endangered and threatened species in the vicinity of the existing Salem and Hope Creek Generating Stations. September 9, 2009.

Salem/ Hope Creek Environmental Audit – Post-Audit Information

Question #: ECO-8 **Category:** Ecology

Statement of Question: Please provide the following information that was made available during the Salem and HCGS License Renewal Environmental Audit in response to Pre-Audit Question # ECO-8.

Attachment #1 – CD containing GIS shape files

Response: The requested compact disc is being provided under separate cover to the NRC Environmental Project Manager for reference only. It is not being submitted for electronic filing into ADAMS because, as the NRC Environmental Project Manager has agreed, the GIS shape files are needed solely for map verification. As such, the GIS shape files do not supplement the Salem and Hope Creek License Renewal Applications.

List Attachments Provided:

Compact disc (submitted separately to the NRC Environmental Project Manager for reference only—not submitted for filing into ADAMS) containing the following GIS shape files for the transmission lines evaluated in the Salem and HCGS License Renewal Environmental Reports:

transmission_lines.shx
transmission_lines.shp
transmission_lines.sbx
transmission_lines.sbn
transmission_lines.prj
transmission_lines.dbf

United States Department of the Interior

FISH AND WILDLIFE SERVICE
New Jersey Field Office
Ecological Services
927 North Main Street, Building D
Pleasantville, New Jersey 08232
Tel: 609/646 9310
Fax: 609/646 0352
http://www.fws.gov/northeast/njfieldoffice

In Reply Refer to:

2009-I-0417

NON-PSEG

SEP 9 2009

Edward J. Keating, Sr. Environmental Advisor
PSEG Nuclear LLC
P.O. Box 236
Hancocks Bridge, New Jersey 08038-0236

Dear Mr. Keating:

The U.S. Fish and Wildlife Service (Service) has reviewed your March 4, 2009 request for information on the presence of federally listed endangered and threatened species in the vicinity of the existing Salem and Hope Creek Generating Stations located on Artificial Island in Lower Alloways Creek Township, Salem County, New Jersey. PSEG Nuclear LLC (PSEG) plans to apply to the U.S. Nuclear Regulatory Commission (NRC) for renewal of the operating licenses for these plants, which expire in 2016 (Salem Unit 1), 2020 (Salem Unit 2), and 2026 (Hope). License renewal would extend the operating period of each reactor for an additional 20 years.

This letter addresses federally listed species in the vicinity of the Salem and Hope plants as well as four existing 500-kV transmission lines that emanate from the plants and extend along southern Salem, Gloucester, and Camden Counties in New Jersey and into New Castle County in Delaware. The proposed relicensing would not involve any expansion of existing facilities, structural modifications or other refurbishments, or change in existing management practices for the plants or the lines. This response has been coordinated with the Service's Chesapeake Bay Field Office regarding the portion of one transmission line that cross into Delaware. This response does not address all Service concerns for wildlife resources, nor any proposals for construction of new or expanded facilities.

AUTHORITY

This response is pursuant to Section 7 the Endangered Species Act of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.*) (ESA) to ensure the protection of federally listed endangered and threatened species; the Bald and Golden Eagle Protection Act (54 Stat. 250; 16 U.S.C. 668-668d) (Eagle Act); and the Migratory Bird Treaty Act of 1918 (40 Stat. 755; 16 U.S.C. 703-712), as amended. These comments do not preclude separate review and comments by the Service pursuant to the National Environmental Policy Act of 1969 as amended (83 Stat. 852; 42 U.S.C. 4321 *et seq.*) (NEPA).

FEDERALLY LISTED SPECIES

No federally listed species under Service jurisdiction are known to occur in the vicinity of the existing Salem or Hope Generating Stations.

Known occurrences and other areas of potential habitat for the federally listed (threatened) swamp pink (*Helonias bullata*), and areas of potential habitat for the federally listed (threatened) bog turtle (*Clemmys muhlenbergii*), occur along the Hope Creek/Salem to New Freedom and Salem to New Freedom South transmission lines. PSEG's current maintenance practices along these lines, including State-mandated vegetation control, may adversely affect these species.

The Service is currently coordinating with PSEG to review all of its 5,402 transmission line spans in New Jersey. When the review is complete, the Service will transmit a Geographic Information System (GIS) layer to PSEG's Environment, Health and Safety Department indicating the presence or potential presence of federally listed species along each span. Concurrent with the Service's review, PSEG is considering written adoption of Service-recommended conservation measures for each federally listed species that could potentially occur along the transmission spans. The Service recommends referencing this coordination process in PSEG's application to the NRC. We also recommend inclusion of all adopted conservation measures in the NEPA documentation for the license renewals. In addition, the Service will recommend inclusion of all adopted conservation measures in PSEG's renewed transmission line maintenance General Permit under the New Jersey Freshwater Wetlands Protection Act (N.J.S.A. 13:9B *et seq*.).

BALD EAGLE

Numerous areas of nesting, foraging, and wintering habitat for the bald eagle (*Haliaeetus leucocephalus*) are mapped along the subject transmission lines by the New Jersey Department of Environmental Protection. This species could also occur along the line in Delaware. The bald eagle was removed from the Federal List of Endangered and Threatened Wildlife effective August 8, 2007. The bald eagle continues to be federally protected under the Eagle Act and the Migratory Bird Treaty Act. In addition, the bald eagle remains a State-listed species under the New Jersey Endangered and Nongame Species Conservation Act (N.J.S.A. 23:2A *et seq*.), which carries protections under the State land use regulation program. Disturbance of bald eagle nests is also prohibited under Delaware State law (7 Del. C. 1953, § 748; 57 Del. Laws, c. 88; 70 Del. Laws, c. 275, §§ 74-77), and new regulations have been proposed in Delaware to strengthen protections for bald eagles. For the continued protection of bald eagles, and to ensure compliance with Federal and State laws, the Service recommends managing bald eagles in accordance with the National Bald Eagle Management Guidelines and all applicable State regulations. Links to New Jersey State agencies and the Guidelines are available on this office's web site at http://www.fws.gov/northeast/njfieldoffice/Endangered. Information on the bald eagle in Delaware is available from the Delaware Natural Heritage and Endangered Species Program; contact information is provided in the enclosed letter from the Chesapeake Bay Field Office.

MIGRATORY BIRDS

The Migratory Bird Treaty Act prohibits the take of migratory birds, their parts, nests, and eggs, even when incidental to an otherwise lawful activity. To minimize avian electrocution and collision risks, the Service recommends that PSEG modify the four subject transmission lines as needed for consistency with the *Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006*. If necessary, upgrades to the *State of the Art* standards can be phased in over time in conjunction with routine maintenance along the lines. If PSEG has not already done so, the Service also recommends preparation of an Avian Protection Plan (APP). The *Suggested Practices* document is available from the Avian Powerline Interaction Committee (http://www.aplic.org/). Guidance for preparing APPs is available from the Service (http://www.fws.gov/migratorybirds, under Bird Hazards).

CONCLUSION

Further consultation with the Service under Section 7 of the ESA is necessary to evaluate and minimize adverse effects to federally listed species from PSEG's current transmission line maintenance practices in New Jersey. The Service appreciates PSEG's cooperation to address impacts from transmission line maintenance on a State-wide basis. We recommend that PSEG reference this effort in its application to NRC, and in NEPA documents for the relicensing. The Service recommends that PSEG comply with the above-referenced guidance documents to minimize impacts to the bald eagle and other migratory birds.

Except for the above-mentioned species, no other federally listed or proposed threatened or endangered flora or fauna are known to occur within the vicinity of the proposed project. If additional information on listed and proposed species becomes available or if project plans change, this determination may be reconsidered.

Please refer to our web site at http://www.fws.gov/northeast/njfieldoffice/Endangered/ for current lists of federally listed and candidate species in New Jersey. The web site also provides contacts for obtaining current information regarding State-listed and other species of concern from the New Jersey Natural Heritage and Endangered and Nongame Species Programs. Contact information for the Delaware Natural Heritage and Endangered Species Program is provided in the enclosed letter from the Chesapeake Bay Field Office.

Please contact Wendy Walsh at (609) 383-3938, extension 48, if you have any questions or require further assistance regarding federally listed threatened or endangered species.

Sincerely,

Acting Supervisor

Enclosures

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Chesapeake Bay Field Office
177 Admiral Cochrane Drive
Annapolis, MD 21401
410/573-4575

August 18, 2009

Wendy Walsh
927 North Main Street, Building D
Pleasantville, New Jersey 08232

RE: Salem and Hope Creek Generating Stations Request for information on threatened or endangered Species.

Dear Ms. Walsh

This responds to your letter, received, August 18, 2009, requesting information on the presence of species which are federally listed or proposed for listing as endangered or threatened within the above referenced project area. We have reviewed the information you enclosed and are providing comments in accordance with section 7 of the Endangered Species Act (87 Stat. 884, as amended; 16 U.S.C. 1531 et seq.).

Except for occasional transient individuals, no proposed or federally listed endangered or threatened species are known to exist within the project impact area. Therefore, no Biological Assessment or further Section 7 Consultation with the U.S. Fish and Wildlife Service is required. Should project plans change, or if additional information on the distribution of listed or proposed species becomes available, this determination may be reconsidered.

This response relates only to federally protected threatened or endangered species under our jurisdiction. For information on the presence of other rare species, you should contact Edna Stetzar, of the Delaware Natural Heritage and Endangered Species Program, at (302) 653-2883 ext. 126. You may also obtain information on how to make such a request by visiting the Program website at www.dnrec.state.de.us/nhp.

Effective August 8, 2007, under the authority of the Endangered Species Act of 1973, as amended, the U.S. Fish and Wildlife Service (Service) removed (delist) the bald eagle in the lower 48 States of the United States from the Federal List of Endangered and Threatened Wildlife. However, the bald eagle will still be protected by the Bald and Golden Eagle Protection Act, Lacey Act and the Migratory Bird Treaty Act. As a result, starting on August 8, 2007, if your project may cause "disturbance" to the bald eagle, please consult the "National Bald Eagle Management Guidelines" dated May 2007.
If any planned or ongoing activities cannot be conducted in compliance with the National Bald Eagle Management Guidelines (Eagle Management Guidelines), please contact the Chesapeake Bay Ecological Services Field Office at 410-573-4573 for technical assistance. The Eagle

Management Guidelines can be found at:
http://www.fws.gov/migratorybirds/issues/BaldEagle/NationalBaldEagleManagementGuidelines.pdf.

In the future, if your project can not avoid disturbance to the bald eagle by complying with the Eagle Management Guidelines, you will be able to apply for a permit that authorizes the take of bald and golden eagles under the Bald and Golden Eagle Protection Act, generally where the take to be authorized is associated with otherwise lawful activities. This proposed permit process will not be available until the Service issues a final rule for the issuance of these take permits under the Bald and Golden Eagle Protection Act.

An additional concern of the Service is wetlands protection. The Service's wetlands policy has the interim goal of no overall net loss of Delaware Bay's remaining wetlands, and the long term goal of increasing the quality and quantity of the Basin's wetlands resource base. Because of this policy and the functions and values wetlands perform, the Service recommends avoiding wetland impacts. All wetlands within the project area should be identified, and if construction in wetlands proposed, the U.S. Army Corps of Engineers, Philadelphia District should be contacted for permit requirements. They can be reached at (215) 656-6728.

We appreciate the opportunity to provide information relative to fish and wildlife issues, and thank you for your interest in these resources. If you have any questions or need further assistance, please contact Devin Ray at (410) 573-4531.

Sincerely,

Leopoldo Miranda
Field Supervisor

Bog turtle (*Clemmys muhlenbergii*)

The bog turtle was federally listed as a threatened species in 1997.

At only about 4 inches long, the bog turtle is one of North America's smallest turtles. This species typically shows a bright yellow, orange, or red blotch on each side of the head. The nearly parallel sides of the upper shell (carapace) give bog turtles an oblong appearance when viewed from above. These small, semi-aquatic turtles consume a varied diet including insects, snails, worms, seeds, and carrion.

Bog turtles usually occur in small, discrete populations, generally occupying open-canopy, herbaceous sedge meadows and fens bordered by wooded areas. These wetlands are a mosaic of micro-habitats that include dry pockets, saturated areas, and areas that are periodically flooded. Bog turtles depend upon this diversity of micro-habitats for foraging, nesting, basking, hibernating, and sheltering. Unfragmented riparian (river) systems that are sufficiently dynamic to allow the natural creation of open habitat are needed to compensate for ecological succession. Beaver, deer, and cattle may be instrumental in maintaining the open-canopy wetlands essential for this species' survival.

Bog turtles inhabit open, unpolluted emergent and scrub/shrub wetlands such as shallow spring-fed fens, sphagnum bogs, swamps, marshy meadows, and wet pastures. These habitats are characterized by soft muddy bottoms, interspersed wet and dry pockets, vegetation dominated by low grasses and sedges, and a low volume of standing or slow-moving water which often forms a network of shallow pools and rivulets. Bog turtles prefer areas with ample sunlight, high evaporation rates, high humidity in the near-ground microclimate, and perennial saturation of portions of the ground. Eggs are often laid in elevated areas, such as the tops of tussocks. Bog turtles generally retreat into more densely vegetated areas to hibernate from mid-September through mid-April.

The greatest threats to the bog turtle are the loss, degradation, and fragmentation of its habitat from wetland alteration, development, pollution, invasive species, and natural vegetational succession. The species is also threatened by collection for illegal wildlife trade.

U.S. FISH AND WILDLIFE SERVICE SPECIES NARRATIVES:
Biology and Threats of Federally Listed Species in New Jersey

Swamp pink (*Helonias bullata*)

Swamp pink was federally listed as a threatened species in 1988.

A perennial member of the lily family, swamp pink has smooth, oblong, dark green leaves that form an evergreen rosette. In spring, some rosettes produce a flowering stalk that can grow over 3 feet tall. The stalk is topped by a 1 to 3-inch-long cluster of 30 to 50 small, fragrant, pink flowers dotted with pale blue anthers. The evergreen leaves of swamp pink can be seen year round, and flowering occurs between March and May.

Supporting over half of the known populations, New Jersey is the stronghold for this swamp pink. An obligate wetland species, swamp pink occurs in a variety of palustrine forested wetlands including swampy forested wetlands bordering meandering streamlets, headwater wetlands, sphagnous Atlantic white-cedar swamps, and spring seepage areas. Specific hydrologic requirements of swamp pink limit its occurrence within these wetlands to areas that are perennially saturated, but not inundated, by floodwater. The water table must be at or near the surface, fluctuating only slightly during spring and summer months. Groundwater seepage with lateral groundwater movement are common hydrologic characteristics of swamp pink habitat.

Swamp pink is a shade-tolerant plant and has been found in wetlands with canopy closure varying between 20-100%. Sites with minimal canopy closure are less vigorous due in part to competition from other species. Common vegetative associates of swamp pink include Atlantic white-cedar (*Chamaecyparis thyoides*), red maple (*Acer rubrum*), pitch pine (*Pinus rigida*), American larch (*Larix laricina*), black spruce (*Picea mariana*), red spruce (*P. rubens*), sweet pepperbush (*Clethra alnifolia*), sweetbay magnolia (*Magnolia virginiana*), sphagnum mosses (*Sphagnum* spp.), cinnamon fern (*Osmunda cinnamomea*), skunk cabbage (*Symplocarpus foetidus*), and laurels (*Kalmia* spp.). Swamp pink is often found growing on the hummocks formed by trees, shrubs, and sphagnum mosses, and these micro-topographic conditions may be an important component of swamp pink habitat.

The primary threats to swamp pink are the indirect effects of off-site activities and development, such as pollution, introduction of invasive species, and subtle changes in groundwater and surface water hydrology. Hydrologic changes include increased sedimentation from off-site construction, groundwater withdrawals or diversion of surface water, reduced infiltration (recharge) of groundwater, increases in erosion, increases in the frequency, duration, and volume of flooding caused by direct discharges to wetlands (such as stormwater outfalls), and increased runoff from upstream development. Other threats to this species include direct destruction of habitat from wetland clearing, draining, and filling; collection; trampling; and climate change.

U.S. FISH AND WILDLIFE SERVICE SPECIES NARRATIVES:
Biology and Threats of Federally Delisted Species in New Jersey

Bald eagle (*Haliaeetus leucocephalus*)

The bald eagle was federally listed in 1967, and classified as an endangered species in 1973. With increasing numbers, bald eagle populations in the coterminous 48 States were re-classified from endangered to threatened in 1995, and delisted on August 9, 2007. The bald eagle continues to be protected under Federal laws including the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. The bald eagle also remains a State-listed species under the New Jersey Endangered and Nongame Species Conservation Act, which carries protections under the State land use regulation program. These Federal and State laws prohibit unauthorized take of bald eagles. For the continued protection of bald eagles, and to ensure compliance with Federal and State laws, the U.S. Fish and Wildlife Service (Service) recommends managing bald eagles in accordance with the National Bald Eagle Management Guidelines and all applicable State regulations. The Service and its partners are monitoring the bald eagle for a 20 year period to ensure populations remain stable following delisting.

With a wingspan that can exceed 7 feet, the bald eagle is the second largest bird of prey in North America. The bald eagle is our National symbol and unmistakable in appearance, featuring a white head and tail that contrast with a dark body. Juvenile birds lack the white head and tail, and are mottled in appearance until their fifth year. Eagles are opportunistic feeders and will eat carrion or live prey, primarily fish, but also small mammals, reptiles, and waterfowl.

Bald eagles occur in New Jersey throughout the year. The breeding season in New Jersey begins in late December to early January. During this period, mating pairs will work diligently to build or repair their nest. First-year nests can measure 2 feet high and 5 feet across. Eagles may use the same nest year to year, adding sticks and other nesting material, making the nest larger and larger each year. By the middle of February, most bald eagles in New Jersey have begun to lay their clutch of one to three eggs. Young eagles learn to fly (fledge) 11 to 12 weeks after hatching. Adults continue to provide food for the juvenile eagles for as long as 3 months after they fledge. During this period, the fledglings learn to fly proficiently and begin to hunt for themselves.

Bald eagles prefer forested or open habitats with little human disturbance near large bodies of water, such as lakes, large rivers, reservoirs, and bays. Eagles are often attracted to a water body as they search for food, and frequently roost in dead or mature trees adjacent to water. In winter, bald eagles gather in large numbers near coasts and inland water bodies that remain ice-free, allowing access to fish and other prey.

Threats to the bald eagle include environmental contaminants, habitat destruction and degradation, and disturbance of nesting and feeding birds.

Salem/ Hope Creek Environmental Audit – Post-Audit Information

Question #: ECO-13 **Category:** Ecology

Statement of Question: Please provide the following documents that were made available during the Salem and HCGS License Renewal Environmental Audit in response to Pre-Audit Question # ECO-13.

Attachment #2 – Bird Impact Procedure
Attachment #3 – 1984 Bird Impact Report
Attachment #4 – 1985 Bird Impact Report
Attachment #5 – 1986 Bird Impact Report
Attachment #6 – Bird Impact Study Termination

Response: The document requested are being provided.

List Attachments Provided:

PSEG Nuclear, LLC. *Cooling Tower Bird Mortality Study*, Hope Creek Generating Station, OP-AP.ZZ-100(Z), Rev. 1. January 1986.

Letter from PSEG (J. Shissias) to NJDEP (J. Weingart) regarding Hope Creek Generating Station CAFRA Permit 74-014, Cooling Tower Bird Mortality Survey, 1984 Annual Report. February 28, 1985.

Letter from PSEG (J. Shissias) to NJDEP (J. Frier-Murza) regarding Hope Creek Generating Station, Cooling Tower Bird Mortality Survey, Special Purpose Salvage Permit, 1985 Annual Report. January 24, 1986.

Letter from PSEG (J. Shissias) to NJDEP (S. Whitney) regarding Hope Creek Generating Station CAFRA Permit No. 74-014, Cooling Tower Bird Mortality Survey, Annual Report and Modification Request. January 29, 1987.

Letter from NJDEP (S. Whitney) to PSEG (J. Shissias) regarding Coastal Permit 74-014-5, Modification in Detail, Hope Creek Generating Station (deleting paragraph 18, which required bird mortality monitoring at the Hope Creek cooling tower). September 10, 1987.

HC 4.12

HOPE CREEK GENERATING STATION

OP-AP.ZZ-100(Z)

COOLING TOWER BIRD MORTALITY STUDY

Remarks:

Prepared By:	W. Merritt	7/13/85 Date
Reviewed By:	Operating Engineer-Hope Creek	1/9/86 Date
ALARA Review:	Radiation Protection Dept.	1-9-86 Date
Reviewed By:	Manager-Licensing and Regulation	1-13-86 Date
Reviewed By:	SQAE	Date
SORC Review:	Chairman	Date
Approved By:	Operations Manager-Hope Creek	Date

COOLING TOWER BIRD MORTALITY STUDY

TABLE OF CONTENTS

COOLING TOWER BIRD MORTALITY STUDY

1.0 PURPOSE

This Administrative Procedure (AP) outlines the Cooling Tower Bird Mortality Study performed at the Hope Creek Generating Station. The study is designed to effectively determine the mortality of birds due to collision with the tower and to meet the requirements of New Jersey Department of Environmental Protection Coastal Area Facilities Permit No. 74-014.

2.0 REFERENCES

2.1 Letter from D. E. Cooley - Manager, Environmental Licensing to G. C. Connor - Operations Manager, Hope Creek, March 2, 1984.

2.2 50 CFR 13, General Permit Procedures, 7/8/83.

2.3 50 CFR 21, Migratory Bird Permit, 1/4/74.

3.0 DEFINITIONS

3.1 Migration Period - The period of time during which birds journey between summer and winter habitats. These periods are somewhat variable, but usually are April 1 to May 31 and September 1 thru October 31.

3.2 Bird Survey Data Summary Sheet - Standardized data sheet used to record the results of the bird mortality surveys.

3.3 Surveyor - Person responsible for conducting the daily or bi-weekly bird mortality surveys.

3.4 Bi-weekly - twice a week.

4.0 RESPONSIBILITIES

4.1 Operations manager - Responsible for assigning personnel within the Operations Department with the responsibility of program implementation.

4.2 Operations Staff - Responsible for the successful implementation of the bird survey program. This responsibility includes ensuring the surveys are performed at the prescribed frequency, results are accurately recorded, any mortalities are properly stored, and all records are retained and retrievable.

4.3 Utility Operator - Responsible for performing the daily/bi-weekly bird surveys. This survey includes the systematic searching of the cooling tower area, bagging and tagging any bird mortalities, filling out the bird data summary sheet, and reporting all results to the Operations Staff.

4.4 Nuclear Licensing and Regulation Department (NL&R) - Responsible for identifying the bird mortalities and reporting the results to the appropriate regulatory agencies.

5.0 PROCEDURE

5.1 The surveyor should perform early morning, systematic searches of the area outlined in Attachment 1 at the frequency given in Table 1 unless unforseen circumstances prevent the operator from conducting the search.

5.2 If a bird mortality is found, the surveyor shall perform the following:

5.2.1 Complete a bird identification tag (Attachment 2) and afix the tag to the bird's leg.

5.2.2 Place the bird in a plastic bag and seal bag.

5.3 If an injured bird is found, it shall be taken to the Operations Staff who shall contact NL&R for instructions.

5.4 The surveyor shall complete a Bird Survey Data Summary Sheet (Attachment 3) after the survey is complete.

5.5 The surveyor shall place all bird mortalities in the bird storage freezer.

5.6 The surveyor shall return the completed Bird Survey Data Summary Sheet to the Operations Clerk who shall update the Bird Collection Log (Attachment 4) as necessary, notify NL&R that a mortality has been found, and then forward the summary sheet to the Operations Staff.

5.7 The Operations Staff shall forward a copy of the Bird Survey Data Summary Sheets to NL&R once a month.

5.8 The NL&R representative shall identify all bird mortalities and arrange for shipment of the birds to the appropriate location.

5.9 The Operations Staff shall maintain a complete file of Bird Survey Data Summary Sheets. Such records shall be retained for 5 years.

5.10 The Operations Staff shall assist NL&R in generating an annual report for submittal to the appropriate regulatory agencies.

TABLE 1

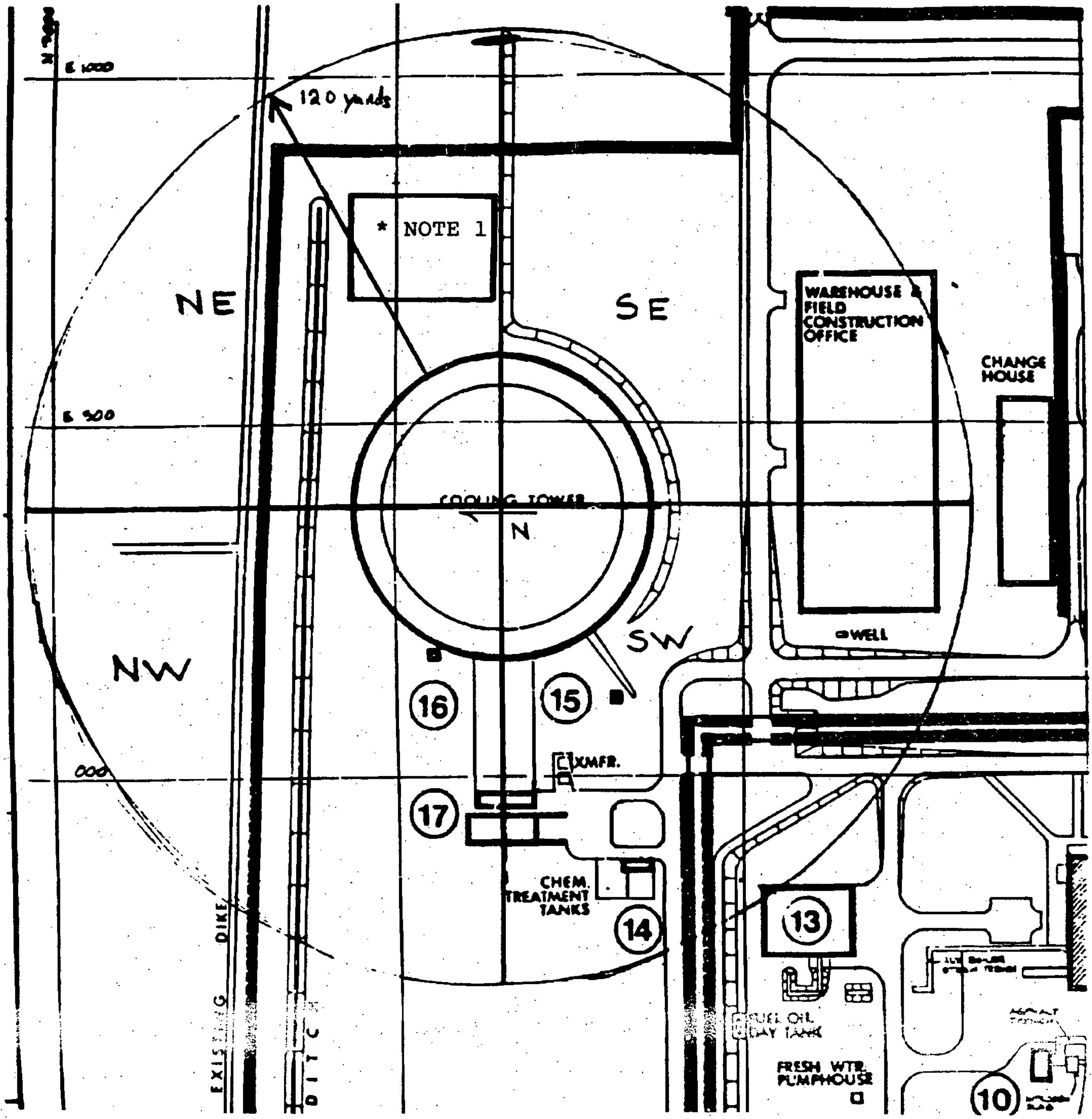
BIRD MORTALITY SURVEY ROUTINE AND FREQUENCY

	MIGRATORY PERIOD	NON-MIGRATORY PERIOD
AREA	APR 1 - MAY 31/ SEPT 1 - -OCT 31	JUNE 1 - AUG 31/ NOV 1 - MAR 31
Grounds around cooling tower	Daily	Bi-weekly
Cooling Tower Basin*	Daily	Bi-weekly
Roof of TB1/ Circ. Water Pump House	Weekly	Weekly

*The Surveyor shall walk around the circumference of the basin and net any bird mortalities within the reach of a long handle dip net.

ATTACHMENT 1

SURVEY AREA



*Note 1 - Roof of this building not required to be surveyed.

ATTACHMENT 2

BIRD IDENTIFICATION TAG

BIRD ID NO. ____

Quadrant __________

Distance from tower _________

Surveyor _________

Time _________ Date _________

*Bird ID No. will run sequentially as birds are found. The ID No. will also include the year when the bird was found. Thus, a typical Bird ID No. would be as follows:

84-007 - Represents the 7th bird found in 1984

ATTACHMENT 3

BIRD SURVEY DATA SUMMARY SHEET

Surveyor ____________________ Day __________ Date __________

Environmental Conditions:

Significant Site lighting Pattern Changes:

General Observation:

Bird ID No.	Quadrant Collected In	Distance From Tower	Bird Identification (For NL&R use only)

ATTACHMENT 4

BIRD COLLECTION LOG

Bird Id No.	Date Found	Surveyor

ATTACHMENT 6

Form SA-AP.ZZ-001-1
PROCEDURE REVIEW AND COMMENT

Procedure: Cooling Tower Bird Mortality Study	Procedure Number: OP-AP.ZZ-100(Z)	Revision: ~~0~~ 1	Pg 1 of 1

Para/ Page	Comments	Response
	No comments	

Reviewer Eileen P. Kaupe Department Rad Pro Date 9-19-85

Comment Disposition Accepted ____________ Date ______

HC 4.12

February 28, 1985

Mr. John R. Weingart, Director
New Jersey Department of Environmental Protection
Division of Coastal Resources
CN401
Trenton, New Jersey 08625

Dear Mr. Weingart:

HOPE CREEK GENERATING STATION
CAFRA PERMIT 74-014
COOLING TOWER BIRD MORTALITY SURVEY
1984 ANNUAL REPORT

Enclosed please find a copy of a report entitled "The Cooling Tower Bird Mortality Survey," for 1984. Such a report is required by Condition 17 of the subject CAFRA permit.

Please feel free to call Mr. Ken Strait at (609)935-7400, extension 2541, if you have any questions regarding the report.

Very truly yours,

J. A. Shissias
General Manager -
Environmental Affairs

AWH:cag
Enclosure

BC General Manager - Nuclear Assurance and Regulation
Manager - Licensing and Analysis
Manager - Environmental Licensing
A. W. Hanna
K. A. Strait
CARMS X

M P85 48/05

ATTACHMENT 1

TABLE 1
HOPE CREEK GENERATING STATION
COOLING TOWER BIRD MORTALITIES

Bird ID No.	Date Collected	Quadrant Collected In	Climatic Conditions	Distance From Tower	Bird Identification
84-001	8-10-84	SW	Hot, Hazy	1 ft.	Clapper rail (Rallus longirostris)
84-002	9-17-84	SE	Clear, Warm	10 ft.	White-eyed vireo (Vireo griseus)
84-003	9-17-84	SE	Clear, Warm	10 ft.	Red-eyed vireo (Vireo olivaceus)
84-004	9-17-84	SE	Clear, Warm	10 ft.	White-eyed vireo (Vireo griseus)
84-005	9-17-84	SE	Clear, Warm	180 ft.	Sora rail (Porzna carolina)
94-006	10-14-84	NE	Partly Cloudy	Inside Basin	Common flicker (Coloptes auratus)
94-007	11-01-84	SW	Sunny, Cool	Inside Basin	Clapper rail (Rallus longirostris)

NOTE: All bird mortalities were collected during daily morning searches of the area surrounding the cooling tower and tower. Collisions are assumed to have occurred during the previous night.

M P85 48/05 2-cag

#c 4.12

PSE&G

80 Park Plaza Newark, NJ 07101 / 201 430-[illegible] MAILING ADDRESS / P.O. Box 570, Newark, NJ 07101

James A. Shissias General Manager
Environmental Affairs

January 24, 1986

JoAnn Frier-Murza, Program Manager
New Jersey Department of Environmental Protection
Division of Fish, Game and Wildlife
Endangered and Nongame Program
CN-400
Trenton, NJ 08625

Dear Mrs. Frier-Murza:

HOPE CREEK GENERATING STATION
COOLING TOWER BIRD MORTALITY SURVEY
SPECIAL PURPOSE SALVAGE PERMIT
1985 ANNUAL REPORT

As required under NJDEP CAFRA Permit No. 74-014, issued for Hope Creek Generating Station, PSE&G must monitor bird mortality due to collision with the cooling tower. The Special Purpose Salvage Permit issued for this activity by the NJDEP in conjunction with USFWS Permit No. PRT-675696 requires that an annual report be submitted to both the USFWS and the NJ Division of Fish, Game and Wildlife.

The attached table summarizes bird mortalities collected during 1985 and is submitted in fulfillment of the NJDEP permit requirement. Also enclosed is a copy of the annual report submitted to the USFWS.

If you have any questions concerning this matter, please contact Ken Strait at (609) 935-7400 extension 2488.

Very truly yours,

ORIGINAL SIGNED BY:
James A. Shissias
General Manager - Environmental Affairs

James A. Shissias
General Manager -
Environmental Affairs

BAP

KAS

KAS/dez
Attachment/Enclosure

The Energy People

BC General Manager - Nuclear Licensing and Reliability
Manager - Licensing and Regulation
Operations Manager - Hope Creek
M.E. Rogers
J.H. Balletto
J.M. Eggers
K.A. Strait

4/kas/8 1/23/86

TABLE 1
HOPE CREEK GENERATING STATION
COOLING TOWER BIRD MORTALITIES

BIRD ID NO.	DATE COLLECTED	QUADRANT COLLECTED IN	CLIMATIC CONDITIONS	DISTANCE FROM TOWER	BIRD IDENTIFICATION
85-01	2/5/85	SW	Cloudy, Cold	200 ft.	Yellow-throat (Geothlypis trichas)
85-02	4/12/85	NW	Clear, Mild	100 ft.	Yellow-billed cuckoo (Coccyzus americanus)
85-03	4/20/85	SE	Clear, Warm	10 ft.	Clapper rail (Rallus longirostris)
85-04	4/20/85	SE	Clear, Warm	10 ft.	Common flicker (Colaptes auratus)
85-05	4/20/85	S	Clear, Warm	15 ft.	Clapper rail (Rallus longirostris)
85-06	5/13/85	NW	Mostly Sunny, Warm	100 ft.	Clapper rail (Rallus longirostris)
85-07	6/18/85	SW	Cloudy, Warm	3 ft.	Barn owl (Tyto alba)
85-08	7/17/85	NW	Sunny, Hot	1 ft.	Least bittern (Ixobrychus exilis)
85-09	8/16/85	SW	Clear, Hot	600 ft.	Clapper rail (Rallus longirostris)
85-10*	-	-	-	-	Red-eyed vireo (Vireo olivaceus)
85-11*	-	-	-	-	Red-eyed vireo (Vireo olivaceus)

Note: All bird mortalities were collected during daily morning searches of the area surrounding the cooling tower. Collisions are assumed to have occurred during the previous night.

*No data available

Form Approved
Budget Bureau No. 42-R324.5

U.S. Fish and Wildlife Service

REPORT OF MIGRATORY BIRDS SALVAGED

Calendar Year 19 85

Permit Number: ____________

[illegible] -12/31/[illegible]
KENNETH STRAIT
PUBLIC SER.. ELECTRIC GAS CO.
[illegible]
NEWARK [illegible]

Permit regulations (50 CFR 21) require you to submit a report of operations ON OR BEFORE JANUARY 31 of each calendar year or whenever requested. Failure to comply is cause for revoking your permit. Please complete the report form below by listing the migratory birds, their nests or eggs taken under your permit during the calendar year. Indicate "NONE" if no activities were conducted. NOTE: Persons reporting their depredation permit activities only use "Common Name" and "Bird" columns. Mail completed form to: Special Agent in Charge, U.S. Fish and Wildlife Service.

P.O. Box 129, New Town Branch
Boston, MA 02258

Number	Common and Scientific Name	State (Where collected)	NUMBERS SALVAGED Birds	Nests	Eggs
85-01	Yellow-throat (Geothlypis trichas)	NJ	1		
85-02	Yellow-billed cuckoo (Coccyzus americanus)	NJ	1		
85-03	Clapper rail (Rallus longirostris)	NJ	1		
85-04	Common flicker (Colaptes auratus)	NJ	1		
85-05	Clapper rail (Rallus longirostris)	NJ	1		
85-06	Clapper rail (Rallus longirostris)	NJ	1		
85-07	Barn owl (Tyto alba)	NJ	1		
85-08	Least Bittern (Ixobrychus exilis)	NJ	1		
85-09	Claper rail (Rallus longirostris)	NJ	1		
85-10	Red-eyed vireo (Vireo olivaceus)	NJ	1		
85-11	Red-eyed vireo (Vireo olivaceus)	NJ	1		
Permittee's signature	Date	TOTALS...	11		

Form 3-430a
(Revised Dec 1974)

2.05.90

January 29, 1987

NLR-E87025

New Jersey Department of Environmental Protection
Division of Coastal Resources
Bureau of Planning and Project Review
CN 401
Trenton, NJ 08625

Attention: Mr. Steven C. Whitney, Chief
Bureau of Planning and Project Review

Dear Mr. Whitney:

HOPE CREEK GENERATING STATION
CAFRA PERMIT No. 74-014
COOLING TOWER BIRD MORTALITY SURVEY
ANNUAL REPORT AND MODIFICATION REQUEST

As required by NJDEP CAFRA Permit No. 74-014, Paragraph 18, PSE&G has been monitoring the mortality of birds colliding with the Hope Creek Generating Station cooling tower. The attached annual report is submitted in fulfillment of this requirement. However, based on three years of monitoring data, bird mortality due to collision with the cooling tower appears to be insignificant and PSE&G requests that this monitoring requirement be deleted from our CAFRA Permit.

Including the 1986 mortalities listed in the attached table, a total of only 30 cooling tower mortalities have been recorded at the Hope Creek Generating Station (see J.A. Shissias to J.R. Weingart, 2/28/85 and 1/24/86). No threatened or endangered species, or unusual bird species have been collected. The few mortalities recorded have been of bird species considered abundant in New Jersey.

Considering the significant effort expended by station personnel to conduct these daily surveys and the relatively few specimens collected , PSE&G believes that this monitoring requirement is no longer warranted. We therefore request a minor modification to CAFRA Permit No. 74-014 to delete Paragraph 18.

Please contact K. Strait at (609) 339-5074 if you have any questions concerning this request.

Sincerely,

ORIGINAL SIGNED BY:
James A. Shissias

J. A. [illegible] Manager - Environmental Affairs
General Manager -
Environmental Affairs

KAS/spk
Attachment

BC General Manager - Licensing and Reliability
Manager - Licensing and Regulation
Operations Manager - Hope Creek
J. H. Balletto
M. E. Rogers
J. M. Eggers
K. A. Strait
Env. Lic. File 4.12 HC

kas:031

HOPE CREEK GENERATING STATION
1986 COOLING TOWER BIRD MORTALITIES

BIRD ID NO.	DATE COLLECTED	QUADRANT COLLECTED IN	CLIMATIC CONDITIONS	DISTANCE FROM TOWER	BIRD IDENTIFICATION
86-001[a]	3/26/86	W	Sunny, Warm	200 ft.	-
86-002[b]	3/26/86	W	Sunny, Warm	200 ft.	-
86-003	3/26/86	W	Sunny, Warm	200 ft.	Clapper rail (*Rallus longirostris*)
86-004	4/2/86	E	Overcast	4 ft.	Clapper rail (*Rallus longirostris*)
86-005	4/2/86	SW	Overcast	4 ft.	Clapper rail (*Rallus longirostris*)
86-006	5/25/86	SW	Sunny, Warm	45 ft.	Clapper rail (*Rallus longirostris*)
86-007	5/25/86	S	Sunny, Warm	60 ft.	Red-eyed vireo (*Vireo olivaceus*)
86-008[c]	9/22/86	NW	Cloudy, Cool	270 ft.	Ring-billed gull (*Larvus delawarensis*)
86-009[d]	-	-	-	-	Hairy Woodpecker (*Dendrocopus villosus*)
86-010	10/29/86	SE	Cloudy, Cool	5 ft.	Common flicker (*Colaptes auratus*)
86-011[e]	10/29/86	S	Cloudy, Cool	5 ft.	Domestic pigeon (*Columba livia*)
86-012	10/29/86	W	Cloudy, Cool	5 ft.	Robin (*Turdus migratorius*)

a Unidentified partial carcass
b Unidentified partial carcass
c Probably not a tower kill
d No data available
e Non-USFWS leg band, probable carrier pigeon

NON-PSEG

State of New Jersey
DEPARTMENT OF ENVIRONMENTAL PROTECTION
TRENTON
September 10, 1987

DIVISION OF COASTAL RESOURCES

PLEASE ADDRESS REPLY TO:
CN 401
TRENTON, N.J. 08625

Public Service Electric & Gas Co.
James A. Shissias, Gen. Manager
80 Park Plaza
Newark, New Jersey 07101

RE: Coastal Permit 74-014-5
Modification in Detail
HOPE CREEK GENERATING STATION
Lower Alloways Creek Township, Salem County
C.E. File #1704-72-01

Dear Mr. Shissias:

In response to your request for two modifications to the above referenced CAFRA permit, and in accordance with the "90 Day Construction Permit Regulations", specifically N.J.A.C. 7:1C-1.5(C) and the "Coastal Permit Program Regulations", specifically N.J.A.C. 7:7-4.10, you are hereby granted a modification for the subject work as follows:

1. Delete paragraph 18 requiring bird mortality monitoring at the Hope Creek cooling tower.

2. Construct a new sewage treatment plant and an improved storm drainage collection system pursuant to specifications as presented in a December, 1986 environmental assessment - Artificial Island Master Plan submitted to the Division in support of this modification, A separate Waterfront Development Permit will be required for a proposed stormwater outfall pipe to discharge to the Delaware River.

A copy of this coastal permit modification has been appended to the original permit. All other conditions of the original permit are to remain in force.

Sincerely,

Steven C. Whitney

Steven C. Whitney, Chief
Bureau of Planning and Project Review

c: Bureau of Coastal Enforcement and Field Services
Frank Cianfrani, Chief, Phila. District ACOE

New Jersey Is An Equal Opportunity Employer

Salem/ Hope Creek Environmental Audit – Audit Questions

Question #: ENV-99 **Category:** Ecology

Statement of Question: March 2009 Letter regarding Geiger Screens

Response: PSEG Nuclear believes that the NRC intended to request a letter regarding Geiger Screens that is dated October 2008 based on the recollection of the PSEB Subject Matter Expert to whom the request was originally made during the Salem and Hope Creek License Renewal environmental site audit, and because no March 2009 letter on the topic of Geiger Screens could be found. A copy of the October 2008 Letter regarding Geiger Screens is being provided.

List Attachments Provided:

1. Letter from PSEG (K. Strait) to NJDEP(P. Patterson) regarding Salem Generating Station NJPDES Permit No. NJ0005622 Circulating Water Intake Screen Pilot Testing Extension to Multidisc™ Rotary Screen Test Period. October 8, 2008.

Environment, Health and Safety
P.O. Box 236, N33, Hancocks Bridge, NJ 08038-0236

PSEG
Services Corporation

CERTIFIED MAIL

October 8, 2008
EEP08103

Pilar Patterson, Chief
Bureau of Point Source Permitting - Region 2
New Jersey Department of Environmental Protection
410 East State Street, CN-029
Trenton, NJ 08625-029

Dear Ms. Patterson:

SALEM GENERATING STATION NJPDES PERMIT NO. NJ0005622
CIRCULATING WATER INTAKE SCREEN PILOT TESTING
EXTENSION TO MULTIDISC™ ROTARY SCREEN TEST PERIOD

As acknowledged by your letter of July 13, 2006, PSEG Nuclear, LLC ("PSEG Nuclear"), has installed and is conducting pilot testing of modifications to one of the existing traveling screens in the Salem Generating Station ("Salem") circulating water intake structure. The modifications being tested were intended to improve the capabilities of the circulating water system to handle the high detrital load present during certain periods of the year and also show potential for maintaining or improving the current impingement survival rates. Pilot testing involves adapting to new data and information, and PSEG Nuclear notified the New Jersey Department of Environmental Protection ("Department") concerning some changes to the pilot screen that were necessary to handle the specific type of debris present at Salem (J. Pantazes to P. Patterson, 02/26/07). PSEG Nuclear made the identified changes to the pilot traveling screen and initiated biological testing in June 2007. Preliminary results from biological testing are positive; however, the pilot rotary screen was still unable to handle the high river detritus levels present in the Delaware River last fall and winter. PSEG Nuclear now intends to further modify the pilot traveling screen to improve detritus handling capabilities and conduct additional pilot testing for a full evaluation of this promising intake technology.

Although the MultiDisc™ Rotary Screen system has been successfully demonstrated to remove debris at other cooling water intake structures, the quantity and type of debris present in the Delaware Bay creates some unique challenges. As indicated in Figure 1, the density of river detritus experienced at Salem can exceed 100,000 $kg/10^6 m^3$. The traveling screens at the circulating water intake are removing over 53 tons/hr of detritus at these peak levels. To improve debris handling capability and allow continued operation of the rotary screen and the fish return system during these episodic events, the manufacturer has recommended installation of: a larger motor, gearbox, and variable frequency drive; a new screen drive chain with upgraded materials; an improved control system with data acquisition and improved operator interface; and replacement of the drilled plastic plate screen panels with new panels having 9.5 mm holes (current panels have 8 mm holes). The increased chain speed will reduce the average blockage of the screen panels. Faster rotation will also reduce through-screen velocity and the length of time impinged fish remain within the fish buckets, which should have positive effects on fish survival. PSEG Nuclear will incorporate these modifications this fall/winter and test the additional modifications for up to two years to encompass the full range of river detritus levels.

As indicated above, PSEG Nuclear was able to conduct some biological testing of the currently installed MultiDisc™ rotary screen, even though it experienced operational problems due to debris loading. Impingement samples to collect specimens for latent impingement mortality (LIM) observations were taken during 28 collection events in July through December, 2007. In these samples, a total of 2,989 individuals were collected representing eleven of the twelve Salem target species. Atlantic menhaden was not collected (**Table 1**). **Tables 2** and **3** compare estimated latent impingement mortality values for the current modified-ristroph screens and the rotary screen. Based on this preliminary data, latent impingement mortality values for the rotary screen appear slightly higher than for the ristroph screen; however, because the rotary screen has a different mesh size than the ristroph screens, an analysis of overall effects must also account for changes in entrainment.

In anticipation of a potential shift in the impingement and entrainment length-frequency distribution, PSEG Nuclear also collected paired entrainment samples from behind a ristroph screen and the rotary screen during June through December, 2007 (**Table 4**). Examination of standardized cumulative length-frequency distributions for these entrained organisms indicates that there is an overall tendency for the rotary screen to retain Atlantic croaker (*Micropogonias undulatus*), bay anchovy (*Anchoa mitchilli*), and striped bass (*Morone saxatilis*) at a smaller size, i.e., shift the length-frequency distribution to the left. These differences are statistically significant. **Figure 2** illustrates this shift in length-frequency distribution for bay anchovy. Differences between the ristroph and rotary screen are not apparent for naked goby (*Gobiosoma bosc*), Atlantic menhaden (*Brevoortia tyrannus*), and weakfish (*Cynoscion regalis*). For naked goby, this is likely due to the overall small size of the specimens. Nearly all pass through both screens and, thus, are entrained. The opposite is likely true for menhaden and weakfish. The average size is large enough that nearly all are impinged regardless of the screen type.

In order to estimate expected entrainment losses associated with installed rotary screens using the extensive data collected with a standard ristroph screen, transfer factors were computed for each species for each 1 mm length class using the ratio of concentrations behind the rotary screen to concentrations behind a ristroph screen. To smooth out some of the variability, a three point moving average was applied to the individual ratios. **Table 5** shows the transfer factors used to convert entrainment concentrations measured behind a ristroph screen to those expected for the rotary screen. As indicated in Table 5, the transfer factor for the rotary screen is less than one for most species and most lengths, indicating that fewer organisms will be entrained (and more impinged) by the rotary screen.

By applying the transfer factor to entrainment concentrations measured behind the ristroph screens and applying the measured rotary screen LIM values to impinged organisms, PSEG Nuclear is able to estimate the combined impingement and entrainment losses for an overall comparison of a ristroph screen to the rotary screen.

For a meaningful comparison of combined impingement and entrainment losses, PSEG Nuclear used the documented impingement and entrainment densities supporting the Salem 2006 Permit Renewal Application and converted the estimated losses to biomass using a Production Foregone Model. The expected entrainment and impingement losses were computed following the methods described in Section 4-IV-H (entrainment numbers), Section 4-IV-G (impingement numbers), and Section 7, Attachment 7-1 of the Salem NJPDES 2006 Permit Renewal Application. Life history parameters for the models can be found in Section 5, Attachment 4 of the same Permit Application. The expected entrainment and impingement losses were computed for only one traveling screen in this instance, versus the multiple screens computed in the Permit Application.

For both the ristroph and rotary screen, the "Proposed Operating Scenario" described in the Permit Application was run using data from 2002 through 2004. The ristroph entrainment and impingement data from 2002-2004 were used to calculate the expected rotary screen concentrations using the transfer factors described above.

The projected difference in biomass lost due to impingement and entrainment (with entrainment survival) through the ristroph and rotary screens is shown in **Table 6**. For the ristroph screen, the total combined biomass loss (production foregone and the biomass on the date of loss) was 1.32, 0.12, and 0.10 $\times 10^6$ lbs for 2002, 2003 and 2004, respectively, with an average of 0.52 $\times 10^6$ lbs for 2002-2004. For the rotary screen the total estimated combined biomass loss would have been 1.25, 0.13, and 0.10 $\times 10^6$ lbs for 2002, 2003 and 2004, respectively, with an average of 0.49 $\times 10^6$ lbs for 2002-2004. Based on these preliminary results, the average combined biomass loss (with entrainment survival) through the rotary screen would be 21,270 lbs (4.1 %) less than through the ristroph screen[1].

[1] *As discussed in the Salem 2006 Permit Renewal Application*, NJDEP has considered entrainment survival in its historical §316(b) determinations and has recognized that some organisms survive entrainment at the Station. In this instance, the assumption of 100% entrainment mortality results in a greater estimated reduction in the average combined biomass loss through the rotary screen than through the ristroph screen (51,057 lbs; 6.4 %).

These preliminary results are based on six months of sampling and include assumptions about organism and life stage survival during non-sampled months, but do provide an indication that the pilot rotary screen may provide an alternative to the current ristroph screens that can improve debris handling capabilities and maintain, or improve, the current combined entrainment and impingement survival rates. Continued biological testing of the pilot rotary screen is required to provide a more comprehensive comparison.

PSEG Nuclear will continue conducting biological testing of these pilot modifications as referenced in your July 13, 2006 acknowledgement letter after installation of the further modifications to the pilot rotary screen and; as previously committed, will provide the Department with a comprehensive report on the pilot testing by mid-2011.

Testing of the MultiDisc™ Rotary Screens with a fish return system will provide biological data that has potential industry-wide application and PSEG appreciates the Department's support of this important research.

Should you have any questions on this matter, please feel free to contact me at (856) 878-6929.

Sincerely,

K A Strait

Kenneth A. Strait
Manager-Biological Programs

C S. Rosenwinkel, NJDEP
J. Joseph, NJDEP

Table 1. Monthly and aggregate number and 48-hour latent impingement mortality of Salem target species collected and tested during 2007

Species		Jul	Aug	Sep	Oct	Nov	Dec	Total
Blueback herring								
	No. tested			1		131	3	135
	% Mortality			**100.0**		**96.9**	**100.0**	**97**
Alewife								
	No. tested		1			9		10
	% Mortality		**100.0**			**100.0**		**100.0**
American shad								
	No. tested	8	6	3	33	62	6	118
	% Mortality	**100.0**	**100.0**	**100.0**	**90.9**	**91.9**	**100.0**	**93.2**
Bay anchovy								
	No. tested	3	1	58	226	487	13	788
	% Mortality	**100.0**	**100.0**	**98.3**	**98.7**	**95.3**	**92.3**	**96.4**
Atlantic silverside								
	No. tested			9	19	36	16	80
	% Mortality			**55.6**	**21.1**	**25.0**	**18.8**	**26.3**
Bluefish								
	No. tested	1	8	1	3	1		14
	% Mortality	**0.0**	**37.5**	**100.0**	**0.0**	**0.0**		**28.6**
White perch								
	No. tested		1	2	1	283	294	581
	% Mortality		**100.0**	**0.0**	**100.0**	**2.8**	**3.4**	**3.4**
Striped bass								
	No. tested	2	2	1	2	31	38	76
	% Mortality	**0.0**	**0.0**	**100.0**	**0.0**	**0.0**	**5.3**	**4.0**
Weakfish								
	No. tested	59	104	237	34	3		437
	% Mortality	**88.0**	**44.2**	**59.5**	**35.3**	**0**		**57.2**
Spot								
	No. tested		4		2	4		10
	% Mortality		**0.0**		**0.0**	**0.0**		**0.0**
Atlantic croaker								
	No. tested			3	109	155	473	740
	% Mortality			**33.3**	**16.5**	**37.4**	**29.2**	**29.1**

Table 2. Latent Impingement Mortality Values for Standard Ristroph Screens (from Salem NJPDES 2006 Permit Renewal Application)

Species	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Alosids	0.081	0.083	0.139	0.209	0.512	0.715	0.808	0.813	0.725	0.538	0.299	0.131
Atlantic Croaker	0.171	0.217	0.218	0.433	0.302	0.282	0.106	0.377	0.157	0.019	0.013	0.076
Bay Anchovy	0.022	0.024	0.620	0.465	0.491	0.716	0.907	0.963	0.947	0.223	0.232	0.046
Spot	0.233	0.279	0.450	0.749	0.611	0.469	0.252	0.135	0.090	0.083	0.045	0.220
Striped Bass	0.000	0.000	0.001	0.002	0.002	0.013	0.339	0.132	0.190	0.020	0.000	0.011
Weakfish	1.000	1.000	0.033	0.147	0.035	0.559	0.624	0.538	0.186	0.191	0.009	0.009
White Perch	0.063	0.007	0.012	0.043	0.318	0.235	0.340	0.125	0.059	0.036	0.017	0.018

Table 3. Latent Impingement Mortality Values for the Rotary Screen

	(No 2007 testing)						(Based on 2007 Sampling Results)					
Species	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**
Alosids*	0.081	0.083	0.139	0.209	0.512	0.715	0.808	0.813	0.725	**0.909**	**0.955**	0.131
Atlantic Croaker	0.171	0.217	0.218	0.433	0.302	0.282	0.106	0.377	0.157	**0.165**	**0.374**	**0.292**
Bay Anchovy	0.022	0.024	0.620	0.465	0.491	0.716	0.907	0.963	**0.983**	**0.987**	**0.953**	**0.923**
Spot	0.233	0.279	0.450	0.749	0.611	0.469	0.252	0.135	0.090	0.083	0.045	0.220
Striped Bass	0.000	0.000	0.001	0.002	0.002	0.013	0.339	0.132	0.190	0.020	**0.000**	**0.053**
Weakfish	1.000	1.000	0.033	0.147	0.035	0.559	**0.881**	**0.442**	**0.595**	**0.353**	0.009	0.009
White Perch	0.063	0.007	0.012	0.043	0.318	0.235	0.340	0.125	0.059	0.036	**0.028**	**0.034**

* Includes results from American shad, blueback herring, and alewife.

Note: **Values in bold are calculated from 2007 Geiger screen survival studies**, non-bold values are from the 2006 Permit Renewal Application (Table 2 above).

Table 4. Annual summary of finfish species, number collected, and percent composition within lifestage, taken in paired Ristroph and Rotary Screen entrainment abundance collections at the Salem Generating Station Circulating Water Intake Structure, during June 4th through December 27, 2007

Number of Samples: Ristroph = 228, Rotary = 228						
Total volume filtered (cubic meters): Ristroph = 11,650, Rotary = 11,690						
Lifestage	Common name	Scientific name	Ristroph No. Collected	Rotary No. Collected	Ristroph Percent Composition	Rotary Percent Composition
Fish Eggs	Bay anchovy	Anchoa mitchilli	38,954	31,412	99.9	99.9
	Rough silverside	*Membras martinica*	5	9	< 0.1	< 0.1
	Atlantic silverside	*Menidia menidia*		3		< 0.1
	Weakfish	*Cynoscion regalis*	34	9	0.1	< 0.1
Fish	Unidentifiable sp.		1		< 0.1	
	American eel	*Anguilla rostrata*		1		< 0.1
	River herring	*Alosa* sp.		1		< 0.1
	Atlantic menhaden	*Brevoortia tyrannus*	109	76	0.8	0.7
	Bay anchovy	*Anchoa mitchilli*	4,514	3,607	31.2	31.8
	Unidentified minnow	*Cyprinidae*		1		0.0
	Unidentified topminnow	*Fundulus* spp.		2		0.0
	Inland/Atlantic silverside	*Menidia* spp.	45	17	0.3	0.2
	Atlantic silverside	*Menidia menidia*	6	4	< 0.1	< 0.1
	Northern pipefish	*Syngnathus fuscus*	6	5	< 0.1	< 0.1
	White perch	*Morone americana*	1	1	< 0.1	< 0.1
	Striped bass	*Morone saxatilis*	2,918	1,500	20.2	13.2
	Weakfish	*Cynoscion regalis*	284	202	2.0	1.8
	Silver perch	*Bairdiella chrysoura*	1	3	< 0.1	< 0.1
	Spot	*Leiostomus xanthurus*	1	1	< 0.1	< 0.1
	Atlantic croaker	*Micropogonias undulatus*	1,340	1,241	9.3	11.0
	Black drum	*Pogonias cromis*	2		< 0.1	
	Naked goby	*Gobiosoma bosc*	5,196	4,648	36.0	41.0
	Green goby	*Microgobius thalassinus*	1		< 0.1	
	Summer flounder	*Paralichthys dentatus*	10	6	0.1	0.1
	Hogchoker	*Trinectes maculatus*	10	9	0.1	0.1
Summary	Fish Eggs		38,993	31,433		
	Fish		14,445	11,325		

Table 5. Transfer Factors for converting entrainment concentrations from Ristroph to Rotary screens (Shaded cells indicate interpolated values.)

							Average of Atlantic Menhaden and Bay anchovy			Atl. Croaker Striped Bass & Weakfish
	Atlantic Croaker	Atlantic Menhaden	Bay Anchovy	Naked Goby	Striped Bass	Weakfish	American Shad	Alewife	Blueback Herring	Other Species
2	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
3	0.982	0.970	1.004	0.911	0.954	0.943	0.987	0.987	0.987	0.960
4	0.965	0.941	1.007	0.822	0.907	0.886	0.974	0.974	0.974	0.919
5	0.947	0.911	1.230	0.781	0.861	0.829	1.071	1.071	1.071	0.879
6	0.929	0.882	1.148	0.812	0.815	0.773	1.015	1.015	1.015	0.839
7	0.912	0.852	1.097	0.885	0.768	0.727	0.975	0.975	0.975	0.802
8	0.894	0.823	0.980	0.881	0.722	0.734	0.902	0.902	0.902	0.783
9	0.876	0.793	0.854	0.856	0.676	0.649	0.824	0.824	0.824	0.734
10	0.859	0.764	0.791	0.904	0.629	0.690	0.777	0.777	0.777	0.726
11	0.841	0.734	0.859	1.099	0.583	0.678	0.797	0.797	0.797	0.701
12	0.823	0.705	0.891	1.095	0.609	0.938	0.798	0.798	0.798	0.790
13	1.010	0.675	0.809	1.091	0.601	0.922	0.742	0.742	0.742	0.844
14	1.150	0.646	0.813	1.087	0.509	0.897	0.729	0.729	0.729	0.852
15	1.135	0.616	0.839	1.083	0.452	0.902	0.728	0.728	0.728	0.830
16	1.023	0.587	0.836	1.078	0.357	0.907	0.712	0.712	0.712	0.763
17	1.046	0.557	0.786	1.074	0.417	0.912	0.672	0.672	0.672	0.792
18	1.077	0.528	0.718	1.070	0.499	0.917	0.623	0.623	0.623	0.831
19	1.162	0.498	0.661	1.066	0.439	0.922	0.579	0.579	0.579	0.841
20	0.944	0.791	0.568	1.062	0.344	0.927	0.679	0.679	0.679	0.738
21	0.846	0.776	0.494	1.058	0.228	0.932	0.635	0.635	0.635	0.669
22	0.899	0.846	0.392	1.054	0.342	0.937	0.619	0.619	0.619	0.726
23	0.900	0.553	0.350	1.050	0.358	0.941	0.452	0.452	0.452	0.733
24	0.823	0.727	0.303	1.045	0.412	0.946	0.515	0.515	0.515	0.727
25	0.844	0.752	0.367	1.041	0.465	0.951	0.559	0.559	0.559	0.753
26	0.774	0.777	0.430	1.037	0.519	0.956	0.603	0.603	0.603	0.750
27	1.029	0.801	0.493	1.033	0.572	0.961	0.647	0.647	0.647	0.854
28	0.790	0.826	0.557	1.029	0.626	0.966	0.691	0.691	0.691	0.794
29	0.725	0.851	0.620	1.025	0.679	0.971	0.736	0.736	0.736	0.792
30	0.771	0.876	0.683	1.021	0.733	0.976	0.780	0.780	0.780	0.826
31	0.817	0.901	0.747	1.017	0.786	0.980	0.824	0.824	0.824	0.861
32	0.863	0.926	0.810	1.012	0.840	0.985	0.868	0.868	0.868	0.896
33	0.908	0.950	0.873	1.008	0.893	0.990	0.912	0.912	0.912	0.931
34	0.954	0.975	0.937	1.004	0.947	0.995	0.956	0.956	0.956	0.965
35	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Table 6. Comparison of Projected Biomass Lost due to Entrainment (with entrainment survival) and Impingement for Ristroph and Rotary Screens

		Entrainment			Impingement			Combined
Scenario	Year	Production Foregone (lbs)	Biomass on Date of Loss (lbs)	Total (lbs)	Production Foregone (lbs)	Biomass on Date of Loss (lbs)	Total (lbs)	Total (lbs)
Ristroph screen								
	2002	1,239,980	20,088	1,260,068	53,014	5,403	58,417	1,318,485
	2003	112,779	4,976	117,755	3,915	3,125	7,040	124,795
	2004	88,376	5,115	93,491	5,647	4,713	10,360	103,851
	Average	480,378	10,060	490,438	20,859	4,414	25,272	**515,710**
Rotary Screen								
	2002	1,098,805	17,816	1,116,621	130,854	7,243	138,097	1,254,718
	2003	102,860	4,400	107,260	14,472	5,192	19,664	126,924
	2004	76,498	4,586	81,084	14,494	6,100	20,594	101,678
	Average	426,054	8,934	434,988	52,273	6,178	59,452	**494,440**

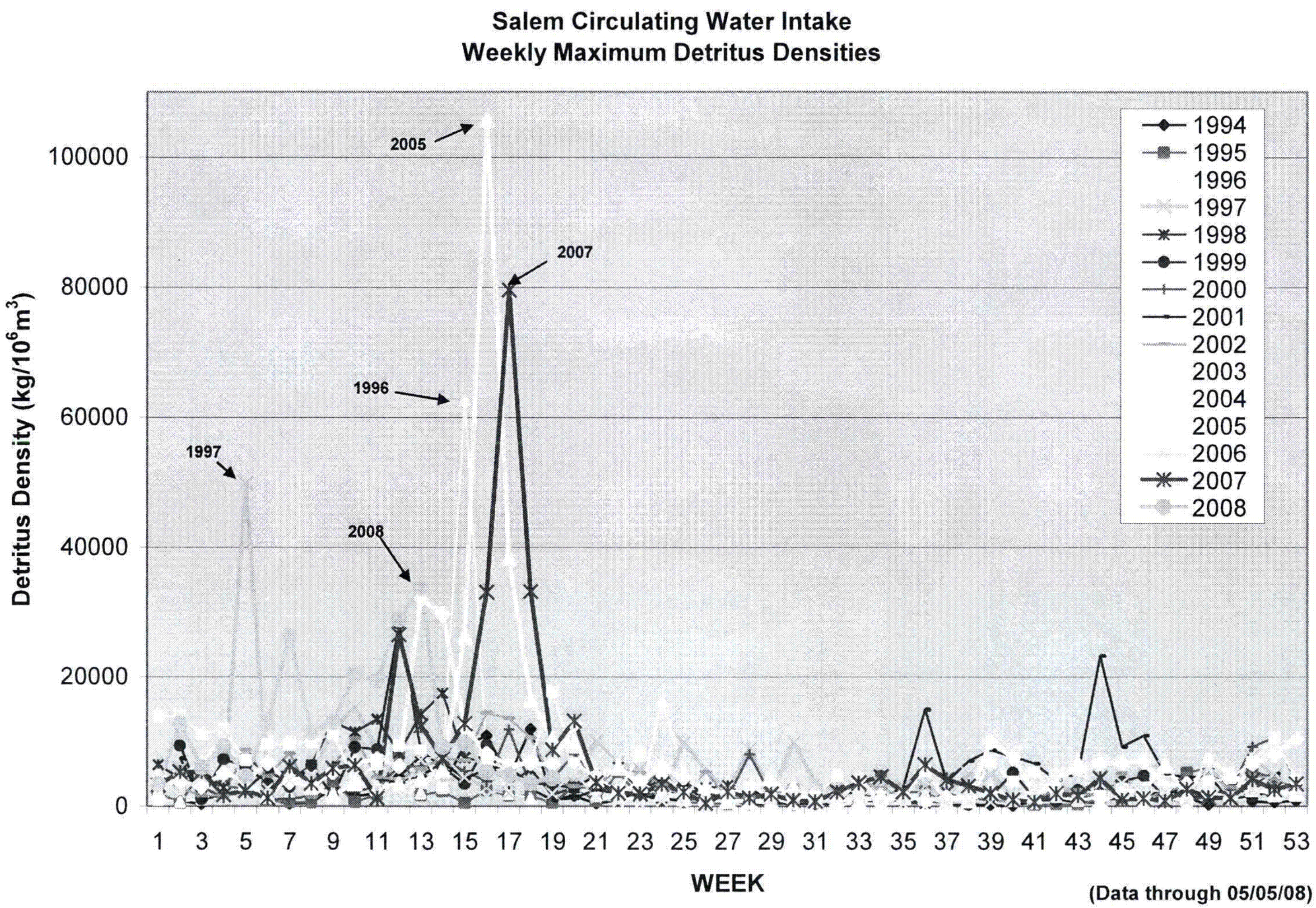


Figure 1. Weekly maximum river detritus density measured during impingement sampling at the Salem Circulating Water Intake Structure (1994-2008).

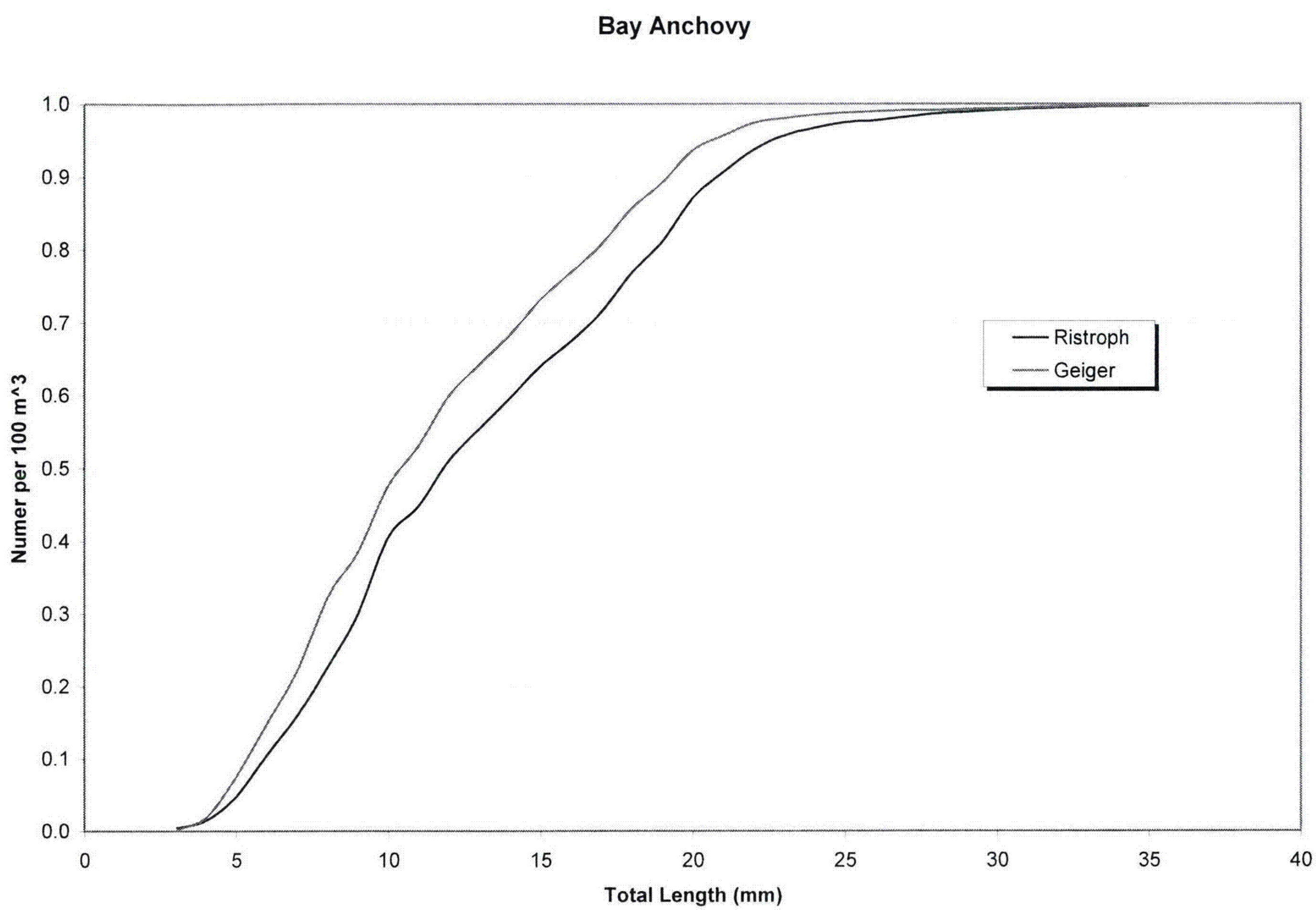


Figure 2. Comparison of bay anchovy standardized cumulative length frequency distributions for impinged fish with Ristroph and Rotary(Geiger) screens in place.

Salem/ Hope Creek Environmental Audit – Post-Audit Information

Question #: ENV-100 **Category:** Ecology

Statement of Question: Please provide the following documents that were made available during the Salem and HCGS License Renewal Environmental Audit.

PSEG comments on 2000 Draft [Salem] NJPDES permit

Response: The document requested is being provided.

List Attachments Provided:

PSEG Nuclear, LLC. "Comments on Draft NJPDES Permit No. NJ0005622, Salem Generating Station." Enclosure to Letter from PSEG (M. Vaskis) to NJDEP (D. Hammond). March 14, 2001.

Table of Contents

Maureen F. Vaskis
Associate General Environmental Counsel

Office of Environmental Counsel
80 Park Plaza T5J Newark NJ [illegible]

March 14, 2001

PSEG
Services Corporation

VIA FEDERAL EXPRESS

Ms. Debra Hammond, Chief
Bureau of Point Source Permitting
Division of Water Quality Region 2
New Jersey Department of Environmental Protection
CN-029
401 E. State Street, 2nd Floor
Trenton, NJ 08625

Re: PSEG Nuclear LLC's Comments
Draft NJPDES Permit No. NJ0005622
Salem Generating Station

Dear Ms. Hammond:

Pursuant to the Public Notice dated December 8, 2000, PSEG Nuclear LLC ("PSEG") submits herewith its Comments on Draft NJPDES Permit No. NJ0005622 (the "Draft Permit") for the Salem Generating Station.

These comments are organized in five parts: Part One is entitled memorandum in support of permit issuance; Part Two is entitled "PSEG's Specific Comments on Draft Permit Terms and Conditions and Fact Sheet;" Part Three is entitled "PSEG's Response to the ESSA Report;" Part Four is a series of Attachments that support Parts One – Three of the Comments; and Part Five includes documents referenced in Parts One through Three of the Comments. Parts One through Four are enclosed herewith. Part Five is being submitted this date under separate cover.

If you have any questions or desire further information, please do not hesitate to call me.

Very truly yours,

Maureen F. Vaskis

Maureen F. Vaskis

Enclosures

cc: E. B. Balint, DAG (w/enclosures)
S. T. Rosenwinkel (w/enclosures

Memorandum

MEMORANDUM
IN SUPPORT OF ISSUANCE
OF NJPDES PERMIT NO. NJ 0005622

PSEG NUCLEAR, LLC.

March 14, 2000

I. INTRODUCTION AND SUMMARY

A. Introduction

On December 8, 2000 the New Jersey Department of Environmental Protection ("Department" or "NJDEP") issued a draft of a permit ("Draft Permit") to renew the current New Jersey Pollutant Discharge Elimination System ("NJPDES") Permit for the Salem Generating Station ("Salem" or the "Station"), NJPDES No. NJ0005622, issued in July 1994, effective September 1, 1994 ("Salem Permit" or "Permit" or "1994 Permit"). PSEG, on March 4, 1999, timely filed a Permit Renewal Application ("Application") for renewal of the 1994 Permit, which by virtue of law remains in effect pending the Department's final determination on the Application. The Draft Permit would renew the 1994 Permit and continue its essential elements, with certain changes and additions. The Department issued a Fact Sheet ("FS") for the Draft Permit, accompanied by a Report on the Application prepared by ESSA Technologies, Inc. ("ESSA"). The Department provided for an 82-day public comment period (later extended for an additional 14 days) and two public hearings on the Draft Permit.

The Draft Permit proposes effluent limitations applicable to the Station's outfalls and special conditions pursuant to Sections 316(a) and 316(b) of the Clean Water Act ("CWA"). It proposes to: authorize the continued operation of the Station with the existing once through cooling water system; renew the Station's Section 316(a) variance; require, as "best technology available" under Section 316(b), additional studies of certain intake technology measures to evaluate their potential for application at Salem; continue the implementation of the wetlands restoration and preservation program and fish ladder measures adopted in the 1994 Permit; require PSEG to conduct an enhanced biological monitoring program; and require PSEG to provide, in any future renewal application, estimates of the increased production of fish from the wetlands restoration and fish ladder measures, expressed in common units of biomass as the losses at the Salem intake.

PSEG's Comments, include this Legal Memorandum (Part One), PSEG's Specific Comments on Draft Permit Terms and Conditions and Fact Sheet ("Specific Comments") (Part Two), PSEG's Response to the ESSA Report ("Response to ESSA") (Part Three), and various attachments which support Parts One – Three (Part Four) and references (Part Five).[1] Subsection B of this section of the Comments summarizes the basic reasons why the Draft Permit should be adopted. Subsection C reviews the basic provisions of the Draft Permit, which are fully supported by the NJDEP's FS determinations and should be adopted. Section D discusses comments on the Application and/or the Draft Permit by certain third party commenters and/or ESSA. These criticisms are without merit and do not provide any valid

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1 As a result of the recent deregulation of the electric utility industry in New Jersey, Public Service Electric and Gas Company ("PSE&G") was required to transfer all of its electric generating assets to non-regulated subsidiaries of PSE&G's parent, Public Service Enterprise Group. All nuclear-related generating assets were transferred to PSEG Nuclear, LLC. PSE&G and PSEG are referred to herein interchangeably as PSEG.

reasons for not issuing the Draft Permit. Subsection E presents an outline of the remainder of the Comments and a brief conclusion.

B. The Draft Permit Wisely Continues The Successful Environmental Protection Strategy Adopted In The 1994 Permit and Should Be Issued

The Department should issue the Draft Permit with certain modifications discussed below.[2] Its provisions find ample support in the voluminous administrative record and the Department's FS determinations. The Draft Permit provisions represent sound environmental regulatory policy. By continuing and extending the basic regulatory strategy adopted by NJDEP in the 1994 Permit, these provisions will ensure continuing and expanded protection of the aquatic resources of the Estuary and other important environmental benefits.

The Draft Permit provisions include three key components:

- Intake Technologies to Protect Fish. Because the Department has properly determined that there are at present no additional fish protection technologies that represent "best technology available" under Section 316(b) for adoption at the Salem intake, the Draft Permit proposes to require PSEG to conduct further studies of potential intake technologies and improvements for adoption at Salem.

- Conservation Measures. The Draft Permit proposes the continued implementation by PSEG of conservation measures - a wetlands restoration and preservation program of unprecedented scope and fish ladders - that will increase the production of fish in the Estuary and generate a wide range of other environmental benefits for the public.

- Biological Monitoring. The Draft Permit proposes to require PSEG to conduct an expanded biological monitoring program that would develop additional information on and enhance understanding of the environmental effects of Salem's operation and the environmental benefits provided by the conservation measures.

These same three basic components are found in the 1994 Permit, where NJDEP, with the blessing of the United States Environmental Protection Agency ("USEPA"), decided against a proposal for retrofit of cooling towers at Salem, that would have involved enormous costs for comparatively small environmental benefit, in favor of environmentally and economic superior alternatives proposed by PSEG. These alternatives consisted of intake screen improvements and studies of additional intake technologies (sound deterrents) for potential application at Salem; marsh restoration and preservation and fish ladder installation; and a comprehensive biological monitoring program. In return, PSEG dropped its legal challenges to NJDEP's proposed adoption of cooling tower retrofit.

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2 Part Two, Specific Comments.

Experience has confirmed the wisdom of the course that NJDEP set in 1994, which it proposes to continue through the Draft Permit. As NJDEP has determined, the intake screen improvements implemented by PSEG pursuant to the 1994 Permit have significantly reduced losses at the intake. Also, the technology studies conducted by PSEG show that sound deterrents have promise for further potential application at Salem. FS page 4. The marsh restoration and fish ladder measures are providing substantial benefits for the fish and other populations of the Estuary and other important environmental benefits. FS page 5. PSEG has successfully implemented an extensive comprehensive biological monitoring program that has generated an enormous amount of new and valuable information on the environmental effects of Salem's operation and the conservation measures. FS page 5.

The Draft Permit continues and builds on the successful three-pronged strategy adopted by NJDEP in 1994 and implemented by PSEG in the years since. As shown below, the Draft Permit provisions, which are fully supported by the administrative record, will ensure expanded protection of the fish populations and other resources of the Estuary and appropriately minimize the potential for any adverse impact from the Salem intake. Accordingly, NJDEP should adopt the Draft Permit with modifications proposed by PSEG.

C. The Draft Permit Provisions are Fully Supported by the Extensive Administrative Record and the Department's Fact Sheet Determinations

The essential provisions of the Draft Permit are fully supported by the abundant administrative record and by the FS determinations made by NJDEP.

The record includes the enormous amount of information and extensive analysis provided in the Application regarding Salem's circulating water system ("CWS") and its environmental effects; the intake screen improvements and sound deterrent studies implemented by PSEG; other intake technologies and fish protection measures potentially available for adoption at Salem; and the wetlands restoration and preservation measures and fish ladder installations implemented by PSEG and their environmental benefits. The Application represents one of the most thorough and detailed assessments of a cooling water system and its effects ever undertaken. A multi-disciplinary team of over 25 experts, who are recognized leaders in their fields conducted the studies and evaluations presented in the Application. Their work draws on many different data sources, pursues multiple, independent lines of analysis and evidence, and uses a variety of methodologies to evaluate the effects of the Station and the other matters addressed in the Application. The Application, including its extensive Appendices, Attachments and Exhibits, provides unprecedented comprehensiveness, depth, and quality of data and analysis for a permit renewal determination pursuant to Section 316(b).

The record also includes the ESSA Report, which reviews certain portions of the Application. The ESSA Report raises questions regarding, and presents criticisms of, various details in the Application. As show below, these criticisms are almost wholly without merit. The Department gave appropriate consideration to the issues raised by ESSA. Further, the fundamental conclusions in the ESSA Report are consistent with PSEG's basic position, the provisions in the Draft Permit, and the Department's FS determinations. The record also includes certain submissions by commenters. These comments provide no grounds for modifying or postponing final adoption of the Draft Permit. Taken as a whole, the record amply supports the Department's determinations and the Draft Permit provisions.

NJDEP has determined that PSEG has fully complied with the Special Conditions and other requirements of the 1994 Permit. FS pages 30, 32, 42, 45, 47, and 54-59. As shown in Section III of these Comments and in the Application, this determination is fully supported by the extensive facts in the record concerning PSEG's implementation of the 1994 Permit. No comment filed to date has disagreed with this conclusion.

NJDEP has further determined that the Section 316(a) Demonstration presented in the Application shows that Salem's existing thermal discharge is protective of the fish, shellfish, and wildlife in and on the Delaware Estuary and that accordingly PSEG is entitled to a Section 316(a) variance for Salem. As shown in Section IV of this Memorandum, these determinations are also fully supported by the record. No comment filed to date has disagreed with these determinations.

In its determinations under Section 316(b), the Department found that the Salem cooling water intake structure is having an adverse environmental effect ("AEI"), and that PSEG should be required to conduct a study of additional intake technology options and certain intake modifications as a requirement of "best technology available" (BTA). FS pages 69 and 70. PSEG disagrees with the Department's determination that the Salem intake constitutes an AEI. This determination was based on the Department's legally erroneous position that the loss of individual organisms at an intake, even the loss of a single fish, constitutes AEI under Section 316(b). See FS page 70; Statement of Dennis Hart, Public Hearings January 23 and 25, 2001. As shown in Section V of these Comments and in the Application, the Department's "single fish" interpretation of AEI is contrary to the controlling legal precedent under Section 316(b), which establishes that AEI consists of adverse impacts on populations of fish or communities of aquatic life, not losses of individual organisms. The evidence of record does not support a finding that Salem's intake is adversely affecting the populations or community of the Estuary. To the contrary, the Application shows appropriately: that Salem's operation has not created any imbalance in the structure of the aquatic community of the Estuary or the outbreak of nuisance species; that the populations of the species most likely to be affected by the Salem intake show trends of increasing abundance; and that the losses of individual organisms at the Salem intake will not impair the sustainability of those populations. Since a permitting agency has the burden of establishing that an intake is causing an AEI before it may impose additional BTA requirements under Section 316(b), the Draft Permit BTA requirements are legally infirm. Notwithstanding this legal issue, PSEG accepts and will implement the Draft Permit requirement for studies of additional intake technologies and intake modifications to protect fish because it recognizes the concern of NJDEP and the public with the potential for adverse impact from the Salem intake.

Furthermore, as shown in Section VI of these Comments and in the Application, even assuming arguendo that the Salem intake is causing an AEI, there is no basis in law or fact for imposing any BTA requirements for the Salem intake beyond the intake technology studies required in the Draft Permit.[3] After a full consideration of the evidence presented in the Application and the ESSA Report, NJDEP determined that there are no additional intake technology or other fish protection measures presently available for application at Salem that would produce environmental protection benefits at a cost not wholly disproportionate to the benefits afforded. FS page 72, NJDEP reviewed the wide range of intake technology options presented in the Application and the ESSA Report. Even with respect to the technologies offering the greatest promise, it found that their suitability for application at Salem was uncertain and that their costs would be wholly disproportionate to any fish protection benefits that they might provide and that, accordingly, these technologies are not BTA for Salem. FS pages 30-33 NJDEP also found that the costs of retrofitting Salem with cooling towers, or of seasonal flow limitations, or of rescheduling refueling outages would be wholly disproportionate to the environmental benefit afforded, and that accordingly these measures are not BTA for Salem. FS page 65. These determinations are fully supported by the information and analysis presented in the Application and the ESSA Report.

In issuing the Draft Permit, the Department also determined that PSEG had successfully implemented the initial phase of wetlands restoration work in accordance with the requirements in the 1994 Permit. FS page 5. Based on the extensive evidence presented in the Application, NJDEP found that the wetlands restoration undertaken to date meets all Permit requirements and success criteria established in the Management Plans established pursuant to those requirements, and that the restored wetlands are already providing benefits for the aquatic populations of the Estuary. FS pages 5. It further determined that PSEG had successfully installed eight fish ladders, three more than required by the 1994 Permit, and that the impoundments and streams made accessible by the fish ladders will produce additional fish for the Estuary. FS page 5. All of these determinations are fully supported by the evidence in the administrative record. Based on these determinations, the Department concluded that the Draft Permit should require continued implementation by PSEG of the wetlands restoration and the fish ladder measures originally proposed by PSEG in 1993 and adopted with modifications by NJDEP in the 1994 Permit. FS pages 43 and 46. These Draft Permit provisions are discussed in Section VII of these Comments, which shows that they are, subject to certain modifications, lawful and appropriate and will provide significant benefits for the Estuary fish populations as well as other significant environmental benefits for the public. Subject to these modifications, the Draft Permit provisions regarding wetlands restorative and fish ladders find ample support in the administrative record and the Commission's determinations, and PSEG undertakes to implement them.

NJDEP further determined that PSEG appropriately implemented the biological monitoring program as required by the 1994 Permit. FS page 5. It also determined, based in part on recommendations in the ESSA Report, that the Draft Permit should include requirements that PSEG implement an expanded biological monitoring program to gather additional information about the fish populations of the Estuary, the effects of Salem's operation, and the benefits of the

3 As noted by NJDEP, FS page 50, the sound deterrent feasibility study conducted by PSEG in accordance with Permit requirements demonstrated that sound deterred certain fish during certain times of the year and that further study of this fish protection technology is warranted.

wetlands restoration and fish ladder measures. FS page 77. The Department reviewed studies undertaken by PSEG to trace the food supplies generated by the restored marshes to the RIS populations, and to quantify a portion of the benefits provided to fish by the marshes. FS page 76. The Department noted the difficulties involved in such quantification efforts. FS page 77. These determinations by the Department are amply supported by the record. In order to provide further information on the benefits provided by the marsh restoration and fish ladder measures, the Department included in the Draft Permit a proposed requirement that PSEG undertake, as a condition of any future permit renewal, additional studies to estimate the fish productivity provided by the restored marshes and the fish ladders expressed in the same units as the analysis of losses at the Salem intake. FS page 77. As discussed in Section VIII of these Comments, the Draft Permit's proposed provisions for biological monitoring are, subject to certain modifications,[4] reasonable, supported by the administrative record and the Department's FS determinations, and will be implemented by PSEG.

Finally, the record amply supports NJDEP's determinations that Salem's non-thermal discharges comply fully with the requirements of the 1994 Permit and the CWA.

Based on the extensive evidence of record and the Department's well-supported determinations, PSEG is entitled to renewal of Salem's Permit and Section 316(a) variance as proposed in the Draft Permit. Accordingly, NJDEP should issue a final permit consistent with the Draft Permit, subject to the minor modifications discussed below.

D. Criticisms of the Draft Permit and Criticisms of the PSEG Application by ESSA and Commenters Are Without Merit and Provide No Grounds for Modifying or Postponing Adoption of the Draft Permit.

Many commenters on the Draft Permit have endorsed its provisions, especially the provisions for continuation of wetlands restoration. Other commenters have challenged the Department's BTA determinations under Section 316(b) and aspects of the Department's determinations regarding wetlands restoration measures. Some commenters have also echoed ESSA's criticisms of PSEG's Application. For reasons summarized herein and presented in greater detail in subsequent sections of this Memorandum, these criticism are without merit and provide no basis for modifying or postponing issuance of the Draft Permit in final form.

1. Commenters' Contentions Regarding BTA

Comments filed by USEPA Region III suggest, without any elaboration or discussion of the record or the Department's FS discussion and findings, that new or modified intake technologies for the protection of fish were not adequately considered by NJDEP in issuing the Draft Permit.[5] This suggestion is utterly baseless. The Application considered a total of 29 possible intake fish protection technologies for adoption at Salem, and conducted a detailed

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4 Part Two, Specific Comments.

5 Letter from Bradley Campbell, USEPA Region III, to Robert Shinn, NJDEP, dated January 19, 2001.

investigation of the four technologies identified as most promising. In addition, the Application provides the results of elaborate studies, conducted by PSEG in accordance with Permit requirements, on the potential to use sound to deter fish from the Salem intake. The Application concluded that none of these technologies is suitable for application at Salem at present. The ESSA Report also provided extensive information and evaluation of intake fish protection technology options. ESSA recommended further study of some of these options but did not recommend any of them for application at Salem at the current time. NJDEP fully considered this extensive evidence and analysis, including ESSA's recommendations. It properly concluded that, at the present time, there are no additional intake technologies that satisfy the criteria of Section 316(b) and that should be adopted at Salem. FS pages 69. The Draft Permit, however, requires PSEG to conduct studies of certain intake technologies for potential adoption at Salem and potential improvements to the intake screen fish return system, in accordance with ESSA's recommendations.

Other commenters, including Riverkeeper and New Jersey Audubon, assert that the losses at the Salem intake justify or mandate a requirement by NJDEP that PSEG retrofit Salem for closed cycle cooling. Other commenters, including USFWS, favor seasonal flow limitations or rescheduling refueling outages. These comments are premised on the legally erroneous view that the loss of individual organisms at the intake represents AEI under Section 316(b) even if those losses do not result in adverse impacts on populations or communities. PSEG has affirmatively shown, by multiple lines of evidence and analysis, that the Station is not having such an impact. Furthermore, these commenters ignore or disregard the well-established legal rule that an intake technology is not BTA under Section 316(b) if its environmental and economic costs are wholly disproportionate to its environmental benefits. NJDEP specifically determined that the costs of each of the alternatives favored by these commenters would be wholly disproportionate to their environmental benefits. These determinations are amply supported by the administrative record. Accordingly, NJDEP lacks legal authority to require adoption of such measures under Section 316(b). Moreover, adoption of such measures would be unsound as a matter of policy because they would involve a waste of scarce societal resources, and because PSEG has proposed, and NJDEP has endorsed as environmentally appropriate, the use of conservation measures to meet the concerns over the potential for adverse environmental impact from the Salem intake. NJDEP properly rejected cooling tower retrofit and intake flow modifications in 1994; USEPA did not disagree with its action. Nothing has changed since 1994 that would justify a different result.

2. Commenters' Contentions Regarding Conservation Measures

Some commenters contend that restoration at the *Phragmites* sites is failing or will never succeed, and that the Draft Permit should be modified to require PSEG to acquire substitute acreage in lieu of the *Phragmites* sites acreage and/or acquire additional upland buffers. These contentions are without merit. NJDEP has determined that the wetlands restoration activities undertaken by PSEG, including the restoration at the *Phragmites* sites, comply with Permit requirements and meet the success criteria established in the Management Plans. PSEG is committed to making restoration a success at all of the sites, and firmly believes that it will do so. There is no basis in the record for concluding that restoration at the *Phragmites* sites will not continue to progress in accordance with applicable requirements and criteria.

Commenters have also expressed opposition to continued use of glysophate in connection with restoration at the *Phragmites* sites on the ground that it poses a serious and undue risk of adverse health and environmental effects. This claim is baseless. EPA has authorized the use of glysophate for applications like those involved at the *Phragmites* sites.[6] There is not a shred of evidence in the administrative record to support the fears expressed by the commenters. To prevent the continuation of restoration efforts that will yield highly important environmental benefits on the basis of baseless, uninformed fears would be wholly arbitrary and unjustified.[7]

Other commenters, including DNREC and USFWS, contend that PSEG should be required to restore or fund acquisition and restoration of additional acres of wetlands and/or acquisition and preservation of upland buffers or install or fund the installation of additional fish ladders on the ground that PSEG has failed to prove that the Permit conservation measures have produced or will produce additional fish in numbers equal to or greater than the numbers of fish lost at the Salem intake. Attachment VI. They suggest that the Draft Permit should be modified to require PSEG to undertake or fund additional conservation measures in order to achieve such an offset. These contentions are without merit in law or fact. NJDEP lacks authority to require PSEG to adopt additional conservation measures because wetlands restoration and fish ladders are not cooling water intake technologies within the meaning of Section 316(b). Furthermore, nothing in the CWA, the Permit, or other applicable law requires a source to either eliminate or offset whatever intake losses may remain after implementation of BTA pursuant to Section 316(b). The Salem intake losses are not causing any AEI on the populations or community of the Estuary. Any potential for AEI from the existing Salem intake, which is BTA under Section 316(b) in accordance with Permit requirements, is adequately addressed by the existing wetlands restoration and fish ladder measures. Finally, the Draft Permit proposes to require PSEG to provide estimates of increased fish productivity due to the conservation measures expressed in common units as losses at the Salem intake.

3. Criticisms by ESSA and Commenters of PSEG's Renewal Application Are Incorrect or Insubstantial and Do Not Justify Modification of the Draft Permit or Postponement of its Issuance

ESSA's Report presents numerous questions and criticisms and makes many recommendations regarding various details of the analysis and conclusions presented in the Application. A number of commenters invoke and echo these criticisms, contending that they compromise determinations made by NJDEP in issuing the Draft Permit and require modification of its provisions or postponement of a decision on Permit renewal. The criticisms raised by ESSA and commenters against the Application are generally erroneous, misplaced, or insubstantial. NJDEP took appropriate account of ESSA's Report in its FS determinations. The criticisms do not justify any modification of the Draft Permit or postponement of its issuance.

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6 PSEG's Application, Appendix G, Exhibit G-2-10 and Attachment IV.B.

7 Some commenters suggest that restoration at the *Phragmites* sites may be undesirable because *Phragmites* provides environmental benefits that are similar to or even greater than those provided by *Spartina* and other marsh grasses.

As explained in Part Three to these comments, which is PSEG's Response to ESSA Report, ESSA's criticisms of the Application are almost entirely lacking in merit. They are misplaced, focus on minutiae, reflect a misreading or misunderstanding of the Application, and wrongly apply highly technical and unrealistic evaluative standards. They ignore that the Application is one of the most detailed, comprehensive and sophisticated CWA permit renewal applications ever submitted pursuant to Section 316, far exceeding applicable regulatory requirements, and that it pursues multiple lines of evidence and analysis that mutually reinforce and fortify its conclusions. ESSA's scattershot approach to reviewing the Application misses the forest for the twigs.

The ESSA contention most frequently invoked by commenters is that the Application significantly underestimates the adverse impact of Salem intake losses because, on ESSA's calculation, production forgone attributable to Salem intake losses is 2.2 times higher than calculated by PSEG. As shown below and in Attachment 1, this contention is baseless. Production forgone is not an appropriate benchmark of AEI. Moreover, ESSA's calculation of production forgone is based on fallacious assumptions that are contradicted by science and the facts. When the conservative assumptions in PSEG's calculations of production forgone are considered, they are, if anything, too high rather than too low.

Furthermore, although the ESSA Report sprays a barrage of questions about the Application, it ultimately recommends renewal of the Permit essentially on the terms proposed in the Draft Permit. Thus, ESSA does not recommend that installation of additional intake technologies be required, does not recommend retrofit of closed-cycle cooling, does not recommend imposition of seasonal flow limitations or rescheduling of refueling outages, and does not recommend any change in the existing wetlands restoration and fish ladder measures as set forth in the 1994 Permit. NJDEP gave appropriate consideration to ESSA's Report. The proposed measures in the Draft Permit are amply supported by the administrative record as a whole including the Application. ESSA's criticism of details in the Application and the efforts of commenters to piggyback on the ESSA Report to derail issuance of the Draft Permit are meritless.

E. Organization of PSEG Comments and Summary Conclusion

The remainder of these Comments is organized as follows. Section II provides a procedural history of Salem permitting pursuant to Section 316 of the CWA. Section III shows that PSEG has complied fully with the 1994 Permit requirements. PSEG's entitlement to renewal of Salem's Section 316(a) variance is presented in Section IV. Sections V and VI respectively show that Salem's cooling water intake structure is not having an AEI, and that even if it were having such an effect the existing Salem intake structure together with the intake technology and modification studies proposed in the Draft Permit are BTA under Section 316(b). The implementation of the Permit wetlands restoration and fish ladder measures and their environmental benefits are discussed in Section VII, which addresses commenters' criticisms of wetlands restoration activities at the *Phragmites* sites and shows that those activities are on a trajectory for success and should be continued, and also addresses commenters' fallacious assertion that PSEG is required to demonstrate that the conservation measures have or will offset all losses at the Salem intake. The biological monitoring program proposed in the Draft Permit is discussed in Section VIII. Section IX discusses criticisms of the Application by ESSA and commenters and other contentions by commenters that are not addressed elsewhere in the Comments. It shows that they do not provide any grounds for modifying or postponing issuance of the Draft Permit. Section X is the Conclusion. It shows that the Draft Permit provisions are the appropriate means for addressing commenters' concerns with the potential for AEI from the Salem intake.

In sum, PSEG has complied fully with the requirements of the 1994 Permit and is entitled to its renewal in accordance with the terms of the Draft Permit, modified as recommended herein. There have been no changes in governing law since 1994. The Station and its operations have not materially changed and there have been no changes to its circulating water system except for the installation of intake screen improvements that have reduced impingement losses at the intake. The wetlands restoration and fish ladder measures implemented by PSEG in accordance with permit requirements are producing significant fish production benefits. The data shows that Salem's operation is not having any adverse impact on the aquatic populations and community of the Estuary; indeed, the populations most likely to be affected by Salem are thriving. No new intake fish protection technologies have been developed that are suitable for adoption at Salem at present. The costs of retrofitting cooling towers or flow modifications continue to be wholly disproportionate to their environmental benefits. Given that there have been no material changes in the governing law or relevant circumstances since issuance of the 1994 Permit that would justify a change in its basic elements, requirements of decisional consistency and principles of stare decisis require renewal on the same basic terms. There is no basis for departing from the course that NJDEP adopted in the 1994 Permit after favorable USEPA review and that PSEG has diligently and successfully carried out over the past six years.

II. PROCEDURAL HISTORY

This section recounts the recent history [8/] of environmental regulatory issues relating to the operation of Salem's cooling water system ("CWS") and its effects on the aquatic biota of the Delaware. It further describes the rigorous review of PSEG's 1999 Application by NJDEP and other interested resource protection agencies leading up to NJDEP's issuance of the Draft Permit.

A. 1990 Draft Permit Proceedings

By virtue of delegation of CWA permitting authority from USEPA, the NJDEP assumed responsibility for implementing the requirements of the CWA in 1982, including the regulation of thermal discharges and cooling water intake structures. As such, the Department assumed responsibility for reviewing PSEG's initial Section 316(a) [9/] and 316(b) Demonstrations [10/].

8/ Appendix A to PSEG's 1999 Application sets forth the full procedural history up to the time of its submission.

9/ In support of its initial Section 316(a) variance request, PSEG submitted a Section 316(a) Demonstration to USEPA prepared in accordance with applicable USEPA guidance in 1974. In response to questions posed by USEPA and other resource protection agencies, PSEG filed three supplements to its initial Section 316(a) Demonstration. These

1. The Versar Report

In April 1986, NJDEP entered into a contract with Martin Marietta Environmental Systems ("MMES"), which later became Versar, Inc. (MMES and Versar, Inc. are hereafter referred to as "Versar"), to conduct a technical review of PSEG's Section 316(a) and Section 316(b) Demonstrations. Versar's initial report (September 1986) found that the effects of Salem's thermal discharge were localized, and had few or no adverse regional consequences; however, Versar also concluded based solely on the predictive model results included in the 1984 Section 316(b) Demonstration that losses to early life stages caused by the Salem cooling water intake system ("CWIS" or "intake") had the potential to affect adversely six RIS, [11/] and that continued operation of Salem without retrofitting the Station to operate with a closed cycle cooling system threatened the balanced indigenous population. [12/] PSEG and its expert scientists thoroughly analyzed the 1986 Versar Report and disputed Versar's findings including the variables, assumptions, and criteria used by Versar. They also contested Versar's ultimate conclusions.

The NJDEP convened technical workshops among scientists representing NJDEP, PSEG and Versar to review the disputed Versar findings. Based on information in PSEG's response to its report and discussions at the workshops, Versar modified certain inputs to the models and

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supplements, submitted in 1975, 1978, and 1979, provided new information concerning the potential biothermal effects of Salem's thermal plume on representative species ("RIS"). The initial 1974 Demonstration and the three supplements thereto are hereinafter collectively referred to as the "Section 316(a) Demonstration."

10/ The Section 316(b) Demonstration, submitted by PSEG to NJDEP in 1984, was a predictive assessment that utilized the RIS approach. Under the RIS approach, the assessment is performed on selected species whose abundance, distribution, ecological roles or economic importance is representative of the species in the vicinity of the facility. The Demonstration presented the following information on the RIS: pre-operational and post-operational abundance and diversity data from the Estuary in the vicinity of Salem; post-operational ecological monitoring studies which PSEG conducted in the vicinity of Salem from 1977 through 1982; detailed life-history information; estimated impingement and entrainment losses; and the results of mathematical model projections of potential population effects based on estimated impingement and entrainment losses. The Demonstration also presented an evaluation of intake technologies potentially available for application at Salem including an assessment of their engineering feasibility, biological suitability and costs.

11/ The species were: weakfish, Atlantic croaker, spot, white perch, bay anchovy, and opossum shrimp.

12/ Martin Marietta Environmental Systems, Inc., Technical Review and Evaluation of Thermal Effects Studies and Cooling Water Intake Structures Demonstration of Impact for the Salem Nuclear Generating Station, 1, VIII-1, VIII-2 (1986).

certain estimates of intake losses. In 1989, Versar issued a revised report. [13/] Consistent with the 1986 Report, Versar found that biological effects from the Station's thermal discharge "were small and localized and not a major source of impact" and, therefore, "do not need to be reduced to protect the balanced, indigenous populations. [14/] Although the 1989 Report made changes in certain of Versar's previous findings relating to the effects of the intake, [15/] Versar nonetheless concluded that the Station's intake had the potential for long-term adverse environmental impact on five RIS. [16/] Versar recommended that PSEG's request for a § 316(a) variance be denied, on the grounds that combined effects of the entrainment and impingement losses with the thermal discharge had the potential to interfere with the protection and propagation of a balanced indigenous community. Versar further concluded that closed cycle cooling was required to control both the discharge of heat and entrainment losses under Section 316(b). [17/]

2. NJDEP 1990 Draft Permit for Salem

Relying heavily on the 1989 Versar Report, NJDEP issued a draft NJPDES Permit in October 1990 ("1990 Draft Permit") that proposed to resolve the pending CWA Section 316 issues by (1) denying the requested Section 316(a) variance, and (2) imposing thermal discharge limitations that would have required the immediate shutdown of Salem to retrofit for closed-cycle cooling. Consistent with Versar's conclusions, the proposed denial of a Section 316(a) variance was based on NJDEP's concerns regarding the potential environmental effects of Salem's intake on five of the RIS, not on the effects of the Station's thermal discharge. [18/] The NJDEP also proposed to determine that closed cycle cooling was BTA for the CWIS under Section 316(b). [19/]

PSEG submitted extensive comments in opposition to the closed-cycle cooling retrofit requirement in the 1990 Draft Permit. The comments included the results of new studies of the characteristics of Salem's plume and a new biothermal assessment. These studies concluded that Salem's thermal discharge did not have an adverse impact on aquatic populations in the

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13/ Versar, Technical Review and Evaluation of Thermal Effects Studies and Cooling Water Intake Structure Demonstration of Impact for the Salem Nuclear Generating Station: Revised Final Report at VI-1 (1989).

14/ Id.

15/ The 1989 Versar Report eliminated one species, Atlantic croaker, from the list of potentially impacted RIS and substantially reduced the projections of intake losses for the other five potentially impacted RIS from those presented in its 1986 Report.

16/ Id. at VI-2.

17/ Id. at VIII-3.

18/ 1993 FS/SB pages 134-136.

19/ Id.

Estuary. [20] PSEG's comments also provided a detailed evaluation of fish abundance trends for all of the RIS utilizing data from field sampling programs in the Estuary and commercial fisheries data encompassing the period from 1966-90, which showed that the trends of abundance for relevant life stages of the RIS were either stable or increasing. The PSEG comments also included the results of updated mathematical model analyses of potential population implications of individual losses which incorporated revised inputs to reflect actual Station operations and newly available information on biological inputs. [21] Finally, the comments presented a detailed analysis of the engineering feasibility, construction requirements, and costs for retrofitting Salem for closed-cycle cooling, including the costs of replacing the lost electricity generated from Salem with electricity from other generating stations, [22] and a cost/benefit analysis which concluded that the costs, including environmental as well as economic costs, of retrofitting Salem to closed-cycle cooling would be wholly disproportionate to the environmental benefits which a retrofit might achieve. [23]

In 1991, numerous third parties, including USEPA, also submitted comments on the 1990 Draft Permit. In its comments, USEPA noted that Section 316(a) is a variance procedure and is not subject to an economic test. USEPA also advised that while mitigation measures should not be used in lieu of control measures on the thermal component of the discharge to achieve a balanced indigenous population, they are an appropriate consideration under Section 316(b) and referred NJDEP to a number of NPDES permit proceedings where USEPA had incorporated mitigation measures. [24] USEPA also stated that a reduction of flow through the cooling water intake structures could be required, but that such a decision would be subject to economic considerations. [25]

B. PSEG and NJDEP's Resolution of the Dispute Concerning the Potential Impact of Salem's CWIS

NJDEP and PSEG initiated discussions in an effort to resolve the dispute over the potential impact of the CWS and the appropriate regulatory response. These discussions culminated in PSEG's filing of a Permit Renewal Application Supplement on March 4, 1993

20/ PSEG, January 14, 1991 Comments on the 1990 Draft Permit ("1991 Comments"), at Appendices E and F.

21/ 1991 Comments at Appendix I.

22/ 1991 Comments at Appendices K and L, respectively.

23/ 1991 Comments at Appendix M.

24/ Letter from Cynthia Dougherty, USEPA to John Fields dated January 14, 1991, transmitting USEPA's comments on the 1990 Draft Permit. In this regard, USEPA attached to its comment letter portions of the administrative record for the Crystal River and John Sevier NPDES permit proceedings for NJDEP's review and consideration.

25/ Id.

("1993 Application"). The 1993 Application proposed a suite of measures in lieu of closed-cycle cooling retrofit in order to address NJDEP's concern regarding the potential for AEI from the Salem intake. PSEG's proposal included three intake-related measures: a limitation on intake flow to ensure that the quantity of water that the Station withdraws would not exceed the maximum projected flow rates that had been used by PSEG in estimating impingement and entrainment losses; modifications to the travelling intake screens to reduce impingement mortality; and a feasibility study for a sound deterrent system to divert fish from the intake so as to reduce impingement losses. (1993 Application) PSEG also proposed conservation measures, including an extensive wetlands restoration and preservation program and installation of fish ladders designed to enhance the aquatic resources of the Estuary and thereby further minimize the potential for adverse effects from the Salem intake. Finally, PSEG proposed a comprehensive baywide biological monitoring program to provide the requisite information for it and the Department to assess the effects of the Station on the aquatic resources of the Estuary and to measure the progress of the implementation of the conservation measure. To provide NJDEP with the scientific underpinnings for this proposed resolution, PSEG's 1993 Application also contained a Technical Appendix which presented data and information providing the technical and scientific bases for the Company's proposal.

1. NJDEP's 1993 Draft Permit for Salem

In June 1993, NJDEP issued for public comment a revised Draft Permit ("1993 Draft Permit") which proposed to allow the Station to continue to operate with a once-through cooling system; grant a Section 316(a) variance; impose as Special Conditions the measures proposed by PSEG in the March 1993 Application with certain modifications; [26]/ determine that Salem's existing intake, in conjunction with the technological measures proposed in the 1993 Draft Permit, constituted BTA under Section 316(b); and determine that the proposed wetlands restoration and fish ladder programs would further minimize the potential for adverse impact from Salem's intake, which is "the objective of Section 316(b)" and would assure the protection and propagation of the balanced indigenous population. [27]/ The NJDEP's decision to issue the 1993 Draft Permit was based on a reconsideration of its 1990 Draft Permit decision in light of the new information presented in the comments submitted by PSEG, USEPA, and others to the 1990 Draft Permit and the measures proposed by PSEG in its 1993 Application.

2. Public Comment Process

The public comment process on the 1993 Draft Permit was unprecedented and included two public hearings, a roundtable discussion among key stakeholders, and two phases of public comment with initial and rebuttal phases. In total, 82 parties submitted comments on the Draft Permit including USEPA, National Marine Fisheries Service ("NMFS"), United States Fish & Wildlife Service ("USFWS"), the Delaware River Basin Commission ("DRBC"), the Delaware

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[26]/ Among these measures were: an intake flow limitation, intake modifications, a sound deterrence feasibility study, wetlands restoration, enhancement and preservation, installation of fish ladders, and an extensive biological monitoring program.

[27]/ Fact Sheet/Statement of Basis page 141.

3. The 1994 Salem Permit

On July 20, 1994, NJDEP issued a final permit ("1994 Permit") for Salem with an effective date of September 1, 1994, which incorporated modifications in response to comments submitted by USEPA, other environmental resource agencies and the public. These modifications included an expansion of the thermal and biological monitoring programs and further requirements for involvement by environmental resource agencies and local government representatives in the design and implementation of the monitoring and conservation measures of the Permit.

Based on the voluminous evidence of record regarding Salem's thermal plume and its potential biological effects, NJDEP concluded that the continued operation of the Station in accordance with the Permit terms "would ensure the continued protection and propagation of balanced indigenous population of aquatic life" in the Estuary. [29/] NJDEP specifically addressed the water quality standards for temperature that would otherwise apply to Salem's discharge [30/] and determined that the thermal discharge limitations that would be required in order to meet the NJ/DRBC thermal water quality standards would be more stringent than necessary to assure the protection and propagation of the balanced, indigenous population. [31/] It therefore granted Salem a Section 316(a) variance from such limitations, [32/] and imposed the same temperature and heat limitations for the Station's discharge as had been imposed by the prior Salem NJPDES permit. [33/]

The 1994 Permit also imposed the requirements of the 1993 Draft Permit Special Conditions including technology-related intake measures and conservation measures, i.e., the wetlands restoration and the fish ladder installation programs. The 1994 Permit also required PSEG to establish a Management Plan Advisory Committee ("MPAC") to provide technical advice to PSEG concerning the development and implementation of the wetlands restoration program. [34/]

29/ Response to Comments at 3; see also 1993 FS/SP, page 150-151.

30/ See Response to Comments at 19-21; N.J.A.C. § 7:9B-1.14(d); NJ/DRBC WQR § 3.30.5.

31/ See Response to Comments at 20-23 (discussing Section 316(a) variance).

32/ Id.; See, 1993 FS/SB, page 150-151.

33/ See, Permit, Part III B/C.1.A.; see Response to Comments at 23; 1993 FS/SB, page 150-151.

34/ The membership of the MPAC includes representatives of PSEG, NJDEP, USEPA, NMFS, USFWS, DNREC, the United States Army Corps of Engineers("ACOE"), and the Delaware Estuary Program ("DELEP"), and of Cumberland, Cape May, and Salem Counties in New Jersey, as well as four independent scientists – Michael S. Bruno, Ph.D., a professor at Stevens Institute of Technology; William S. Mitsch, Ph.D., a professor at Ohio State University;

Further, the 1994 Permit required PSEG to develop and implement a comprehensive biological monitoring program, which includes requirements: to perform a baywide abundance-monitoring program; as recommended by USEPA, to conduct a comprehensive Salem's thermal monitoring program and biothermal assessment. The Permit required PSEG to establish a Monitoring Advisory Committee ("MAC") to provide technical advice to PSEG concerning the design and implementation of the Company's biological monitoring program. [35]/

4. USEPA's Favorable Review of the 1994 Salem Permit for Salem

The CWA and its implementing regulations authorize USEPA to review state-issued NPDES permits, such as the Salem Permit, to determine whether such permits comply with the CWA, properly apply the facts, and adequately consider and respond to comments of affected states. [36]/ The CWA thus establishes USEPA as the administrative authority to ensure that state-issued permits conform to the CWA and as the umpire to consider and resolve controversies over the interstate effects of state-issued NPDES permits. [37]/

Shortly after the NJDEP issued the Permit in July 1994, the ALS, Riverkeeper and other groups filed a petition with USEPA headquarters and Region II alleging that the Permit was inconsistent with CWA, and urging veto of the Permit and the recission of NJDEP's status as a delegated state agency for implementation of NPDES program. [38]/ DNREC also filed petitions

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and R. Eugene Turner, Ph.D., a professor at Louisiana State University Coastal Ecology Institute; Joseph Shisler, Ph.D., at Rutgers University. Although the Delaware River Basin Commission ("DRBC") and the United States Geological Service ("USGS") initially participated in the MPAC, their representatives resigned, citing competing demands on their time.

[35]/ The membership of the MAC includes representatives of PSEG, NJDEP, DRBC, DNREC, USFWS, NMFS, and DELEP, as well as independent scientists – Edward D. Houde, Ph.D., of the University of Maryland, Chesapeake Biological laboratory Center for Environmental and Estuarine Studies; Ronald T. Kneib, Ph.D., of the University of Georgia, Marine Institute; Nancy Rabalais, Ph.D., of Louisiana University Marine Consortium; Rick Deriso, Ph.D., a professor at Scripps Institution of Oceanography; and Joseph Miller, formerly with USFWS. While not a member of MAC, USEPA requested NJDEP to establish procedures by which USEPA can actively monitor the Committee's work. PSEG is required to provide USEPA with copies of all meeting notices, meeting minutes, and technical documents submitted to the MAC.

[36]/ 40 C.F.R. 123.44© (1994) [hereinafter all citations to C.F.R. refer to C.F.R. (1994).

[37]/ See CWA §§ 402(b)(5), (d)(2), (4), 42 U.S.C. §§ 1342(b)(5), (d)(2), (4); International Paper Co. v. Ouellette, 479 U.S., 481 (1987).

[38]/ See Report in Support of Petition Requesting EPA Veto of Clean Water Act Permit NJ 0005622, prepared by James R. May, Esq. (August 9, 1994). Contemporaneous with the issuance of the 1993 Draft Permit, ALS and Riverkeeper had filed similar petitions with both USEPA headquarters and Region II urging veto of the permit. See Advisory Memorandum Petitioning EPA Action Regarding DEPE's Issuance of a Draft Permit to PSE&G on June 24,

with USEPA headquarters and Region III alleging NJDEP had failed to consider appropriately the comments of Delaware, an affected state.

In a September 22, 1994 letter to NJDEP, USEPA Region II stated that: "[it has] completed [its] review of the final permit issued by [NJDEP to Salem]." This letter raised no objections to the Permit. 39/ USEPA's favorable review of the Permit confirmed the validity and controlling legal effect of the NJDEP's decision under the CWA.

5. Settlement of DNREC and Riverkeeper Hearing Claims

DNREC and Riverkeeper each requested an adjudicatory hearing before the New Jersey Office of Administrative Law to challenge the 1994 Permit. The challenges raised both legal issues concerning NJDEP's authority to consider conservation measures and the effectiveness of the measures included in the Permit. PSEG entered into settlement agreements with DNREC 40/ and with the Riverkeeper 41/ resolving these challenges. As a result of these settlement agreements, DNREC and the Riverkeeper withdrew their hearing requests.

C. Implementation of 1994 Permit Requirements

As required by the 1994 Permit, PSEG developed its plan for the wetlands restoration program, relying on its team of nationally and internationally recognized wetlands and coastal processes scientists and engineers. It then sought further advice from the MPAC prior to submitting the Management Plans to NJDEP for approval. PSEG, furthermore, conducted this program in full accord with applicable federal, state and local regulations. Similarly, it developed its biological monitoring program with the assistance of recognized scientists familiar with the aquatic biota of the Delaware with wetlands vegetation and hydrology before seeking advice from the MAC and ultimate approval of the program from NJDEP.

The interaction with MPAC and MAC and the federal, state, interstate regulatory agency representatives and the committees has continued to date. PSEG meets regularly with these advisory bodies to review the status of the wetlands restoration to seek input on plans for ongoing restoration efforts and to review the results of monitoring programs.

1993, prepared by James R. May, Esq. et al on behalf of Delaware Riverkeeper, an Affiliate of the American Littoral Society, and The Listed Environmental Consortium (July 26, 1993).

39/ Letter from Richard L. Caspe, USEPA Region II, to Dennis Hart, NJDEP (September 22, 1994).

40/ Settlement Agreement between PSE&G and DNREC (Mar. 23, 1995) (hereinafter, "DNREC Settlement").

41/ Settlement Agreement between PSE&G and Riverkeeper (May 12, 1995) (hereinafter, "Riverkeeper Settlement").

As the Fact Sheet for the 2000 Draft Permit [42]/ indicates, PSEG has appropriately implemented all the measures required in Salem's 1994 Permit including the technological and conservation measures, the biological monitoring program, and the establishment of advisory committees. [43]/

D. Proceedings for Renewal of Salem's NJPDES Permit

PSEG's timely filed an application for the renewal of Salem NJPDES permit (the "Application") with the NJDEP on March 4, 1999. The 1994 Permit, including Salem's Section 316(a) variance, remains in effect pending a final decision on renewal. Consistent with the requirements of the CWA and Salem's 1994 Permit, PSEG's Application presented: (1) a comprehensive demonstration that PSEG complied with the Special Conditions of the 1994 Permit; (2) a comprehensive analysis, consistent with applicable regulatory guidance, of Salem's effects on the Delaware estuary and its aquatic biota, including demonstrations pursuant to Section 316(a) and 316(b) of the CWA; (3) a comprehensive evaluation of the biological efficacy of the intake screen impingements and conservation measures required in the 1994 Permit ; and (4) assessment of the cumulative effects of the Station on the aquatic life of the Estuary, taking into consideration the benefits associated with the implementation of the wetlands restoration and fish ladder progress.

1. PSEG's Application is Legally Sufficient, Comprehensive and Sponsored by Recognized Experts

Discrete components of the Application were developed and sponsored by scientists, engineers, economists and other professionals with recognized expertise in each of the relevant disciplines, including but not limited to hydrodynamics, fisheries biology, population dynamics, biostatistics, quantitative stock assessment, fisheries management, risk assessment, wetlands ecology, estuarine/marsh fisheries, engineering, economics, and environmental and administrative law. After a comprehensive review and analysis of the relevant data, this team concludes that Salem's operation has not and will not have an adverse impact on the fish and shellfish population or the aquatic community of the Delaware Estuary, that the Station's existing CWIS reflects BTA, and that the intake screen improvements and conservation measures implemented in accordance with the 1994 Permit ensure that the biological resources of the Estuary are being and will continue to be protected. This Application provides the requisite evidentiary record for renewal of the Permit in accordance with the determinations made by NJDEP in 1994 in issuing it.

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[42]/ FS pages 30, 32, 42, 45, 47, and 54-59.

[43]/ PSEG has also complied with all of the provisions of the Settlement Agreements with DNREC and Riverkeeper. See Application, Appendix G.

PSEG's Application includes a presentation and, as appropriate, a synthesis of relevant source information on the Station, the Estuary and its biological resources, biological principles and legal guidance. [44]

The Section 316(a) Demonstration [45] presents relevant information on the Station's operation and the Estuary, summarizes the results of the Station's comprehensive hydrothermal monitoring program, describes the hydrodynamic models used to characterize the thermal plume, depicts the temporal and spatial characteristics of the thermal plume predicted by those models, and presents the results of a predictive assessment of the effects of the discharge on the RIS and a retrospective or "no prior appreciable harm" assessment based on more than twenty years of post-operational data and information. The Section 316(a) Demonstration concludes that the Station's thermal discharge and plume, including the combined effects of heat on other pollutants in the River, is protective of the balanced indigenous populations ("BIP") in the Estuary.

The Section 316(b) Demonstration presents: assessments of predictive and retrospective effects of the cooling water intake structure that address the methodology applied in conducting the impact assessment and the end-points or indicators of AEI, the effects of the CWIS on the aquatic biota, and the analyses of those effects pursuant to each indicator; a BTA demonstration that presented the results of an evaluation of the engineering feasibility and biological efficacy of the alternative technologies and operational scenarios potentially applicable at Salem and a cost-benefit analysis which considered the costs to society and the economic value of the benefits associated with each of these alternatives. The Section 316(b) Demonstration is presented in Appendix F. The impact assessment component of the Section 316(b) Demonstration, sponsored by Lawrence W. Barnthouse, Ph.D. with Douglas G. Heimbuch, Ph.D. as a contributing author, concludes based on the retrospective assessment that the operation of Salem over the past twenty years does not show adverse changes in the balance of species present in the Estuary and no

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44/ The Station, its cooling water system and relevant data about its operations are presented in Appendix B, sponsored by James M. Nicholson of Stone & Webster Engineering Corporation. The description of the physical, chemical and biological properties of the Delaware estuary, including detailed life history information on key species or RIS is presented in Appendix C, sponsored by Robert Biggs, Ph.D. and Richard Horwitz, Ph.D. Detailed species-specific life history information is presented in Attachments to Appendix C. Each of the species-specific life history reports was developed under the overall direction of, and is sponsored by, James H. Cowan, Ph.D. Each was peer-reviewed by a scientist with a recognized expertise in the species. Appendix I describes the current state of the science on the operation of compensatory mechanisms in fishery populations. It was sponsored by Lawrence W. Barnthouse, Ph.D. with James H. Cowan, Ph.D., Kenneth A. Rose, Ph.D., Ransom A. Meyers, Ph.D., and Ray W. Hilborn, Ph.D. as contributing authors, Appendix J presents a comprehensive assessment of relevant data sets on the abundance of the RIS in the estuary and was sponsored by Douglas G. Heimbuch, Ph.D. Appendix L presents the data used in conducting the analyses and assessments relied on in the demonstrations. Finally, Appendix D presents a discussion of the relevant legal precedent prepared by Richard B. Stewart, Esq.

45/ The Section 316(a) Demonstration is presented in Appendix E of the Application and is sponsored by E. Eric Adams, Ph.D. and Charles C. Coutant, Ph.D.

downward trends in abundance of species, attributable to the Station's operations. The predictive assessment, based on modeling of the Station's impacts on the sustainability of fish stocks, demonstrates that these impacts have not affected fish stocks in the past and should not affect them in the future. The BTA component of this Section 316(b) Demonstration, sponsored by Edward P. Taft, and David Harrison, Ph.D., concludes that while certain other technologies or operational scenarios had potential for application at Salem, the costs of those technologies or operational scenarios exceeded the value of the benefits to the estuary associated with their implementation (i.e., the costs were wholly disproportionate) and therefore that the existing intake was BTA for Salem.

The Compliance Demonstration (Appendix G) presents an evaluation of the intake technology measures (intake screen measures and a sound deterrent study) implemented by PSEG, including reductions in impingement losses resulting from the intake modifications, and the biological efficacy of the conservation measures implemented by PSEG. 46/

In addition to the individual components described above, the Application contains a cumulative effects assessment (Appendix H), sponsored by Vaughn C. Anthony, Ph.D., retired chief scientist for the Northeast region of NMFS, that evaluates on an integrated basis, the

46/ The evaluation of screen effectiveness was conducted by Douglas G. Heimbuch, Ph.D. and includes an analysis of impingement survival data collected before and after the modifications to the intake screens. This analysis indicated an overall improvement of 50% in impingement survival. (Exhibit G-2) The feasibility study of sound as a deterrent for fish includes a state-of-the art study. This feasibility study, conducted under the direction of Arthur N. Popper, Ph.D., indicates that sound is an effective deterrent for certain species during certain times of the year. (Exhibit G-7)

A report sponsored by John M. Teal, Ph.D., Professor Emeritus at Woods Hole Oceanographic Institution, documents and evaluates PSE&G's program to acquire restore, and/or preserve more than 14,000 acres of degraded wetlands and associated uplands in the Estuary. (Attachment G-2)

A second report, sponsored by Kenneth W. Able, Ph.D., Professor of Marine and Coastal Sciences and Biological Sciences at Rutgers University, presents an evaluation of how fish and other components of the fauna have responded to marsh restoration activities in Delaware Bay.

A third report sponsored by C. Paul Ruggles, former Director of Freshwater and Anadromous Fish Division of Canada's Department of Fisheries and Oceans, describes the results of PSE&G's fish ladder program.

Finally, the Compliance Demonstration also presents estimations of the increased productivity associated with the restoration of both the degraded wetlands (Attachment G-4) and the river herring spawning runs (Attachment G-6). This work, directed and sponsored by James F. Kitchell, Ph.D., A. D. Hassler Professor, Department of Zoology at the University of Wisconsin, relies on recognized and peer-reviewed bioenergetics models to quantify portions of the increases in production.

combined effects of impingement, entrainment and thermal exposure on the RIS and, the fish production resulting from the wetlands restoration and fish ladder installations implemented pursuant to the 1994 Permit. The cumulative effects assessment concluded that:

- The thermal discharge is and will be protective of the balanced indigenous population, taking into account the effects of the intake and other sources of stress on the relevant populations;
- The intake is not having and will not have an adverse environmental effect;
- The Station's operations as a whole have not and will not have an adverse environmental effect; and
- The validity of the above conclusions is reinforced when the benefits provided by the wetlands restoration and fish ladder programs are taken into account, as well as the improvements in the water quality of the Estuary and the improvements in fisheries management.

2. Reviews of PSEG's Application

PSEG's Application has been the subject of a myriad of reviews, which included opportunities for NJDEP, MAC, MPAC, NJDEP's consultant ESSA, other federal and state agencies, and independent scientists not only to evaluate the Application itself but also to question the expert scientists, engineers and economists who prepared the Application.

These reviews extended over the course of a year and are briefly described below.

a. Experts' Meetings with NJDEP

Between April and mid-May of 1999, NJDEP met with representatives of PSEG and the experts who prepared each component of the Application. 47/

The NJDEP's team reviewing the application, including representatives of the senior management team, the NJDEP's Divisions of Water Quality, Fish & Wildlife and Land Use

47/ In addition to an initial meeting at which PSEG representatives provided NJDEP with an overview of the application, the sponsors of the following components of the Application met with the NJDEP: (1) § 316(a) Demonstration (Appendix E); (2) Section 316(b) Impact Assessment Demonstration (Appendix F-§ VII); Entrainment and Impingement Losses (Attachment F-4); Alternative Technologies (Appendix F, § VIII); Cost-Benefit Analyses (Appendix F, § IX); Wetlands Restoration (Attachment G-2); Ecological and Human Health Assessment of Herbicide Use (Appendix G-2-10); Faunal Response to Wetlands Restoration Effects of Herbicide the Efficacy of the Sound Deterrent System (Attachment G-7); Fish Ladders (Attachment G-5), Bioenergetics Modelling of Increased Production associated with the wetlands restoration and fish ladder installation (Attachments G-4 and G-7), trends analysis (Appendix J) and the cumulative effects assessment (Appendix H).

Regulatory Program, and the deputy attorney general assigned to this matter, attended some or all of these review sessions.

The sponsors of each section provided NJDEP with assessments of the data which formed the basis of their respective components of the Application, an overview of the analytical methods employed, and their findings and conclusions and responded to questions raised by NJDEP's review.

b. PSEG Meetings with the Permit Advisory Committee

PSEG provided copies of relevant portions of the Application to the members of MPAC and the full 36 volumes to the MAC. As described above, these advisory committees include nationally and internationally recognized scientists from academia and from federal and state regulatory agencies with particular expertise in issues relevant to the assessment of the RIS and/or the efficacy of the conservation measures implemented pursuant to the 1994 Permit.

PSEG's expert witness team met with the MPAC in May 1999 for two days. PSEG's scientists presented an overview of the Section 316(a) and 316(b) Demonstrations and the cumulative effects assessments and full briefings on the wetlands restoration and faunal response components of the Application. PSEG met with the MAC in June 1999 for three days to review the Application in detail, with particular emphasis on the impact assessment under Section 316(b). These meetings afforded an opportunity for a full and fair discussion on PSEG's data, analyses and conclusions among the members of the Committees as well as members of NJDEP's review team who attended.

c. PSEG Briefings for DNREC

In addition to the briefings provided to all of the representatives of the resource agencies participating on the Advisory Committees including DNREC's representative(s?), PSEG afforded DNREC additional opportunities to discuss the Application with both the Company and its expert witnesses. In May 1999, in advance of the Advisory Committee meetings, PSEG representatives met with key DNREC personnel to provide an overview of the Application. At that time, PSEG offered to make its scientists available to respond to any questions DNREC might have concerning the Application. Subsequent to the MAC meetings and in response to DNREC's request to the NJDEP, PSEG sponsored a two day workshop in July 1999 for DNREC fisheries biologists, representatives of NJDEP and the scientists sponsoring PSEG's Section 316(b) impact assessment, trends analyses and cumulative effects assessment. This workshop afforded DNREC scientists an opportunity to discuss in detail these components of PSEG's Application with the sponsoring scientists. Throughout this period and continuing to the present, DNREC scientists have sought clarifications on and/or additional information concerning issues addressed in the Application. PSEG and its expert team have responded fully to these requests. DNREC submitted a total of three comments on PSEG's Application and the Draft Permit to NJDEP. [48/]

[48/] DNREC's first comment, December 22, 1999, included a report prepared by C. Phillip Goodyear, entitled "Comments on Appendix F of the PSE&G Permit Application for Salem

(1) PSEG Briefings for DRBC

PSEG provided the DRBC with a complete copy of its Application in early March 1999. In April 1999, PSEG representatives met with the Executive Director and technical staff of the DRBC to provide an overview of PSEG's Application. Subsequent to that meeting, PSEG representatives and the sponsor of both the hydro-thermal monitoring component of the biological monitoring program and the hydrodynamic modelling effort met with technical staff including DRBC's in-house hydrodynamic modellers to review those components of PSEG's Section 316(a) Demonstration. Subsequent to that meeting, NJDEP referred certain requests for

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4 March 1999" ("Report"). See letter from Roy Miller, DNREC, to Debra Hammond, NJDEP, dated December 22, 1999. DNREC's transmittal letter indicates that it retained Dr. Goodyear to "...review the entrainment and impingement impact assessment..." in the Section 316(b) Demonstration component of the Application. PSEG's expert scientists who conducted the impact assessment and cumulative effects components of PSEG's Application reviewed the Goodyear Report and prepared a report entitled "Rebuttal to Accusations and Response to Technical Criticisms raised in 'Comments on Appendix F of the PSE&G Permit Application or Salem 4 March 1999,' Letter to D. Hart from R.E. Selover, February 18, 2000" ("Goodyear Rebuttal"), which PSEG submitted to NJDEP. See Letter from R. Edwin Selover to Dennis Hart dated February 18, 2000. Copies of the Goodyear Rebuttal were also sent to DNREC and ESSA staff members.

On April 15, 2000, PSEG received a copy of a second DNREC report providing comments to NJDEP on the Application. This report, entitled "Mortality of Delaware River Striped Bass from Entrainment and Impingement by the Salem Nuclear Generating Station" was prepared by Desmond M. Kahn, Ph.D. of DNREC's Division of Fish & Wildlife. See letter from Roy Miller to Debra Hammond dated March 30, 2000. The Kahn Report addresses the alleged impacts of the Station on striped bass in the Delaware. The scientists who prepared PSEG's impact assessment reviewed the Kahn Report and prepared a response, entitled "Response to DNREC's Assessment of the Impact of Entrainment and Impingement by the Salem Nuclear Generating Station on Delaware River Striped Base," ("the Response to Kahn Report") to NJDEP. See letter from John H. Balletto to Debra Hammond dated August 25, 2000. PSEG provided a copy of its response to DNREC.

Finally, April 15, 2000, DNREC provided NJDEP and PSEG with a memorandum prepared by Dr. Kahn, regarding PSEG's loss estimates. See Memorandum from Desmond M. Kahn, Ph.D. to Andrew Manus, dated September 26, 2000, regarding alleged deficiencies in PSEG's Application. PSEG's impact assessment scientists as well as the economists who prepared the cost-benefit analysis reviewed Dr. Kahn's Memorandum and prepared a report in response. See Letter from Maureen F. Vaskis, Esq. to Debra Hammond transmitting Response to Memorandum dated September 26, 2000, from Desmond Kahn, Ph.D. to Andrew Manus. These DNREC comments and PSEG's responses are discussed at IX § C and at various points in these comments.

clarification from the DRBC relative to the biothermal assessment to PSEG for response. PSEG provided additional information and/or clarification. [49]

d. PSEG Interactions with ESSA

NJDEP, DNREC and PSEG met with the members of ESSA's review team shortly after ESSA began its review. NJDEP outlined its approach for ESSA's review, sought PSEG's cooperation with ESSA and invited DNREC to participate in the review process. PSEG provided an overview of its Application. [50] Subsequently some members of ESSA's team met with certain of PSEG's impact assessment scientists to review in detail PSEG's methodology for calculating losses and its use of fisheries models. The ESSA team also toured the Station's CWIS and met with PSEG's expert team and in-house technical personnel responsible for the hydrodynamics evaluation, impact assessment, alternative technologies evaluation and cost-benefit analyses in early December 1999. Finally, PSEG's cost-benefit expert met with ESSA's economist to review that analysis in detail and participated in a follow-up conference call to respond to ESSA's questions.

In addition to these meetings among ESSA's reviewers, the PSEG experts responded to various requests or clarification and generally made themselves available to assist ESSA in its review. PSEG also provided ESSA with a substantial number of references to the Application.

In March 2000, NJDEP hosted a meeting attended by representatives of PSEG and DNREC at which ESSA presented its preliminary findings. The Department afforded PSEG the opportunity and a limited time to prepare a response which would clarify, supplement or direct ESSA's attention to information in PSEG's Application. On May 17, PSEG submitted its response to ESSA's presentation. [51] Shortly thereafter, ESSA finalized its Report, which NJDEP released for review and comment on December 8, 2000.

e. USEPA Review

As noted in the Fact Sheet at 6, NJDEP met with USEPA prior to the issuance of the Draft Permit. USEPA Region II, which includes New Jersey and New York, has oversight jurisdiction over NJDEP's implementation of the Salem Permit. On January 19, 2001, USEPA

49/ To date, DRBC has not filed comments on the Draft Permit.

50/ See PSEG Presentation at November 8, 1999 Meeting included as Attachment III.A to letter filing.

51/ See letter from Maureen F. Vaskis to Susan T. Rosenwinkel, dated May 17, 2000, transmitting PSEG's response to ESSA's Presentation of Preliminary Findings to the March 1999 Permit Renewal Application, included as Attachment II.C.

Region III, which includes Delaware and Pennsylvania, sent comments to USEPA Region II with a copy to NJDEP. [52/]

f. Federal Resource Agency Review

Both USFWS and NMFS representatives serve on the MPAC and MAC. Through their representatives, other agencies received a complete copy of PSEG's Application and had the opportunity to discuss the Application with its sponsoring experts. USFWS also retained a retired USFWS employee who serves on the MAC to review the fisheries component of the Application. USFWS submitted comments on the Application to the NJDEP, [53/] met with the Department prior to the issuance of the Draft Permit, and subsequently filed comments on the Draft Permit.

g. The Draft Permit for Salem

On December 8, 2000, NJDEP issued a Public Notice, Fact Sheet and Draft Permit for Salem. This Draft Permit essentially proposes to continue the determinations that NJDEP made in its 1994 Permit, with a number of additional study requirements in response to recommendations by ESSA.

The Draft Permit proposes effluent limitations applicable to the Station's outfalls and specific requirements pursuant to Sections 316(a) and 316(b) of the CWA. It proposes to authorize the continued operation of the Station with the existing once through cooling water system; renew the Station's Section 316(a) variance; require PSEG to conduct expanded analyses to provide a better understanding of the Stations effects on the aquatic resources of the Estuary; require, as best technology available under Section 316(b), additional studies of certain intake technology measures and modifications to evaluate their potential for application at Salem; continue the implementation of the wetlands restoration and preservation program and fish ladder measures adopted in the 1994 Permit; require PSEG to conduct an enhanced biological monitoring program; combine the existing advisory committees into a single committee to provide advice with respect to both biological monitoring and the status of the wetlands restoration sites; and require PSEG to demonstrate in its next renewal application the increased productivity associated with the wetlands restoration and fish ladder installation.

The NJDEP's Fact Sheet sets forth the legal and technical bases for the Department's proposed permit decision. It amply documents the breadth and depth of PSEG's Application, the level of detail and rigor of the NJDEP's review, and the Department's efforts to ensure that all

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52/ See Letter from Bradley Campbell, USEPA Region III to Robert Shenn dated January 19, 2001, transmitting Mr. Campbell's letter of January 19, 2001 to William Muszinsky, USEPA Region III. These comments and PSEG's response thereto are discussed below in Section IX. They alleged that the NJDEP's proposed permit decision was inconsistent with applicable law; and challenged the adequacy of the alternative technology and cost-benefit analyses upon which the Draft Permit was based.

53/ FS, page 80.

interested parties had a full and fair opportunity to participate in the review process. Subsequent portions of these Comments addresses the Fact Sheet in detail and requests clarification on certain statements therein at the time the Department issues its Draft Permit.

In developing the Draft Permit and Fact Sheet, the Department carefully considered ESSA's findings and recommendations and included proposed specific requirements in the Draft Permit to address ESSA's comments and recommendations.

In recognition of the high degree of public interest in this Draft Permit, the NJDEP established a 90-day comment period, a substantially longer period than the 30 days required by applicable regulations (N.J.A.C.7:14A-15.10(c)) and held two public hearings. In response to requests from the ALS, Riverkeeper and others at the public hearing and written requests from Weidner Environmental Law Clinic, NJDEP granted a 14-day extension of the Comment Period. This afforded PSEG and all other interested third parties 104 days to review the Draft Permit, including the ESSA Report and the Administrative Record upon which it was based. The public had had the opportunity to review PSEG's Application ever since its filing on March 4, 1999. [54/]

A broad spectrum of governmental business agencies, conservation, environmental organizations, scientists from academia and private citizens presented testimony at the public hearings or submitted comments to the NJDEP. Commenters, including USFWS, support NJDEP's statement in the Fact Sheet that PSEG complied with all of the terms and conditions of the 1994 Permit. Many of these commenters offer enthusiastic support for PSEG's wetlands restoration program, citing the progress made to date, the critical linkage between wetlands and coastal fisheries, the utilization of the restored wetlands by a wide variety of birds and other fauna, and the educational and ecotourism benefits of the programs. A number of commenters, however, disagreed, asserting the lack of progress with the restoration at the *Phragmites*-dominated wetlands sites, the likelihood of adverse effects from the use of herbicide (glysophate) used at these sites, and harm to the horseshoe crab population as result of the restoration. Other commenters raised questions concerning the Station's impact on the biota of the Estuary and challenge whether the Station's intake is reflective of BTA. Other commenters strongly supported renewal of the Salem Permit in accordance within the terms of the Draft Permit. These and other comments and PSEG's response are discussed in greater detail in Section X below and in PSEG's Response to Issues Raised in Third Party Comments, included as Attachment VI to PSEG's Comments.

III. RESPONSE TO ESSA'S SECTION 1: INTRODUCTION

This part of PSEG's Response addresses issues raised in the introductory discussion of the ESSA Report. ESSA's introduction sets forth its objectives and approach in reviewing

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54/ As discussed above, in Section B.5, PSEG was required to provide James R. May, Esq. and Edward J. Lloyd, Esq. with copies of PSEG's Application within 30 days of its being filed. Therefore, Mr. May's claim (See Comments of James R. May, Esq., Feb. 9, 2001) of having limited time to review the Application is without merit.

portions of the Application, outlines the structure and context of its review, and identifies the ESSA review team.

A. ESSA Report § 1.1: Objectives and Approach

In § 1.1, ESSA summarizes the specific portions of PSEG's Application that NJDEP asked ESSA to review, and describes the parameters of the review as outlined in the NJDEP Scope of Work for ESSA's review (provided as Annex 1 to the ESSA Report). ESSA indicates that the major objective of the review is to review PSEG's assessment as to whether technological measures can be implemented at Salem that will reduce the numbers of organisms lost, where the economic costs are not wholly disproportionate to the benefits. (ESSA Report, page 1.) According to ESSA, ESSA's specific objectives included review of: (1) the accuracy of PSEG's entrainment and impingement mortality estimates; (2) PSEG's evaluation and determination as to available technologies to reduce impingement and entrainment mortality; (3) PSEG's assessment of economic costs and benefits associated with the technologies; and (4) the models and analyses "presented to demonstrate that the actual and potential effects of [the Station] are fully understood and adequately documented" for the RIS (id.).

PSEG agrees in essential respects with this summary of ESSA's Scope of Work. However, PSEG notes that the charge from NJDEP to ensure that the effects of Salem are "fully understood" is one that, from a scientific perspective, is poorly worded: it would be impossible for PSEG, or indeed anyone, to comply with this charge, as science cannot achieve that degree of explication regarding effects on ecosystems. PSEG has never understood the objective of a Section 316(b) demonstration as demonstrating "full understanding" of the Station's effects, but rather as demonstrating, on the basis of reasonable and reliable evidence, that the Station is complying with the requirements of Section 316(b) to minimize adverse environmental impact. PSEG believes that its Application does so demonstrate that Salem Station is not causing any AEI, and that the Station's technology alternatives are BTA for minimizing AEI.

Further, as detailed in Section I.D of this Response, PSEG notes that ESSA took a highly detailed and somewhat compartmentalized approach in conducting its review. As a result, ESSA's Report seems to focus overwhelmingly on the quality of the technical documentation of the Application, rather than on the significance of PSEG's analytical approach of using multiple lines of evidence interpreted by experts. However, as discussed throughout PSEG's Response, the ESSA Report does not, in essence, challenge any of PSEG's basic findings.

B. ESSA Report § 1.2: Structure and Context of Review

This section of ESSA's Report describes the structure and context of its review, indicating that ESSA addressed three distinct analyses in the Application: compliance with the 1994 Permit, the cost-benefit analyses of technology alternatives, and the assessment of the Station's effects on fish populations and the Delaware River ecosystem. (ESSA Report, page 2.) ESSA also indicates that the three analyses are "essentially independent" with respect to methodology and implications of results and conclusions (id.), and states that:

> ... the methodology used to assess the effects of entrainment and impingement on fish in the impact assessment and the methodology used for the cost-benefit analysis of BTA are very different, and based on distinctly different definitions of adverse impact of the Salem station. (ESSA Report, page 2.)

PSEG notes that, although ESSA is essentially correct regarding the relative independence of PSEG's analyses regarding 1994 Permit compliance, the costs and benefits of technology alternatives, and the cumulative impact assessment, ESSA is incorrect in stating that the cost-benefit analysis of BTA and the impact assessment use different definitions of adverse impact. The cost-benefit analysis is not concerned with defining adverse impact, but only with quantifying the relative costs and benefits of the various technology alternatives. In contrast, the impact assessment is concerned with defining adverse environmental impact, which, as discussed in Section I.C.3. of PSEG's Response, is defined at the population level.

1. ESSA Report § 1.2.1: Site Visit and Technical Meetings

In this section, ESSA acknowledges that PSEG "provided the review team with full support and extensive cooperation throughout the review" (ESSA Report, page 4), and describes a site visit and some technical meetings that occurred. PSEG appreciates ESSA's recognition of the efforts PSEG made to ensure ESSA had full access to PSEG's team of specialists and any other assistance that ESSA might need in understanding and evaluating the portions of the Application ESSA was charged with reviewing. However, it is not completely accurate to characterize PSEG's assistance as actually "provid[ing]" the full support and cooperation PSEG would have liked to provide. In fact, as detailed above in Section I.D.3.e., with the exception of a few instances, ESSA did not fully utilize the research assistance and expertise PSEG made available. Had ESSA done so, it is likely that ESSA would have been able to clarify many of the issues that are raised throughout its review. In particular, the ESSA Report does not incorporate or address the supplemental information PSEG provided in the May 2000 Report (see Attachment II-C) that addressed many of the concerns raised in ESSA's Report.

2. ESSA Report § 1.2.2: ESSA Review and Section 316(b)

In this section, ESSA notes that the focus of its review was the "technical and scientific analyses" presented in the Application, and that determination of the "relevance and application of the results of the ESSA review" to Section 316(b) requirements is "outside the scope" of ESSA's task (ESSA Report, pages 3-4). PSEG agrees that ESSA's task did not include making any determinations regarding how its findings should impact NJDEP's Section 316(b) determination.

While PSEG agrees that making any comments evaluating the adequacy of PSEG's Application under Section 316(b) would certainly have been outside ESSA's scope, PSEG also notes that in fact it would have been appropriate for ESSA to take into consideration the Section 316(b) context in evaluating the Application, which ESSA did not do. As detailed at greater length in Section I.D.3.d., the academic, highly critical approach taken by ESSA to evaluating the "scientific rigor" of the documentation in the Application is inconsistent with Section 316(b) legal and regulatory precedent. As a result, many of ESSA's critical comments, while they have some relevance to furthering abstract understanding of some of the highly complex technical matters in the Application, do not translate into practical guidance in assessing whether PSEG's analyses meet the standards for a successful 316(b) demonstration.

Given the potentially slippery slope between taking into account the Section 316(b) context and actually making judgments regarding the adequacy of an analysis under Section 316(b), perhaps the balance struck by the ESSA Report – i.e., ignoring the Section 316(b) context in conducting its review – is appropriate. At any rate, however, PSEG feels it is important that NJDEP and interested third parties reviewing the ESSA Report bear in mind the distinction between ESSA's academic, highly technical evaluations of the analyses in PSEG's Application and the statutory and regulatory standards applicable to those analyses. As detailed at length in Section I.D.2., those precedents consistently indicate that the goal of a Section 316(b) demonstration is not theoretical "scientific rigor," but reasonably reliable evidence sufficient to support a Section 316(b) determination.

C. ESSA Report § 1.3: ESSA Review Team

This section briefly lists and describes ESSA's team of "ecologists, fish population biologists, engineers, and resource economists" that undertook the review (ESSA Report, page 5). The information provided does not allow PSEG to evaluate the merit of the scientific skills of the individual members, but PSEG recognizes and acknowledges that collectively the team appears to possess a level of technical expertise regarding scientific issues relating to ecological and economic analysis. PSEG notes also that its own team of expert scientists, engineers and economists who sponsored the various sections of the PSEG Response are listed in Section I.A.3., with summaries of their qualifications provided in Appendix A to PSEG's Response.

IV. AS NJDEP DETERMINED, SALEM'S THERMAL DISCHARGE IS PROTECTIVE OF THE BALANCED INDIGENOUS POPULATION OF THE ESTUARY AND PSEG IS ACCORDINGLY ENTITLED TO RENEWAL OF SALEM'S SECTION 316(A) VARIANCE

As found by NJDEP, Salem's thermal discharge is protective of the balanced indigenous population (BIP) of the Estuary and, accordingly, PSE&G is entitled to renewal of Salem's Section 316(a) variance. FS pp. 59-64

The Application contains a Section 316(a) Demonstration conducted by PSEG in accordance with Permit requirements that presents the results of a comprehensive thermal monitoring program and new hydrothermal modeling studies characterizing Salem's thermal plume. See Application, Appendix E-IV and V. The modeling results consistently demonstrate that the basic characteristics of Salem's thermal plume are the same as shown by the six earlier plume studies relied upon by regulatory authorities, including the NJDEP, to grant permits or other regulatory authorizations to Salem. The plume is characterized by a very small area of more elevated temperatures in the immediate vicinity of the discharge that cools rapidly as the discharge surfaces and spreads, and a larger area of mildly elevated temperatures. NJDEP has stated that it "agrees that Station operations and the resulting physical thermal plume have not significantly changed since the onset of Station operations, with the exception of extended outages." FS pp. 63-64. The Demonstration also presents two biothermal assessments of the Salem plume, a predictive assessment and a retrospective assessment, which are based on modeling studies, the information generated by the thermal monitoring program, and data on the aquatic populations of the Estuary. The assessments were reconducted in accordance with applicable guidance issued by USEPA. The assessments, which took into account the effects of nearby thermal discharges other than Salem, the interaction of the heat in the plume with other pollutants, and fish losses at the Salem intake, concluded that the discharge has not had and will not have any adverse effect on any RIS populations and will protect the balanced indigenous population of the Estuary. The Department agrees that the ". . . the velocities associated with the [zone of initial milking=ZIM] are high. . ." and "RIS species would not reside in this area of "biological significance." FS p. 64. The Department also noted that the trends in abundance of most of the RIS species appear to be increasing. Id.[55]

NJDEP found that "the administrative record determined that the thermal effects of Salem's discharge assured the protection and propagation of a balanced, indigenous population." FS p. 59. It concluded that the "Department has determined that a variance under Section 316(a) is warranted." Id. at 64.

None of the comments on the Draft Permit filed to date have challenged renewal of the variance.

V. SALEM'S COOLING WATER INTAKE HAS NOT CAUSED AND WILL NOT CAUSE ADVERSE ENVIRONMENTAL IMPACT

Controlling judicial and regulatory precedent require a permitting agency to show that a CWIS is having an adverse impact on populations or communities before it may impose additional technology controls on the intake. Losses of individual organisms, without more, is insufficient. The administrative record fails to show that the Salem CWIS is having an adverse impact on the populations or community of the Estuary. Indeed, it shows affirmatively that it is

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[55] NJDEP determined that PSEG has complied with Special Condition II of the 1994 Permit which provides that on renewal of the Permit, NJDEP's Section 316(a) determination will include, but not be limited to, a review of whether the natures of the thermal discharge or the aquatic population associated with the Station have changed, whether the measures required under the proposed Special Conditions have, in fact, assured the protection and propagation of the balanced indigenous population, whether the best scientific methods to assess the effect of the Permittee's cooling system have changed and whether the technical knowledge of stresses caused by the cooling system has changed.

not having such an impact. Accordingly, as a legal matter, NJDEP may not unilaterally impose additional BTA requirements for the Salem intake. [56]

A. Regulatory and Judicial Precedent Establish That Adverse Environmental Impact Consists of Harm to Populations, Not Individuals; The Benefits to Populations of Fish-Production Conservation Measures Must be Taken Into Account in Determining Adverse Environmental Impact

Under Section 316(b), a permitting authority must demonstrate that an intake is having or will have an "adverse environmental impact" ("AEI") before it can impose additional BTA requirements on a CWIS under the CWA. Under Section 316(b), adverse environmental impact consists of harm to population or communities, not individual losses. This interpretation is dictated by Section 316(b) regulatory precedent and sound science. The position that losses of individuals, without more, constitutes adverse environmental impact is contrary to controlling law, basic ecological principles, and the practice of resource management agencies under analogous regulatory programs. Moreover, consistent with Section 316(b) permitting precedent and ecological principles, the fish production benefits afforded to aquatic populations by PSEG's implementation of the wetlands restoration and fish ladders measures required by the Permit must be taken into account in determining whether the Salem intake is having or will have an AEI.

1. Longstanding Decisional Precedent Under Section 316(b) Defines Adverse Environmental Impact at the Population/Community Level

The controlling precedent on the definition of AEI is found in the USEPA Administrator's Seabrook decisions, which repeatedly made clear that the effects of cooling water intake structures on populations, not losses of individual organisms, are the bases for Section 316(b) determinations. [57] These decisions refused to impose additional BTA controls (relocation of an intake structure), notwithstanding large individual losses, in the absence of a showing that such losses would result in significant adverse population-level impacts. The Administrator specifically recognized that, because of compensatory mechanisms, losses of large numbers of individual early life forms due to impingement or entrainment do not necessarily mean that adult populations will be reduced to an equivalent extent, and that population models which disregard compensation mechanisms are excessively conservative. In Seacoast Anti-Protection League v. Costle, 572 F. 2d 872 (1st Cir. 1998), the First Circuit upheld the Administrator's decision against challenge from environmental groups, based on his finding that there would be no adverse impact on fish populations. Subsequent permitting decisions pursuant

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[56] As discussed in Section VI, PSEG nonetheless accepts and intends to implement the additional intake technology and modification studies required in the Draft Permit.

[57] See In re Public Service Co. of New Hampshire, Seabrook, (NPDES Permit No. 0020338, Initial Decision of Administrator), June 10, 1977 (requiring showing of adverse impacts on biotic populations before additional regulatory requirements may be imposed). In re Public Service Co. of New Hampshire, Seabrook (NDES Permit No. NH0020338, Decision of Administrator on Remand), Aug. 4, 1978.

to Section 316(b) as well as Section 316(b) guidance materials issued by USEPA have followed this interpretation of adverse environmental impact. See Application 114-115, Appendix D, § V.B.; William A. Anderson, II & Eric P. Gitting, Taken in by Intake Structures? Section 316(b) of the Clean Water Act, 26 Colom. J1 Envtl. L 1 38-46 (2001) (hereinafter cited as Anderson & Gitting, Section 316(b)).

These authoritative interpretations confirm that the appropriate regulatory focus under Section 316(b) is on the impact of an intake on overall populations and communities rather than individual organisms. 58/ Such an approach is, for example, apparent in USEPA's 1997 Guidance for Evaluating Adverse Impact of Cooling Water Intake Structures on the Aquatic Environment: Section 316(b) P.L. 92-500 ("USEPA 1977 316(b) Guidance"), which continues to govern Section 316(b) determinations by permitting agencies. 59/ The Guidance invokes a wide number of indicators for assessing AEI, and emphasizes that determinations must be made case-by-case (p. 14), require substantial data (a one- to three-year biological survey in the case of a new plant (p. 14)), and require substantial professional judgment to determine, for example, whether losses of individuals at an intake are causing impacts on a "water-body-wide or local population basis" (p. 39). If, as contended by NJDEP and certain commenters and as discussed below, the loss of a single fish constitutes AEI, there would be no need for the wide-ranging, multi-factor, data-rich assessment of the ultimate effects of intake losses provided in USEPA's Guidance.

2. Sound Science Defines Adverse Environmental Impact at Population/Community Level; This Definition is Confirmed by the Most Recent USEPA Risk Guidelines

A population/community-level interpretation of AEI is the only interpretation that accords with sound science. All individuals die; only populations persist. This simple and indisputable fact is the basis for all scientific approaches to assessing ecological impacts of human activities (Suter and Barnthouse 1993). Biologists define a "population" as a self-sustaining group of organisms belonging to a particular species, in which the inevitable deaths of individuals, whether due to predation, disease, or other causes, are roughly balanced by births of new members of the group. For nearly 100 years, biologists have been studying the various factors that govern the rates of increase or decrease in the numbers of organisms present in populations (Lotka 1925, Deevey 1947; Andrewartha and Birch 1954). For at least 50 years, biologists have been using principles learned from these studies to predict the responses of fish populations to harvesting by fishermen (Beverton and Holt 1954, Ricker, 1975, Hilborn and Walters 1992). This vast body of science has firmly established the fact that estimates of the numbers of organisms harvested or otherwise killed are meaningless unless they are interpreted

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58/ Losses of individual members of endangered or threatened species present a special case. Data from Salem show that its operations are not having adverse effects on any such species. See Application, Appendix H, § I.B.1.b.

59/ See Memorandum by Michael B. Cook, USEPA Director of Office of Wastewater Management (December 18, 2000)(affirming continuing applicability of USEPA 1977 316(b) Guidance) in the context of the total size of the population, the prevailing rates of reproduction and mortality, and the various compensatory processes that permit populations to persist despite natural environmental fluctuations and to sustain high levels of mortality imposed by human activities.

A community is a set of populations that interact through predator-prey relationships, by competing for the same resources, or simply by sharing the same habitat. Any community-level effects of the losses of individual organisms that may exist are inconsequential unless they affect the persistence of populations or the relationships between populations.

The central role of populations and communities in ecological assessments is confirmed in 1998 EPA's Guidelines for Ecological Risk Assessment ("ERA Guidelines"). [60/] According to the ERA Guidelines, ecological risk assessment is "...a process that evaluates the likelihood that ecological effects may occur or are occurring as a result of exposure to one or more stressors." "Stressors," according to EPA, may be physical, biological, or chemical. Although entrainment and impingement are not explicitly identified as "stressors" in the ERA Guidelines, they are applicable to all types of ecological assessments conducted by the agency, including assessments in Section 316(b) determinations.

The selection of "Assessment Endpoints" is, according to the ERA Guidelines, a critical step in the development of an ecological risk assessment:

> Assessment endpoints are explicit expressions of the actual environmental value that is to be protected, operationally defined by an ecological entity and its attributes. Assessment endpoints are critical to problem formulation because they structure the assessment to address management concerns and are central to conceptual model development. (ERA Guidelines, p. 25)

The ERA Guidelines provide specific guidance on defining assessment endpoints in terms of "ecological entities" and "attributes", this guidance makes it clear that assessment endpoints should generally be defined based on population or community-level characteristics:

> Two elements are required to define an assessment endpoint. The first is the identification of the specific valued ecological entity. This can be a species (eelgrass, piping plover), a functional group of species (e.g., piscivores), a community (e.g., benthic invertebrates), an ecosystem (e.g., a lake), a specific valued habitat (e.g., wet meadows), a unique place (e.g., a remnant of native prairie), or other entity of concern. The second is the characteristic about the entity of concern that is important to protect or potentially at risk. Thus, it is necessary to define what is important

60/ The ERA Guidelines were developed to improve the quality of the agency's ecological risk assessments and to increase the consistency of assessments among the Agency's regions and program offices.

> for piping plovers (e.g., nesting or feeding conditions), a lake (e.g., nutrient cycling) or wet meadow (e.g., endemic plant community diversity). For an assessment endpoint to serve as a clear interpretation of management goals and the basis for measurement in the risk assessment, both an entity and an attribute are required. (ERA Guidelines, p. 32)

For endangered species, losses of individual organisms can be a valid assessment endpoint because individual losses may be significant for the sustainability of the population. The loss of 10 individuals out of an endangered species consisting of only 20 members would represent a dire threat to the continued persistence of the species. The loss of 10 individuals belonging to a common fish species consisting of many populations, each of which contains millions or even billions of individual fish, is a quite different situation. The loss of 10 organisms out of a million would not alter the abundance, compensatory reserve, likelihood of persistence, or any other important characteristic of the species. For common species, it is the populations themselves, not the individual organisms, that are "important to protect" and would be "potentially at risk" if the losses were high enough. For such species, which include all of the non-endangered species entrained or impinged at power plants, only population or ecosystem-level assessment endpoints meet EPA's definition and selection criteria. Hence, in accordance with sound scientific principles and the USEPA ERA Guidelines, AEI for the purpose of 316(b) determinations must be defined in terms of effects on populations and communities.

3. The Position That the Loss of A Single Fish or Even of Large Numbers of Individuals, Without More, Constitutes Adverse Environmental Impact is Legally and Scientifically Unsupportable.

In these proceedings, NJDEP has expressed the view that individual losses of organisms at the Salem intake- even the loss of a single fish- constitutes, without more, "adverse environmental impact" for purposes of Section 316(b) justifying BTA regulation. FS p. 70. [61]/ This position has also been expressed by USFWS in its comments on the draft permit. [62]/ This position is squarely inconsistent with the controlling Seabrook precedent and the long line of permitting precedent which has consistently followed Seabrook for more than 20 years. It is also inconsistent with applicable USEPA guidance and sound science. In assessing the "single lost fish" interpretation of adverse environmental impact, NJDEP and USFWS have not discussed or sought to distinguish or otherwise justify their departure from these precedents and principles. [63]/

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[61]/ NJDEP noted that it and PSEG disagree on the proper definition of AEI under Section 316(b). FS p. 70.

[62]/ The New York Department of Environmental Conservation has also recently expressed the view that the threshold for what constitutes an "adverse" impact is a relatively low one. In the Matter of an Application for A State Pollutant Discharge Elimination System (SPDS) Permit by Athens Generating Co., LP, NYDEC No.: 4-1922-00055/0001, at 9n.5 (June 2, 2000).

[63]/ NJDEP's current "single fish" definition of AEI is inconsistent with the position that it took in the 1994 Permit proceedings, where it justified the imposition of BTA requirements on

The single fish interpretation espoused by NJDEP not only contravenes the long-standing precedent under Section 316(b), but is also inconsistent with the approach taken by resource management agencies, including USFWS, in similar regulatory contexts.

The single fish definition of AEI espoused by NJDEP and USFWS in the context of regulation under Section 316(b) is also inconsistent with the population-level approach taken by resource management agencies, including USFWS, under analogous regulatory programs.

For example, in implementing the Marine Mammal Protection Act ("MMPA") both USFWS and NMFS look to impacts on communities, rather than on individuals, to assess impacts for regulatory and management purposes. In determining whether a take of marine mammals has a negligible impact, the USFWS implementing regulations require that the agency "take into account the status and the particular biological requirement of the species or stock, as well as the effects of the incidental taking on the rate of recruitment." 54 Fed. Reg. 40,338, 40,342 (1989). The FWS has recognized that qualitative, case-by-case judgments must be made on how anticipated incidental takings of individuals would affect the status and population trends of the species or stocks concerned. Factors used in making this determination include "the status of the species or stock relative to its optimal sustainable population, whether the recruitment rate for the species is increasing, decreasing, stable or unknown, and the size and distribution of the population, and existing impacts and environmental conditions." Id. at 40,341.

NMFS takes a similar approach based on population-level analysis under the MMPA. In its general guidelines, NMFS states that a take of marine mammals will be permitted if, "based on the best scientific evidence available, the total taking by the specified activity during the specified time period will have a negligible impact on species or stock of marine mammal(s) and will not have an unmitigable adverse impact on the availability of those species or stocks of marine mammals intended for subsistence uses." 50 C.F.R. § 216.102(a) (1997) (emphasis added).

The Magnuson-Stevens Fishery Conservation and Management Act, 16 U.S.C. § 801 et seq., also uses concepts of overall communities and populations to establish allowable harvest levels of various species of commercial fish. In determining whether a proposed agency action will have an adverse environmental impact and thus require preparation of an Environmental Impact Statement under NEPA, agency practice and judicial decisions recognize that adverse environmental impact with respect to biota consists of harm to populations or communities, not losses of individuals, except in the case of endangered or threatened species. Even under the Endangered Species Act, losses of individuals are relevant only to the extent that they impact populations Under the Federal Power Act, FERC has applied population-based standards in issuing licenses for new power plants. See Application, Appendix D-§ V.B.3.

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its determination that the Salem intake losses posed a "potential" for AEI. [1993 FS/SB, page 137] NJDEP's 1994 approach implicitly accepted a population/community-level definition of AEI but presumed (erroneously, in PSEG's view) that a determination of "potential" effects at such a level is sufficient to satisfy Section 316(b)'s threshold prerequisite for BTA regulation. NJDEP has not provided an explanation for its changing its 1994 position.

Thus, practice under other relevant regulatory and resource management programs accords with the longstanding interpretation of AEI under Section 316(b) and also reflects sound scientific principles; adverse environmental impact must be defined at the population or community level. There is no basis in law, policy, or sound science for a single fish definition of AEI.

Thus, the "single fish" interpretation of AEI espoused in this proceeding by NJDEP and USFWS contravenes longstanding Section 316(b) precedent, disregards sound science, and is inconsistent with relevant resource management policy and practice.

NJDEP and USFWS may be espousing the single fish interpretation in order to effectively eliminate the need to establish AEI before imposing Section 316(b) regulation. Any CWIS, even one at a facility that uses cooling towers, involves some losses of individual organisms. This attempted shortcut, however, is obviously inconsistent with Congressional intent. If Congress had intended to equate AEI with loss of a single fish, there would have been no need for it to require permitting agencies to establish AEI before requiring BTA regulation on a CWIS, since each and every CWIS would be causing AEI. Congress would simply have authorized permitting agencies to require BTA for all CWIS. Since that is not the course that Congress took, it must have intended that AEI constitute something more, namely adverse effects at a population/community level.

It is understandable that Section 316(b) permitting agencies might wish to avoid the need to establish adverse impact at the population/community level. As USEPA's 1977 Guidance makes clear, such determinations require considerable data, analysis,, and the application of expert judgment. The single fish interpretation promises an easy escape from the tiresome need to address such matters. This promised escape, however, is illusory. Even if the single fish interpretation were valid, thereby enabling a permitting agency effortlessly to meet the threshold burden of showing AEI, the permitting agency would still have to determine the magnitude of adverse effects at the population/community level in determining BTA. As shown below, Section VI.A, a determination of BTA requires an analysis of the costs and benefits of CWIS technology options; a technology whose costs are wholly disproportionate to its benefits is not BTA. The benefits of intake technologies must be assessed at the population/community level, because it is only effects at that level that affect societal welfare in a manner that affects benefits analysis. Indeed, NJDEP has acknowledged the need to address population-level effects in connection with the determination of BTA. FS page 7 Hence, the need to assess intake effects at the population/community level can not in the end be avoided.

4. The Benefits To Relevant Populations Of Conservation Measures Must Be Considered In Determining Whether There Is Adverse Environmental Impact from an Intake.

A long line of permitting precedent, including NJDEP's decision in issuing the 1994 Permit, shows that conservation and mitigation measures that benefit aquatic life potentially affected by a source's cooling water intake may lawfully and appropriately be included in a NPDES permit pursuant to Section 316(b) where they have been proposed or accepted by the permittee. See Application Memorandum, page 114; Appendix D, Attachment D-1; Thomas J. Schoenbaum and Richard B. Stewart, The Role of Conservation and Mitigation Measures In

Achieving Compliance with Environmental Regulatory Statutes: Lessons from Section 316 of the Clean Water Act, 8 N.Y.U. Envt'l L. J. 237 (2000) "(Schoenbaum & Stewart, Conservation Measures"). This precedent further establishes that the environmental benefits of such measures must be taken into account in determining whether and to what extent an intake will have an adverse environmental impact and the need, if any, for BTA measures. Thus, permitting agencies have in many cases issued § 316(b) permits which provide for conservation measures such as fish stocking programs, fish ladders, wetlands restoration, and construction of artificial reefs. In these decisions, the permitting authority specifically invoked and relied upon the environmental benefits provided by conservation and mitigation measures as a reason not to require additional or more extensive BTA measures. See Appendix D, Attachment D-1; Schoenbaum and Stewart, Conservation Measures at 108 n.14.

B. The Renewal Application Appropriately Evaluated Whether or Not the Salem Intake is Having an Adverse Environmental Impact Through Use of Several Independent Scientifically Recognized Benchmarks Using Multiple Lines of Evidence and Analysis.

Based on USEPA guidance and the relevant science, PSEG selected three benchmarks, each employing a somewhat different perspective, by which to assess possible adverse environmental effects at Salem.

Absence Of Balance In The Indigenous Community Of Aquatic Biota. This community structure benchmark was drawn from Section 101(a)(2) of the CWA, which establishes a "national goal" of "protection and propagation of fish, shellfish, and wildlife"; Section 102(a) of the Act, which adopts as an objective the "protection and propagation of fish and aquatic life and wildlife"; and Section 316(a) of the Act, where it is clear that Congress views the loss of population or community-level "balance" as an adverse environmental effect. [64]/ Three indicators were applied in order to evaluate whether the operation of the Salem intake has caused an imbalance in the aquatic community of the Delaware Estuary: whether the species composition of the Estuary is similar in pre-operational and operational periods; whether fluctuations in species abundance have remained within anticipated ranges; and whether there have been eruptions of nuisance species, non-indigenous species or species indicative of degraded conditions.

Continuing Decline In Abundance Of Aquatic Species. This benchmark evaluates whether any long-term continuous declines in RIS abundance have occurred, and, if so, whether the operation of the Salem intake is the cause. It is drawn from biology and population dynamics. By examining long-term data sets, an evaluation can appropriately place any short-term variability in the context of long-term trends.

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[64]/ Section 301(h)(2) of the CWA, which provides for variances from otherwise applicable secondary treatment requirements for discharges from publicly owned treatment works to marine waters, also invokes the standard of protection and propogation of a balanced, indigenous population of shellfish, fish, and wildlife . . . in and on the water.

Fish Stock Sustainability Placed In Jeopardy. This benchmark considers whether the effects of the Salem intake, combined with the existing effects of fishing, would significantly reduce the ability of fish populations to sustain themselves and place the sustainability of the stocks in jeopardy. This benchmark, drawn from fisheries management, uses predictive models and fishery management reference points to evaluate the potential effects of Salem.

ESSA concluded that the use of these three benchmarks to evaluate adverse environmental impact was appropriate, indeed, "necessary." (ESSA Report, page 75.) It urged, however, that an additional benchmark be used to determine adverse environmental impacts, namely production foregone -- the reduction in forage for predator fish and harvest by the fishery due to intake losses at the Estuary. (ESSA Report, pp. 100-101.) As shown in detail in PSEG's Response to ESSA Report, production foregone is not an appropriate benchmark of adverse environmental impact because it, unlike the benchmarks selected by PSEG, does not measure any ultimate impact on populations or communities. In the terms of US EPA's ERA Guidelines, it does not measure a biological end-point. [65/]

C. Extensive Empirical Data Demonstrate that Salem Has Not Caused and Is Not Causing Adverse Environmental Impact on the Aquatic Population of the Estuary

Because Salem has now been in operation for over 20 years, abundant empirical data for assessing the effects of Station operations on the biologic community and populations of the Estuary are now available. It is no longer necessary to rely solely on predictive modeling studies of potential impact, as had been the case for PSEG's initial 1984 Section 316(b) Demonstration and NJDEP's consultant Versar did in the reports that it prepared for NJDEP during the 1980s. Accordingly, PSEG's Applications used the community structure and population abundance trend benchmarks for determining adverse environmental impact, which were conducted through retrospective studies. The data used by PSEG in conducting these retrospective studies were obtained from a wide range of independent sources, including surveys of aquatic life in the Delaware conducted by NJDEP, DNREC and PSEG over almost 30 years, the results of the extensive biological monitoring program implemented by PSEG pursuant to the 1994 Permit, and data collected and evaluations performed by fisheries management authorities. This rich array of data was evaluated in the context of two benchmarks and several different indicators of adverse environmental impact. The data do not show any adverse environmental impact from Salem's operations. Observations over 22 years of Station operation show no adverse changes in the balance of species present in the Estuary and no continuing downward trends in abundance of species that are attributable to the Station.

65/ ESSA's discussion of production foregone is examined further below, page 88. As shown, evaluation of production foregone attributable to the Salem intake does not show that Salem is having an adverse impact on the aquatic population and communities of the Estuary.

1. The Salem Intake Has Not Caused Any Imbalance in the Balanced Indigenous Community of the Estuary

The first suite of empirical studies of adverse environment impact presented in the Application's Section 316 Demonstration considered whether the data show any adverse effect by Salem on the community structure of the Estuary's aquatic populations. These empirical studies used three indicators of balance/imbalance in community structure. Evaluation, based on data collected over almost 30 years, of each of these indicators concluded that the balanced indigenous community of aquatic biota in the Delaware has not been adversely affected by the operation of the Salem intake.

Species Presence/Absence In Pre-Operational And Operational Periods. The first indicator of community structure used in the studies was species diversity. Biological communities are said to be "diverse" if many species are present. Empirical observations have demonstrated that the diversity of many types of biological communities is reduced by a wide variety of environmental stresses. See Application, Appendix F VII.A. Measures of species diversity are accordingly used as indicators of the influence of environmental stress on biological communities. If effects of Salem are analogous to effects of other disturbances that reduce community diversity, then those effects are likely to be detectable, most likely as reductions in the diversity of the fish community following the startup of the Station.

Two types of measures are especially useful for assessing species diversity for this purpose: *numerical* richness, meaning the number of species present in a collection containing a specified number of individuals, and *areal* richness, also called species density, often measured in terms of the number of species present in a standard-sized sample. The impact of Salem on the fish community of the Delaware Estuary was evaluated by comparing numerical richness and species density in the 1970-1977 pre-operational period to the 1986-1998 operational period based on bottom trawl data for the nearfield region, which is representative of the ecological zone within which the Station is located. The numerical richness analysis showed no difference in richness between the pre-operational and operational periods. The species density analysis showed that the mean number of species per sample in the operational period is significantly greater than the mean number of species per sample in the pre-operational period. Almost all species present in one period were present in the other period. The analysis thus shows that there has been very little change in the fish community in the vicinity of Salem since the startup of the Station in 1977.

Fluctuations Within Anticipated Range. Even if the number of species present in the vicinity of Salem has not changed as a result of Station operations, the relative abundance of the dominant species could have changed in ways that disrupt the functioning of the community. For example, the balance of predator and prey species could be altered if either predators (e.g., weakfish and striped bass) or prey (e.g., bay anchovy) were adversely affected by Salem. Changes in water quality and in fisheries management practices that have occurred since the 1970s have also influenced the abundance of some species. However, these potentially confounding influences would also have affected the balance of predators and prey, but in ways that differ from the expected effects of depletion of species by Salem. Specifically:

- If Salem were depleting predator populations, then the abundance of predators should decline and, because of the reduced level of predation, prey populations should increase.

- If, on the other hand, Salem were depleting prey populations, then the abundance of prey should decline and, because of the reduced availability of prey, predator populations should also decline.

- If improved water quality were increasing the quality or productivity of the ecosystem, then the abundance of both predator and prey species should increase.

- If reduced harvesting of predators were increasing the reproductive success of predator populations (the goal of recent harvest limitations imposed on both striped bass and weakfish), then the abundance of predators should increase and, because of increased levels of predation, prey populations should decline.

Accordingly, in this part of the evaluation, observed changes in the relative abundance of predator and prey species in the Estuary were used to test the hypothesis that Station operations have been depleting predator or prey species against the alternative hypotheses that changes in the abundance of these species have been determined primarily by changes in water quality and fishing mortality.

The impact hypotheses stated above imply that two patterns of change are consistent with significant adverse effects of Salem on predator or prey species: (1) a decrease in predator abundance and an increase in prey abundance, or (2) a decrease in both predator abundance and prey abundance. An increase in the abundance of predators or of both predators and prey would indicate that the abundances of these species are being controlled by factors other than losses at the Salem intake. If improved water or sediment quality were increasing the survival or growth rates of fish that utilize the improved regions, then the abundance of those species (whether predators or prey) should increase. If reduced harvesting were increasing the spawning stock size and reproductive success of harvested predator species, then the number of juvenile predators present in the estuary should increase and the abundance of prey should decline.

An examination of abundance trends in the RIS finfish species showed that seven of the nine have increased in abundance since 1980. Abundance trends for three species, spot (which fluctuated without trend), Atlantic croaker (which increased) and blueback herring (which decreased), are clearly attributable to coastwide environmental phenomena and are unrelated to changes occurring within the Delaware Estuary. The six remaining species, all of which increased in abundance, include both predators (striped bass, weakfish, and white perch) and prey (bay anchovy, alewife, and American shad). Three of these species (striped bass, white perch, and American shad) utilize a region of freshwater Delaware River that has seen major improvements in water quality since 1980. Harvests of three species (striped bass, weakfish, and American shad) have been restricted in recent years to promote recovery of the spawning populations from severe overfishing. The observed abundance trends are, therefore, consistent with the "improved water/sediment quality" and "reduced harvesting" hypotheses. Because both predators and prey have increased, however, the observed trends are inconsistent with the hypothesis that entrainment and impingement at Salem are depleting predator or prey populations and therefore potentially disrupting the predator-prey balance of the Estuary. This result indicates that the abundances of predator and prey species in the Delaware Estuary are, in fact, being controlled by factors such as water quality and fisheries management and not be losses at the Salem intake.

Absence Of Outbreaks Of Nuisance Species. Nuisance species are species that, because of their high abundance and adverse effects on other species, threaten the balance of a community. Outbreaks of nuisance species have not been observed in the Estuary following start-up of Salem operations. All of the available evidence indicates that no outbreaks of nuisance species in the Estuary have occurred that could be attributed in any way to Salem's operations.

Conclusion Regarding Community Balance Benchmark. The data and evaluations with respect to each of the three indicators the community balance benchmark, species presence/absence, population fluctuations, and absence of nuisance species -- all support the conclusion that Salem's intake has not caused any adverse environmental impact.

2. The Operation of Salem's Intake Has Not Resulted In A Continuing Decline In The Abundance Of Any Representative Important Species

The continuing abundance decline benchmark for determining whether adverse environmental impact has occurred is drawn from biology and population dynamics. To minimize the potential for mistaking natural cyclical variability from unidirectional trends, population trends should be examined for as long a period as possible. PSEG's studies used data from three different surveys, carried out by NJDEP, DNREC, and PSEG over almost 20 years. Because young fish are typically the most abundant, because they can be early indicators of population changes, and because life stages younger than one year are those most likely to be affected by the Salem intake, trends in fish less than one year old were the primary focus of the analysis. Indices of relative abundance (average catch per haul) were calculated for each program and then tested for statistically significant trends.

The results of the trends analyses are set forth in considerable detail in the Application, Appendix J. These analyses' using comparable observations and rigorous statistical methods, clearly demonstrate that the abundance of juvenile alewife, American shad, weakfish, Atlantic croaker, striped bass, white perch, bay anchovy and blue crabs has increased during Salem's operation. In the case of Atlantic croaker, white perch, alewife and weakfish, the increases are remarkable, exceeding 10% per year over the period of study. For reasons discussed above in evaluating the significance of trends in abundance data in the context of the community balance benchmark, these increases would not be expected to have occurred if the Salem intake were having a significant impact on these RIS populations.

Abundance of trends for the two species, spot and blueback herring, that do not show increases are clearly the result of coastwide phenomena, not Salem operations. The Delaware Estuary is at the northern extreme of the geographic range of spot. Its abundance in Delaware Estuary in each year depends on its coastwide distribution pattern. Although the abundance of spot in Delaware Estuary has declined, the coastwide abundance of spot, as indicated by fishery landings, has been stable since the early 1980's.

The observed decline in abundance of blueback herring is consistent with trends in landings of river herrings in the Mid-Atlantic region which have declined dramatically since the mid-1960's. That decline began a decade earlier than the beginning of Salem operations.

3. Federal and Interstate Resource Agency Stock Assessments Show Key Fish Populations of the Estuary Continue to Increase in Abundance

Recent independent stock assessments performed by relevant resource management agencies confirm that the Atlantic coastal striped bass and weakfish populations have increased greatly during the period of Salem's operation.

Data compiled by the Atlantic States Marine Fisheries Commission ("ASMFC") (1999) show that from the mid 1980s to the late 1990s the spawning stock biomass of striped bass increased by 20% per year, from 2,000 tons to 14,000 tons. A study performed by the Delaware Department of Fish and Wildlife (Kahn et al. 1998) found that the Delaware Estuary component of the coastal stock greatly increased from 1980 through 1995, and concluded that the population had fully recovered from its formerly depleted state. DDFW's conclusion was supported by the National Marine Fisheries Service ("NMFS") (1998), which stated that the Delaware River striped bass population had "grown exponentially" from the mid-1980s through the mid-1990s, and grew faster than the coastal stock as a whole. While the increase in abundance of striped bass, both within the Delaware and coastwide, is clearly a result of effective stock management, it is significant that this remarkably rapid increase occurred during a time in which Salem was in full operation. This rapid increase would not have occurred if Salem were having a significant adverse impact on the striped bass population.

Similarly, for weakfish, trends in spawning stock biomass and recruitment show that the coastal stock is responding strongly and quickly to fishery management initiatives instituted in the early 1990s. Data compiled by NMFS (2000) show that recruitment (i.e., production of young fish) remained at high levels from 1982-1987, even though excessive fishing was causing declines in spawning stock biomass throughout this period. In the late 1980s, uncontrolled fishing mortality caused both spawning stock biomass and recruitment levels to drop precipitously. When fishing began to be controlled, weakfish recruitment began to increase again, growing at a rate of 14% per year from 1989 through 1999. The spawning stock biomass of weakfish also increased during this period, by an average of 34% per year. According to NMFS (2000), these increases were consistent with the expected effects of the ASMFC's management actions.

These findings are supported by a review of the status of the Estuary's fisheries performed for the Delaware Estuary Program (Santoro 1998). This review found that "[i]ncreases have been noted in the abundance of American shad, weakfish, striped bass, Atlantic croaker, Atlantic silverside, bay anchovy, black drum, hogchoker, northern kingfish, and striped anchovy." Although improved water quality (and, for striped bass and weakfish, improved fishery management) is probably responsible for most of these increases, it is again noteworthy that they occurred during a time in which Salem was in full operation, contradicting the hypotheses that the Salem intake is having a significant adverse environmental impact on the relevant populations.

In short, federal, state, and interstate management agencies confirm that major Delaware Estuary fish species have increased in abundance at a remarkable rate in recent years. There is no evidence of any adverse impact due to Salem.

4. ESSA and Commenters' Criticisms of PSEG's Retrospective Studies Are Without Merit.

Comments and criticisms of PSEG's retrospective analysis were submitted by ESSA, from the U.S. Fish and Wildlife Service ("USFWS") and from Dr. C.P. Goodyear (on behalf of "DNREC"). As shown in greater detail in Attachment VI, these criticisms are either misplaced, insubstantial or simply wrong. They in no way impair the conclusion of the retrospective studies, namely that Salem has not had an adverse impact on the aquatic populations and community of the Estuary.

According to ESSA, all of the retrospective approaches used by PSEG are confounded by changes in other stressors (i.e., water quality, changes in harvest). Inferences made on these assessment endpoints are therefore dependent on historical assumptions regarding other stressors. ESSA argues that, for this reason, alternative indicators -- estimates of total numbers of fish killed by entrainment and impingement, and estimates of the total biomass lost to the ecosystem due to entrainment and impingement -- should be used as indicators of Station impacts. ESSA asserts that these indicators are "related directly to the impacts of the power station intakes, are less confounded by other factors, and require fewer assumptions about unknown parameters." (ESSA Report, page 76.)

With respect to the aquatic community studies, ESSA argues that: (1) the indices used by PSEG are "of undocumented but generally low sensitivity to power stations and other stresses, of unknown ecological significance, and based on data from a small geographic subset of the range occupied by the community" (ESSA Report; page 76); (2) the assumption that absence of observed change means absence of effects is unwarranted, given the many confounding factors that could influence the results. (ESSA Report, page 76); and (3) PSEG failed to consider other components of the ecosystem "such as shellfish, plankton and benthos, as well as other indicators of ecosystem function and structure." (ESSA Report, page 76)

With respect to the trends analysis, ESSA argues that PSEG's results were "exploratory" and that PSEG's conclusions were "premature and overstated," because: (1) "Changes in relative abundance indices over time are confounded by changes in other factors (i.e., changes in water quality, harvest rates) that may mask effects of the station," (ESSA Report, page 76), (2) that trends in spawning stock biomass may not be the same as the trends in juvenile abundance documented by PSEG, and (3) that various assumptions and diagnostic procedures used by PSEG were inadequately documented. (ESSA Report, page 76.)

ESSA also provides comments on the "species-specific retrospective analyses" presented in Appendix H of the Application, which synthesized all of the available information concerning the status of each RIS species and used this information to develop a qualitative evaluation of the significance of Station impacts relative to other factors influencing the populations. ESSA calls Appendix H "a laudable effort at synthesizing a great deal of information from many separate sections of the Permit Application" (ESSA Report, page 137) but claims that "Inconsistency in the use of terminology, poorly defined terms, and a tendency to draw conclusions that are not supported by the information presented detract from the rigor of this section and raises skepticism about the results." ESSA Report, page 76

The USFWS questions the quality of the data used to support PSEG's retrospective analyses, and also states that PSEG had failed to account for confounding environmental influences. The USFWS asserted that "irregularities" in PSEG's finfish sampling programs "impose a bias in the resulting data." USF&W letter dated June 30, 2000, page 4. Specific irregularities discussed by the USFWS include changes in sampling program designs over the period from 1970 through the filing of the Application, changes in gear deployment methods over the same period, inappropriate interpretation of baywide sampling data, and use of the wrong type of midwater trawl. Because of these concerns, the USFWS questioned PSEG's ability to adequately sample finfish and determine effects of Station operations.

In addition, the USFWS noted that a variety of factors influence fish populations, and claimed that without data to separate the influences of these factors from influences of the Station, it is impossible to conclude that the direct effects of the Station on RIS are small or insignificant. The USFWS suggested that recent increases in the abundance of RIS populations might have been even greater except for losses at the Station.

Goodyear does not provide a detailed critique of PSEG's retrospective studies. He simply states that Station operations could cause the relative abundance of species to "shift in important ways" that would not be reflected in PSEG's definition of a Balanced Indigenous Community. DNREC letter dated December 22, 1999, page 3. Goodyear further claims that, in using the trends analysis as an indicator of Station impacts, PSEG was asserting that "... if species don't exhibit declines toward extinction, then there's no deleterious impact." Id.

All of the above criticisms are inaccurate and none refute PSEG's conclusion that Station operations have not had an adverse environmental impact on RIS finfish populations.

The argument that PSEG's retrospective studies do not establish absence of AEI because Salem's effects may have been offset by confounding factors such as improvements in water quality and reduced harvest levels is raised both by ESSA and by the USFWS. PSEG was and is fully aware that all environmental data are potentially subject to confounding influences. Contrary to commenters' innuendoes, these influences were not overlooked or ignored in the Application. Major changes in environmental quality and management practices affecting Delaware Estuary fish populations were specifically described and analyzed in Appendices C, F and H of the Application. This is why PSEG used multiple, independent lines of evidence to evaluate Station impacts, and (in the fish community analysis) used trends in the abundance of predator and prey species to evaluate alternative hypotheses concerning the relative influences of environmental quality, harvest reductions, and losses at the Station on the estuary's fish community. PSEG's conclusions were derived from the combined weight of *all* of the available evidence. Different "confounding factors" would be expected to influence the several different benchmarks used in PSEG's assessment in different ways. For example, the abundance indices used in the trends analysis may be influenced by changes in the spatial distributions of juvenile fish (in response to changes in temperature, flow, or other factors) that increase or reduce their abundance in the regions sampled by DNREC, NJDEP, and PSEG. These changes in distribution may, however, have no effect at all on the indicators used in the BIC analysis. Uncertainty in estimates of the life history parameters used in the stock jeopardy analysis would affect the results of that analysis, but would have no effect on the trends or BIC analyses. Water quality changes could affect the abundance of some species and therefore could be confounding factors for the trends analysis, but might not affect the BIC analysis. Fisheries management changes are potentially confounding factors for the trends analysis but are not confounding factors for the stock jeopardy analysis. The reason for this is that fishing mortality rates are included as specific parameters in the SSB and SSBPR models, and therefore are explicitly considered in the analysis. Thus, PSEG's use of a number of different benchmarks and indicators of AEI, all of which conclude that Salem is not having an AEI, minimizes the risk that the conclusion is compromised by confounding factors and makes it especially robust.

The use of multiple lines of evidence in ecological risk assessments is explicitly discussed and endorsed in the ERA Guidelines at 104:

> Confidence in the conclusions of a risk assessment may be increased by using several lines of evidence to interpret and compare risk estimates. These lines of evidence may be derived from different sources or by different techniques relevant to adverse effects on the assessment endpoints, such as quotient estimates, modeling results, or field observational studies.

ESSA's assertion that estimates of the numbers of fish entrained and impinged (or of "lost biomass" estimates extrapolated from the loss estimates) are "less confounded" and therefore are superior to observations of the actual conditions of the potentially affected populations is contrary both to established principles of scientific inquiry and to accepted standards of ecological risk assessment practice. Raw numbers of fish lost are, in and of themselves, biologically meaningless because of the high rates of mortality typically suffered by early life stages of fish and because of the operation of compensatory mechanisms that act to offset part or all of the mortality imposed by Salem. ESSA's "lost biomass" indicator is similarly meaningless because it assumes that entrained and impinged fish are permanently removed from the ecosystem and that no compensation occurs; moreover, the indicator is not linked to any population-level effects. ESSA's proposed indicators are "less confounded" only in the sense that they ignore all data concerning the actual conditions of the populations being addressed. Moreover, ESSA provides no criteria for determining the ecological significance of any given number of fish or quantity of biomass lost. Without such criteria, ESSA's approach is useless.

The USFWS' assertion that the growth rate of RIS finfish populations in the Delaware might have been even greater except for losses at Salem was not supported by any data or analysis. It's possible to argue that the loss of even a single organism will reduce the growth rate of a population, but for typical fish populations the reduction would be trivially small, ecologically insignificant, and unmeasurable by any conceivable monitoring program. This comment by the USFWS is simply meaningless. There is no way to either prove or disprove this assertion. At least in theory, all mortality, however, large or small, reduces the growth rate of a population. Since there is only one Delaware Estuary, there is no way to test directly whether the small increase in early life stage mortality caused by Salem actually reduced the rate of growth of any of the susceptible fish populations. Because it is unfalsifiable, this comment by the USFWS is simply meaningless. It is likewise useless for the practical business of regulation and resource management.

The ESSA and USFWS technical critiques of the individual retrospective studies presented in the Application are in many cases inaccurate, and in all cases irrelevant to any objective evaluation of PSEG's results and conclusions. As discussed above, ESSA and USFWS claimed that PSEG's fish community indicators are not sensitive to entrainment and impingement impacts, are confounded by environmental variation, and are insufficiently comprehensive because they do not address impacts on ecosystem components other than fish. ESSA argues that PSEG's trends analysis was confounded by environmental variation, failed to consider trends in spawning stock abundance, and was inadequately documented. ESSA also argues that PSEG's "species-specific retrospective analyses," as presented in Appendix H were inconsistent with respect to terminology and were not supported by the information presented. (ESSA Report, page 137.) The USFWS questions the quality of PSEG's data and argues that influences of confounding factors had not been separated.

A large body of peer-reviewed scientific literature supports PSEG's use of the species richness and species density indicators as measures of Station impacts on the Delaware estuary fish community. In spite of the potential influence of natural variations and confounding factors, significant differences were, in fact, found in one of the indicators evaluated. The difference detected, however (an increase in species density between pre-operational and operational periods) is inconsistent with the effect that would be expected if the Station were adversely affecting the fish community (i.e., a decrease in species density). PSEG did not evaluate effects on "shellfish, plankton and benthos, as well as other indicators of ecosystem function and structure" because such an evaluation would be outside the scope of a proper 316(b) Determination. The USEPA 1977 Draft Section 316(b) Guidance, where continued applicability was recently reaffirmed by USEPA (Cook 2000), states that Section 316(b) studies should emphasize meroplanktonic organisms (e.g., opossum shrimp and scud), macroinvertebrates (e.g., blue crab), and fish. Because of their short life cycles and high regeneration capacities, the guidance suggests that phytoplankton and zooplankton should be selected for analysis only if they have a "special or unique value." Contrary to ESSA's criticisms, the guidance does not suggest that impacts on benthic communities should be addressed, or that "other indicators of ecosystem function and structure" should be quantified.

The trends analysis shows that, irrespective of the influences of any confounding factors, data collected by PSEG, DNREC, and NJDEP all confirm that the juvenile abundances of most of the RIS species have increased since the startup of Station operations. PSEG focused on the abundance of juvenile fish because reductions in the annual production of young fish are early indicators of potential future declines in the abundance of adults, and because juvenile and younger fish are most directly affected by Station operations. Hence, strong increases in juvenile abundance are persuasive evidence that Salem is not adversely affecting these RIS. The methods used in the trends analysis are adequately documented in Appendix J to the Application; additional details were provided in PSEG's Response to the ESSA report. "Confounding factors" of the types cited by ESSA and USFWS typically introduce uncontrolled variation into trends data, making the trends more difficult to detect. In PSEG's trends analysis, however, these factors did not prevent PSEG from detecting trends. Therefore, the existence of any such factors is of no relevance to the objective of the trends analysis, which was to determine whether any of the RIS species had exhibited continuing declines that could be related to Station losses. The result of the trends analysis was clear and unambiguous: no such declines occurred; in fact, statistically significant increases were observed in most of the RIS species.

ESSA's comments on Appendix H largely address the form of PSEG's assessment and matters of terminology, but do not affect the substance. Different types and quantities of data are available for different species, therefore, different approaches to evaluating the status of each species are inevitable.

The "irregularities" in sampling noted by the USFWS -- namely, changes in sampling programs and differences among them, should not be unexpected in the context of three independent monitoring programs that span more than 30 years and have been subject to multiple, changing regulatory requirements and program designs throughout that period. As documented in the Application, PSEG employed rigorous data selection criteria to ensure that only comparable data were used in each analysis and that the results derived from those analyses reflected actual trends in the populations and communities being evaluated, not artifacts of sampling.

Taken in total, PSEG's retrospective studies do, in fact, show that the RIS finfish species evaluated in the Application, and the fish community as a whole, have responded exactly as expected to known improvements in water quality and fisheries management, while showing no evidence of any adverse impacts due to the Station. None of the reviewers of PSEG's Application dispute the obvious facts that the fish community of the Delaware Estuary has changed very little since 1970, and that most of the RIS populations are much larger and healthier than they were when the Station began operating.

D. Predictive Assessments Also Show that Salem's Intake Will Not Adversely Impact the Aquatic Populations of the Estuary

The third benchmark used by PSEG in the Section 316(b) demonstration considers whether the sustainability of the RIS fish stocks are placed in jeopardy as a result of the operation of Salem's intake. In applying this benchmark, PSEG used predictive models employed by fisheries management authorities to determine whether various levels of individual mortalities at the intake will adversely affect the sustainability of fish populations when added to existing mortalities from fishing. The analyses concluded that the Salem intake is not impairing the sustainability of the RIS stocks. Although some commenters were critical of certain aspects of these predictive studies, their criticisms are erroneous or unpersuasive and do not disturb the studies' finding of no adverse environmental impact from the Salem CWIS.

1. Analytical Methods Used By Fisheries Resource Agencies Show That Salem's Intake Will Not Impair The Sustainability Of The RIS Stocks.

The fisheries management methodologies used in PSEG's predictive assessment of the Salem intake's effect on the RIS populations are appropriate for examination of Salem's effects because they represent the state-of-the-art in predictive studies and because many of the RIS stocks are managed as fisheries. The sophisticated analytic tools developed and used for fisheries management can appropriately be used to evaluate the potential effects of losses at the Salem intake on these same stocks and to analyze the effects of the intake relative to the effects of fishing mortalities.

Fisheries managers use predictive models based on spawning stock biomass per recruit ("SSBPR") [66]/ or total spawning stock biomass ("SSB") to determine the impact of fishing on stock sustainability. Fisheries managers then set percentages of the unfished SSBPR or SSB to serve as reference points to determine the level of exploitation of stock that will maximize yield on a sustainable basis (e.g., 35% of the unfished SSBPR) or that creates a danger of overexploitation that may threaten stock sustainability (e.g., 20% of the unfished SSB). Fisheries managers seek to regulate exploitation levels that will maximize yield on a sustainable basis while avoiding overexploitation. They consider the removal of 70 to 80 % of an unfished stock's SSB and 65 to 80% of a SSBPR to be safe, given the compensatory reserve inherent in most fish stocks as a result of density-dependent compensation in fish populations.

The stock jeopardy analysis assumed that a potential adverse impact due to Salem would exist if the combined impacts of fishing and Salem would either (1) reduce the SSB of a species to below 20% of the biomass of an unfished population, or (2) reduce the SSBPR to less than 30% of the SSBPR of an unfished population. These criteria are consistent with guidelines provided in the Magnuson-Stevens Fish Conservation Act. Application of the SSB and SSBPR approaches showed that the incremental impacts of Salem would not reduce the spawning stock of any species to a level that could approach or exceed either criterion.

The methodologies used by fisheries managers to assess the impacts of individual losses on fish populations are superior to the approach taken in most studies of the population-level implications of individual losses at cooling water intakes, which have generally focused solely on conditional mortality rates ("CMRs") (fractional reduction in recruitment, exclusive of any effects of compensation, due to the intake). The SSB and SSBPR models provide a better measure of the impacts of stock sustainability than simple CMR results because they focus on the reproductive capacity of a population and directly or indirectly take biological compensation into account. For this reason, the results of analysis based on SSB and SSBPR models are more accurate and relevant in evaluating population-level effects of individual losses, which is why they are widely used by fisheries managers.

PSEG's predictive studies used the SSBPR and SSB approaches to evaluate the incremental effects of individual losses at the Salem intake on the reproductive capacity of the finfish RIS, treating intake entrainment and impingement mortality as the equivalent of any other mortality, including fishing mortality. Indicators of spawning-stock biomass were compared to the biological reference points, such as those used by fisheries managers, to determine whether the losses at the Salem intake, when added to fishing mortalities, would jeopardize the sustainability of the stocks. The Station was assumed to operate at full power throughout the year except for scheduled outages. The data used to implement the SSBPR approach include

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66/ SSB is defined as the total weight of reproducing fish present in a population. SSBPR is defined as the total weight or egg production a recruit (typically a one-year-old fish) is expected to contribute to the spawning stock over its lifetime.

estimates of natural mortality rates, CMRs for entrainment and impingment, and fishing mortality rates for the species being addressed. For the SSB assessment, estimates of the strength of compensation operating in each stock were also included.

The results of the SSBPR and SSB analyses of the population-level effects of Salem intake losses, summarized in Application pp. 131-136 and Appendix F, showed that Salem operations are not jeopardizing and will not jeopardize the stock sustainability of those finfish RIS assessed. The analysis showed that the incremental impacts of Salem on the sustainability of each of those RIS stocks are negligibly small. Even for those species for which existing data are insufficient for full quantification of Salem's impact -- striped bass and Atlantic croaker -- it is clear that Salem's influence is inconsequential compared to the influence of fishing and (for Atlantic croaker) by catch in the shrimp fishery.

2. Commenter's Criticisms of the Findings from the Predictive Assessment are Without Merit

Comments and criticisms of PSEG's predictive assessment of the effects of the Salem intake were received from ESSA, Dr. C.P. Goodyear (on behalf of DNREC), and Dr. Desmond Kahn (DNREC). As shown herein, these criticisms are without merit and do not compromise the predictive studies' conclusion that the Salem intake will not adversely affect the sustainability of the RIS populations.

According to ESSA, the "meta-analysis" approach used by PSEG to quantify compensation in fish populations is "not well enough developed to provide reliable measures of compensation in the RIS species." (ESSA Report, page 144.) ESSA identified four problems that it claimed limit the utility of PSEG's approach, and argued that because of these limitations PSEG's assessment overestimated the strength of compensation in the RIS species. ESSA further argued that PSEG's SSB assessment was biased because of biased estimates of compensation and because of the excessively simplistic nature of the modeling approach used. ESSA stated that the results of PSEG's SSBPR assessment were biased because of purported biases in PSEG's CMR estimates, and that the approach itself is inherently less conservative than the SSB approach and can provide only lower bounds on Station impacts. Id.

Kahn developed his own estimates of striped bass CMRs and used these to argue that the Station had killed approximately one-third of all striped bass produced by the Delaware River during the period 1989-1998. He further claims that harvests would have to be reduced to offset this loss and allow the population to grow.

ESSA's criticisms are largely academic and superficial. The assumptions and limitations inherent in the "meta-analysis" approach used by PSEG to estimate compensation were acknowledged and thoroughly discussed in the Application.

The "meta-analysis" used in PSEG's Application allows conservative estimates of compensation to be derived from analysis of data compiled for hundreds of well-studied species. The term "meta-analysis" refers to a recently-developed statistical technique for using many independent data sets to develop estimates of parameters of interest to scientists. PSEG used meta-analysis to estimate compensation parameters for the RIS species from data sets compiled for several hundred fish species in which compensation has been measured. The scientific credibility of PSEG's use of this meta-analysis approach to quantifying compensation is demonstrated by the fact that since 1995 more than a dozen papers documenting the methods and results of this approach have been published in highly respected scientific journals. These advances in fisheries science, documented in the Application, Appendix I and in Appendixes B-E of PSEG's Response to ESSA, permitted conservative estimates of compensation to be developed for all of the Salem RIS species. These estimates were used in the stock jeopardy assessment as inputs to the SSB approach to analyzing the impact of individual losses on populations.

In its response, PSEG has provided a comprehensive, quantitative analysis of the two most important potential sources of bias discussed by ESSA, and showed that neither could have appreciably affected PSEG's estimates of compensation. New data on the Atlantic coastal striped bass and weakfish populations, made available subsequent to the filing of PSEG's Application, demonstrate that PSEG underestimated the strength of compensation in both species. ESSA's other criticism of the SSB and SSBPR approaches were irrelevant or inaccurate. As demonstrated in PSEG's response to ESSA's report, PSEG's CMR estimates were not biased. Moreover, the model used in PSEG's SSB approach is one of the most widely used models in all of fisheries science. PSEG used the model in exactly the way that it is used by others: to project long-term average populations sizes, based on figure for mortality (whether due to fishing harvests or intake losses), given specific estimates of compensation and other model parameters. The SSBPR approach, contrary to ESSA's assertion, was specifically recognized by the National Research Council (1998) as being appropriate for defining conservative (i.e., protective) levels of losses (whether from fisheries or power plants) that are protective of fish populations, not as providing lower (i.e., possibly non-protective) bounds on impacts.

Goodyear's comments regarding biases in PSEG's analysis were incorrect, and his conclusions regarding the need for management action to offset Station impacts are refuted by published agency stock assessments. As shown in PSEG's response to Goodyear's report, his arguments that the Station may be jeopardizing white perch, striped bass, weakfish, and other exploited fish populations were based on hypothetical, unsubstantiated assumptions rather than as was the case with PSEG's stock assessment studies, on actual data. (PSEG's Response to Goodyear Febuary 2000). His conclusions regarding striped bass and weakfish are inconsistent with the most recent stock assessments for these species (NMFS 2000, ASMFC 1999), which show that both populations have fully recovered from historic overexploitation, are showing clear signs of density-dependent mortality in early life stages, and need no reductions in harvests beyond the agencies' target levels, which do not explicitly take into account losses at the Station.

PSEG did not include striped bass in its stock jeopardy analysis, because adequate data for calculating an entrainment CMR for striped bass, a required input for the SSB and SSBPR models, were not available. The data and method used by Kahn to estimate CMRs for striped bass were, as documented in PSEG's response to Kahn's report, flawed and severely biased. (PSEG's Response to Kahn August 2000) The most important of the flaws in Kahn's calculations was his failure to account for the transport of striped bass early life stages from Chesapeake Bay to the Delaware Estuary through the Chesapeake and Delaware Canal. Previously published studies have documented this transport, and the fact that strong striped bass year classes in Chesapeake Bay (e.g., in 1989, 1993, and 1996) have coincided with anomalously high entrainment of striped bass at the Station strongly suggests that a large fraction of the striped bass entrained in those years were derived from Chesapeake Bay rather than from the Delaware River. Kahn's calculations are also inconsistent with the documented fact that the Station is located well down-river from the principal spawning and nursery habitats utilized by striped bass in the Delaware. Finally, the overall credibility of Kahn's analysis is severely compromised by his earlier use of the same information to argue an opposite conclusion. In his Salem analysis, submitted in 2000 to NJDEP, Kahn stated:

> [The] conditional mortality [of striped bass] is high enough to be of serious concern, since it must be considered in addition to fishing mortality in stock management and may be a major impediment to stock productivity.

Kahn's Salem analysis also stated that

> The resilience of this stock [striped bass], or its ability to recover from reduced densities, has been reduced. In addition, it will not be possible to attain Maximum Sustained Yield from this stock, since exploitation has to be reduced to allow sufficient spawning stock biomass to accumulate. This reduction is exploitation will be marked, since about 1/3 of the stock is killed at the outset of its life.

But in 1998, in a DNREC submission to fisheries management agencies that used the same data as the Salem submission, Kahn presented a very different conclusion -- Kahn's 1998 stock assessment found that the striped bass population had fully recovered and that fishing restrictions should be lifted:

> [o]ur conclusion is that the Delaware River striped bass stock should be declared restored by both the Delaware River Basin Fish and Wildlife Management Cooperative and the Atlantic States Marine Fisheries Commission and can be safely fished at rates at or below the targets developed for Atlantic Coast striped bass. Indeed, this stock has continued to grow while being fished at rates similar to other stocks in the recent past.

Kahn's 1998 conclusion, issued prior to initiation of the preceedings for renewal of the Salem Permit, was consistent with findings of the NMFS Stock Assessment Review Committee (NMFS 1998). The ASMFC accepted DNREC's recommendation and declared the Delaware River stock to be restored (ASMFC 1998, Addendum III to Amendment 5 to the Interstate Management Plan for Atlantic striped bass). Kahn's 1998 argument that the striped bass stock is healthy clearly contradicts his current assessment, submitted in the context of this Salem Permit renewal proceeding but based on the same data. Kahn's 1998 report was endorsed by a NMFS peer review committee and by the ASMFC. Accordingly, his 2000 report is not credible.

In sum, the criticisms by commenters of PSEG's predictive assessment are unavailing and do not disturb the assessments' finding that the projected future losses at the Station will not in any way jeopardize the health and sustainability of Delaware Estuary fish populations.

E. Salem's Numerically Large Intake-Related Losses Must Be Evaluated in the Light of Natural Mortality and Mechanisms of Biological Compensation and Were Appropriately Considered in PSEG's Evaluations of Adverse Environmental Impact

ESSA argues that estimates of raw Station losses (numbers of organisms entrained and impinged), and estimates of "biomass lost to the ecosystem" extrapolated from the losses, should be used as additional indicators of AEI, because they are "more direct" measures of Station impacts than are PSEG's benchmarks. The USFWS argued that the magnitude of the losses alone is sufficient to show that Station impacts are ecologically significant. These contentions are without merit.

Neither ESSA's nor the USFWS's arguments address the fundamental question of impacts on populations, which is at the heart of any scientifically valid definition of adverse environmental impacts. Unless interpreted in the context of populations, the loss estimates, and any secondary indicators derived from the loss estimates, are meaningless.

Using 1998 data as an example, the USFWS asserts that more than 3.3 billion "fish" are lost each year at the Station due to entrainment, and that a further 5.5 million are lost due to impingement. The USFWS does not acknowledge that the great majority of these "fish" are not "fish" as understood in common parlance, but fish eggs and larvae. For the year in question, 2 billion of the entrained "fish," or more than 60% of the total, were bay anchovy. Of these, 1 billion were eggs and 0.8 billion were larvae. These two life stages represent approximately 90% of all the bay anchovy lost due to entrainment and impingement combined in 1998. The apparently large number of bay anchovy organisms lost at the Station in 1998 -- 2 billion organisms, almost all of them eggs and larvae -- is an extremely small fraction of the number that were actually present in the Estuary during that year. According to data from PSEG's baywide survey for 1998, approximately 46 trillion bay anchovy eggs, larvae, and juveniles were estimated to present in the Estuary that year. Station losses accordingly represented less than $1/200^{th}$ of 1% of that total.

1. High Natural Mortality Rates Minimize Effects of Losses of Early Life Stages.

Natural mortality rates in early life stages of fish are extremely high, so that only a small fraction of the entrained eggs or larvae would survive to adulthood, even if Salem did not exist. For example, a single female striped bass can spawn up to 4 million eggs in a single year and up to tens of millions of eggs over her entire lifespan. On average, only two of these eggs need to survive to adulthood to sustain the population according to mortality rate estimates found in the scientific literature and presented in the Application. Only about 25% of striped bass eggs are likely to hatch successfully. Less than 0.07% of the newly-hatched larvae will survive to the juvenile life stage, and of these only 4% will survive to the age of one year. Altogether, less than one striped bass egg in 100,000 is likely to survive to become a one-year-old fish, and less than one in a million is likely to survive to reach six years of age, the median age at which female striped bass become sexually mature. Mortality rates for early life stages of other species susceptible to entrainment and impingement at Salem are similar. Even a very small fish such as the bay anchovy can spawn up to 50,000 eggs per year, of which only two are likely to survive to become one-year-old adults. For this reason, counts of total numbers of organisms killed, irrespective of the life stage affected, reveal very little about the impact of the Station on fish populations.

2. Compensatory Mechanisms Operate to Sustain Populations Despite Losses of Early Life Forms.

By "compensation," biologists mean a tendency for the growth rate of populations to decrease when populations are high and to increase when populations are low. Any biological population that persists despite natural fluctuations in the environment must exhibit some degree of compensation. In fact, the concept of compensation is fundamental to the understanding and management of all natural populations. Many different mechanisms of compensation have been documented in both terrestrial and aquatic ecosystems. See Application, and Appendix I to PSEG's Response to ESSA, Appendix E. If compensation did not exist, species could not sustain themselves in highly variable natural environments or sustain the additional mortalities imposed by fishermen and by power plants.

Identifying the operation of compensation and quantifying the effects of compensation have been a major focus of fisheries science for decades. For well-studied species such as striped bass and weakfish, empirically verified species-specific models that quantify compensation are used by resource management agencies to estimate future population sizes and establish allowable harvest rates. For other species, new methods such as

Several recent studies on major fish stocks (i.e., Hudson River striped bass stock, Atlantic coast striped bass stock, Atlantic coast weakfish and Atlantic coast demersal fish stocks) provide strong evidence for the presence of compensatory mortality. These studies are briefly summarized in this section.

The Hudson River striped bass population has been studied intensively for over two decades by the Hudson River utility companies and the New York State Department of Environmental Conservation ("NYSDEC"). (Draft Environmental Impact Statement ("DEIS"), State Pollutant Discharge Elimination System Permits for the Indian Point, Bowline Point, and Roseton generating stations (Central Hudson Gas & Electric Corp, et al., 1999).

These studies indicate that the abundance of the adult component of the Hudson River striped bass population has grown substantially since 1980, while the operation of three large power plants located in the principal nursery area utilized by early life stages of striped bass has continued. The large year classes produced since 1980 were not heavily fished, resulting in a large increase in the size of the spawning stock by the early 1990's. As the size of the spawning stock increased (due to controls on fishing mortality), the densities of striped bass early life stages in the estuary also increased. However, the average abundance of juvenile striped bass, as reflected in the annual NYSDEC beach seine index, did not increase. This is because the relative productivity or index of pre-recruit survival (recruits, "r", divided by spawning stock biomass, "ssb", that produced it) decreases as the spawning stock biomass increases.

The lack of correlation between early life stage abundance and subsequent year-class strength was noted previously (Pace et al. 1993). Data for recent years, presented in the DEIS, confirm this pattern. The abundance of early life stages of striped bass in the Hudson River estuary has continued to increase with spawning stock size, but juvenile abundance has not increased. Recruitment production is equal to the relative productivity multiplied by the spawning stock biomass. When recruitment remains stable as spawning stock biomass increases then the decrease in relative productivity just offsets the increase in spawning stock biomass. The increase in abundance of adults, eggs, and larvae, coupled with stable production of juveniles, provides strong evidence for density-dependent mortality of early life stages of striped bass in the Hudson River estuary.

The above data were used to develop a stock-recruitment model of the Hudson River striped bass population (Appendix VI-4 of the DEIS). Analysis of the model indicated that reproductive success in striped bass is highly density-dependent or compensatory in nature. Density-dependent mortality is so strong that annual CMRs as high as 20% on fish less than Age-1 would result in only an approximate 1% reduction in average annual recruitment (assuming a fishing mortality rate of F<0.5, and a 28 inch size limit).

According to the ASMFC stock assessment for striped bass, the abundance of the east-coast stock of striped bass has increased since 1989 (ASMFC 1999, Figure 11). As documented in Appendices J and H of the Application, the abundance of juvenile striped bass in Delaware River also increased over those years. During this period of increasing abundance, the first-year survival rate of striped bass has been decreasing. The decrease in first-year survival rate is indicated by a pronounced decline in the ratio of the number of recruits (i.e., Age-1 fish) to the spawning stock biomass (i.e., the total weight of spawning aged fish in the population). This decline in first year survival rate in response to the increase in spawning stock biomass (Figure 12) is characteristic of the presence of strong density dependent mortality.

The 30th Stock Assessment Review Committee ("SARC") report documents increases in the abundance of the stock of weakfish since they early 1990's (NMES 2000, Figure 13). The abundance of juvenile weakfish within the Delaware estuary increased during that period also (see Appendices J and H of the Application). As was the case for striped bass, the first-year survival rate of weakfish (as measured by the ratio of the number of recruits to the spawning stock biomass) declined sharply while the spawning stock biomass increased (Figure 14). Again, this pattern is characteristic of the presence of strong density-dependent mortality. In the 30th SARC report, the authors stated that "the rapid rebuilding of the stock reflected high estimated compensatory reserve."

In July of 1999, the Stock Assessment Workshops Northern Demersal Working Group reviewed the relative productivity (r/ssb) for eleven groundfish stocks (NMFS 2000). For all eleven stocks, the maximum value of r/ssb occurred at or below average ssb level of abundance. Similarly, for 8 out of 11 stocks, the minimum r/ssb value occurred at an above average ssb level. The working group concluded: "The apparent decline in r/ssb, as ssb increased in 10 out of 11 stocks, was consistent with the notion that compensation influenced relative productivity of these stocks." This recent report is consistent with other information, documented in Appendix I of the Application, demonstrating that density-dependent responses to increased mortality are commonly observed in fish populations and that the concept of compensation is now firmly entrenched in fisheries management practice.

The SSBPR approach, which has become a standard analysis tool of fisheries managers, was developed as an indirect method of estimating the amount by which the spawning stock of an exploited fish species can be reduced without threatening future recruitment due to the presence of compensation. The approach assumes that the expected lifetime reproductive capacity of a typical recruit (i.e., a 1-year-old fish) measured either as egg production or as spawning stock biomass, provides an indirect estimate of the replacement capability of a population. To sustain a population, each female recruit must produce enough eggs over its lifetime to exactly replace itself, i.e., to produce another one-year-old female fish. In a typical unfished population, however, a female recruit can lay enough eggs over her lifetime to produce 5, 10, or even 20 new female recruits under optimal environmental conditions. The excess reproductive capacity is termed "compensatory reserve," and is an indirect measure of compensation. Mortality imposed by fishermen reduces this compensatory reserve because it reduces the expected lifespan of each fish, and therefore the number of eggs it can be expected to contribute to future generations. Published research has shown that the compensatory reserve of many fish populations, as measured in terms of "spawning stock biomass per recruit," can be reduced to surprisingly low levels (e.g., 20% or less of the SSBPR in an unfished population) without resulting in a detectable decrease in recruitment. The reason for this is that, because of compensation, a reduction in the number of eggs produced per recruit results in an increase in the probability that each spawned egg will survive to become a recruit.

The observed trends in abundance of major fish populations of the Delaware Estuary confirm the operation of compensation. If the Station were significantly depleting these populations, then after more than 20 years of operation a measurable reduction in abundance of the most vulnerable species should have occurred. However, only two of the 9 RIS finfish species have failed to increase over the period of operation of the Station. The abundance of both of these two species, blueback herring and spot, were shown in the Application (Appendices H and J) to be controlled by coast-wide environmental processes unrelated to conditions in the Delaware Estuary.

3. Contrary to ESSA's Claims, Production Foregone is Not An Appropriate Benchmark of AEI; Analysis of Production Foregone Does Not Show That Salem is Having an Adverse Environmental Impact.

In its Report, ESSA describes a method for using entrainment and impingement loss estimates to calculate the "production foregone" to the ecosystem due to Station operations. According to ESSA, production foregone is a measure of the impact of the Station on the ecosystem as a whole. ESSA claims that this indicator requires fewer assumptions than PSEG's benchmarks and indicators. This claim is erroneous. ESSA's proposed indicator is based on a crudely simplistic view of estuarine ecosystems, relies on assumptions that are demonstrably false, and because of those assumptions grossly overstates the actual impacts of the Station on estuarine fish production. Moreover, the production foregone indicator has no credible scientific foundation and no regulatory precedents as a measure of population impacts.

Fish production within the Delaware estuary is ultimately derived from primary production, i.e., the conversion of inorganic matter to living biomass by green plants. Invertebrates such as opossum shrimp and scud consume plants and decaying organic material, and are consumed, in turn, by small fish, including forage species such as bay anchovy and early life stages of other species. These small fish constitute the prey biomass available for consumption by predators such as striped bass and weakfish.

ESSA's approach to calculating production foregone assumes that the biomass of entrained and impinged organisms would all have been eaten by predators. ESSA's approach also assumes that all of the future growth of entrained and impinged organisms, had they survived, would be removed completely from the ecosystem. Furthermore, ESSA's model assumes prey that would have been consumed by the predator fish lost at the intake (if the predator fish had survived) would never be eaten by other predator fish in the Estuary, and therefore would not contribute to the growth of any other fish.

ESSA's approach is deeply flawed because it ignores the effects of density-dependent compensation and alternative energy pathways within the ecosystem. The prey organisms that would have been consumed by the entrained or impinged fish, had they survived, are available for consumption by other predator fish in the Estuary. Because of reduced competition and increased prey availability, the fish that are not lost at the intake grow more rapidly and suffer lower rates of natural mortality. Ultimately, a large fraction of the biomass lost due to the deaths of entrained and impinged fish may be recovered due to a compensatory increase in the biomass provided by the survivors. The processes responsible for compensation are well-documented in the scientific literature, and are summarized in Appendix I to PSEG's Application. The degree to which these processes offset the direct losses at the Station can be estimated with sufficient accuracy for the purposes of assessing Salem's impact on populations using the methods used by PSEG in its SSB analysis. It is possible that the only biomass actually lost to the ecosystem is the biomass of the entrained and impinged organisms at the time of death. Even this loss may simply be a transfer of biomass from one component of the community to another. Blue crabs, a Salem RIS, would be among the many species that could utilize this biomass. Furthermore, the Station does not remove biomass from the ecosystem, and does not alter the productive capacity of the ecosystem. Rather than being removed from the ecosystem, entrained and impinged early life forms and fish are returned to the Estuary where they are available for consumption by other organisms. If not consumed, they decompose and the nutrients released become available for new primary production. Because of the recycling of the organisms that are entrained and impinged, more invertebrate biomass is produced.

Even if a scientifically sound and more realistic indicator of production foregone than that advanced by ESSA could be developed, such an indicator would still not be a valid benchmark of AEI. All three of PSEG's benchmarks satisfy three key criteria necessary for a regulatorily valid assessment: they are directly related to population or ecosystem health; they are supported by clear regulatory precedent; and for each benchmark, objective criteria exist by which the significance of measured or predicted impacts can be interpreted. An improved production foregone indicator might arguably be related to population or ecosystem health. Such an indicator, however, would still not satisfy the other two criteria. First, ESSA cited no regulatory precedents for using production foregone to assess adverse impacts of mortality imposed on fish populations; PSEG is aware of no such precedent. Second, no criteria exist for determining the magnitude of foregone production that should be considered adverse. Without such criteria, ESSA's indicator is useless for determining AEI.

4. PSEG's Studies Appropriately Evaluated the Ecological Significance of Salem Intake Losses.

All of PSEG's benchmarks of AEI were developed using established scientific methodologies and are consistent with applicable guidance and assessment practices. Each benchmark addresses impacts of the Station at the population or community level, the appropriate level of organization for determining AEI. Each appropriately reflected or took into account natural mortality and compensation. Each benchmark was addressed independently, using different data sets and analytical methodologies. PSEG's conclusions were derived from the combined weight of the evidence and conclusions for all three benchmarks, an approach that is recognized by US EPA's ERA Guidelines as being appropriate for dealing with the inevitable uncertainties and confounding influences associated with biological studies in complex and variable environments.

The weight of evidence from PSEG's studies clearly demonstrates that the Station's cooling water intake structure has not had, and will not in the future have, an adverse environmental impact on the aquatic populations and comments of the Delaware Estuary.

F. The Further Monitoring and Analytical Studies Required by NJDEP will Appropriately Address Concerns Raised by ESSA and Commenters Regarding the Assessment of the Effects of Salem's Intake on Aquatic Populations

As previously noted, PSEG fully implemented all of the many components of the extensive biological monitoring program required in the 1994 Permit, as NJDEP has determined FS page 51. During the course of its implementation, the monitoring program was refined and adjusted by PSEG in consultation with the MAC and modifications were approved by NJDEP. ESSA's Report contains comments of the form and adequacy of some of the monitoring data and data analyses used in PSEG's assessments of Salem's effects. (ESSA Report § 5.6.) As shown in detail in PSEG's Response to ESSA, these criticisms lack substantial merit and do not affect the validity of the assessments' conclusion that the Salem CWIS is not having an adverse impact on the populations and community of the Estuary. (PSEG's Responses to ESSA, Section VII). ESSA's report also made recommendations regarding expanded or additional data collection and analyses to be conducted in the future. (ESSA Report, page 152-53.)

NJDEP gave appropriate consideration to the monitoring and data analysis issues raised by the ESSA Report, which were echoed by some commenters (Attachment VI), and to ESSA's recommendations in determining the monitoring and data analysis requirements in the Draft Permit. FS pp. 58, 72-75, 77. The Draft Permit continues the basic elements of the extensive biological monitoring program required by the 1994 Permit, but adds a number of new and additional elements, many of which were recommended by ESSA. The results of these new or expanded study efforts will assist NJDEP, other resource agencies, and the public in assessing the effects of Salem.

The revised and expanded monitoring and analyses program required by the Draft Permit was summarized by NJDEP as follows:

- continued monitoring for adult and juvenile passage of river herring in connection with fish ladder sites. Stocking of impoundments shall also be continued until such time as the adults using the ladder meets the minimum number of adults calculated per acre for the minimum number of juveniles (1005 / acre).

- improved impingement and entrainment abundance monitoring
- improved bay-wide abundance monitoring
- review and discussion as to the appropriateness of the representative important species
- continued detrital production monitoring, including vegetative cover mapping, quantitative field sampling and geomorphology.
- continued study of fish utilization of restored wetlands
- other special monitoring studies as may be required by the Department and/or recommended by the EEPOC. Residual pesticide release monitoring could be required for any replacement acreage deemed necessary. FS page 57.

This program must be implemented in accordance with a Biological Monitoring Program Work Plan to be prepared by PSEG, submitted to EEPOC for review, and approved by NJDEP.

In specific response to ESSA's comments, NJDEP proposes to require PSEG to conduct a "revised fisheries analysis" that would "address ESSA's findings regarding the Production and Catch Foregone analysis." FS, page 72. NJDEP notes that the ESSA Report had raised issues concerning "the utility of biological survey data as it relates to the trends and the survey data for each RIS." Id. It stated that: "The Department is requiring improved biological monitoring [referring to the elements summarized above] which will aid in addressing this concern. Improved biological monitoring will also improve any future fisheries analysis including loss estimate." Id. NJDEP also noted that the Draft Permit would require the following with respect to further analysis of losses at the Salem intake, FS at pages 72-73:

- The biomass lost to the ecosystem should be calculated either using a slightly modified version of the production foregone model for all RIS or the spreadsheet approach.
- The contribution of RIS other than Bay Anchovy to the forage available for commercial and recreationally important species should be examined. This has the potential to significantly increase the estimates of lost revenue in the fishery.

- A more detailed analysis of the levels of uncertainty in the production and catch foregone estimate needs to be considered.

- The estimates used for the survival rates Age 0 -- Blueback Herring used in the Appendix F4 analysis (March 4, 1999 application) should be reviewed given the different values used in Appendix G-6.

- The base case entrainment and impingement mortality estimates should be compared against the historical averages to ensure consistency.

- Projected increases in RIS abundance should be included in the estimates of catch and production foregone.

- The potential to customize intake protection strategies to minimize the impact of the plant on catch foregone and the biomass lost to the ecosystem should be further investigated.

In further response to ESSA's recommendations, the Draft Permit proposes that PSEG be required to conduct a number of studies of the hydrodynamics at the Station intake, FS page 74; to study enhancements to entrainment and impingement sampling and analysis, FS page 75; and to estimate fish production from the wetlands restoration sites and the fish ladders and intake losses in common units of biomass. FS page 77.

Thus, NJDEP gave full and appropriate consideration to ESSA's concerns and recommendations, and has proposed many new and additional requirements regarding biological monitoring and analyses in the Draft Permit. The new and additional information that would be produced as a result of these requirements will assist NJDEP and the public in continuing to monitor and evaluate the effects of the Station intake, the benefits of the marsh restoration and fish ladder measure, and the appropriate nature of permit requirements for Salem. 67/

G. The Wetlands Restoration and Other Conservation Measures Implemented by PSEG are Providing Significant Benefits to Fish Populations and Must be Taken into Account in Assessing the Overall Impact of the Station, Reinforcing the Conclusion that Salem is not Having an Adverse Environmental Impact

In determining whether the Station intake is having or will have an adverse environmental impact on the fish populations of the Estuary, permitting authorities must take into account the benefits provided to those same populations by PSEG's compliance with the Permit requirements for marsh restoration and fish ladder construction. Application, Appendix D-§ V.C.4, Anderson & Götting, Section 316(b), at 47; Schoenbaum & Stewart,

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67/ In requiring these additional expanded studies, NJDEP specifically noted that even if this new and additional information had been available in time for consideration in this permit renewal proceeding, it would not have affected the Department's BTA determinations because, as ESSA found, there are at present no additional intake technology measures to protect fish that are suitable and appropriate for implementation at Salem. FS p. 72.

Conservation Measures, at 107-108, 158, 164. As noted by NJDEP in its Section 316(b) determinations on Permit renewal, "it is important to consider the available evidence relevant to assessing the fish production benefits of these measures." FS p. 75. As explained by NJDEP, FS p. 5, the primary objective of the Permit conditions, is to increase fish production in order to address any potential impacts of Salem's intake. As explained more fully below in Section VII, the restored marshes and the impoundments made accessible by fish ladders are increasing the Estuary's biological productivity. This production will increase further in the future. These contributions must be included in considering the overall effect of Salem on the populations of the Estuary. Accordingly, before imposing any additional intake requirements, the NJDEP must determine that the Salem intake is having or will cause an AEI on the populations of the Estuary, taking into account the productivity benefits provided by the marshes and fish ladders.

As noted by NJDEP, "Marsh restoration and the revival of the river herring runs are not yet fully complete and a widely acceptable common metric for quantifying all of the increased production is not readily at hand." FS p. 75. NJDEP further noted, however, that "the evidence is clear that the restored marshes, are quickly coming to have the form and function of 'natural marshes' based on a comparison of restored verses (sic) reference marshes." Id. As shown in detail in the Application, the restored marshes at the former salt hay farm sites are already providing benefits to fish populations like those provided by the reference marches. Bioenergetics modeling and evidence from stable isotope analysis confirm that the most fully restored marshes are already providing significant food benefits to the fish that use the marshes, including fish that later migrate to open waters. The NJDEP noted that "the evidence shows that the restored marshes are producing food that is eventually consumed by upper-level predators, which would include many of the commercially and recreationally important RIS." FS p. 76.

The restored salt hay farm sites and *Phragmites*-dominated sites are increasing detrital production in the Delaware Estuary. Detrital monitoring for standing crop biomass was initiated by PSEG in 1995 at selected wetland restoration sites and reference marshes and has continued annually since that date. Monitoring of those portions of the restored sites that are already dominated by *Spartina* shows levels of biomass production indistinguishable from those at the reference marshes and near the high end of the range of peak season biomass reported for *Spartina* in salt marshes along the Atlantic coast. (PSEG 1999 Application, Exhibit G-2-4). The contribution of this biomass to the Estuary for the benefit of its aquatic populations will increase in the future as restoration progresses.

In addition, as noted by NJDEP, "more than 700 acres of impoundments are being made available for river herring spawning as a result [of PSEG's] installation of fish ladders." FS p. 76. As also noted by NJDEP, PSEG studies estimate that these ponds will produce significant amounts of forage fish for consumption by predator fish such as striped bass and weakfish as well as 200,000 adult river herring, which will be available for fishery harvest or for spawning. Id.

Consideration of these substantial fish production benefits from the wetlands restoration and fish ladder programs reinforces the conclusion that the Salem intake is not causing and will not cause an AEI on the Estuary's aquatic population. [68]

H. Integrated, Cumulative Environmental Assessment Shows that Salem's Cooling Water Intake is Not Having an Adverse Environmental Impact

The Application also presents the results of a cumulative assessment of the effects of the Station on the aquatic populations of the Estuary. See Application, Appendix H. The cumulative assessment considers the combined effects of impingement of organisms on the intake, entrainment of organisms through the cooling water system, and contact with the thermal plume created by the cooling water discharge. It also provides an integrated assessment of the effects of the Station together with the fish production benefits of the wetlands restoration and fish ladder measures undertaken by PSEG and the influence of other anthropogenic factors affecting the aquatic ecosystem of the Estuary. This assessment builds upon the previously described assessments of the effects of the Station's thermal discharge and intake, and the voluminous data, scientific information, and analyses upon which these assessments were based. This integrated, cumulative effects assessment includes both a retrospective and a predictive evaluation.

The retrospective evaluation searches for evidence of adverse impact from Salem's operations in the RIS populations and the Estuary community based on direct empirical evidence regarding the condition of finfish and macroinvertebrate populations of the Estuary both prior to and during the 22 years of operation of Salem. It found no evidence of adverse impact. Thus, the evaluation found that the aquatic community in the vicinity of Salem has experienced no detrimental changes since Salem began operations. The list of species found in the area is essentially unchanged, as is the species richness. Species density has actually increased. There have been no outbreaks of nuisance species or of species indicative of degraded environmental conditions. The long-term finfish monitoring programs (sponsored by DNREC, NJDEP and PSE&G) show statistically significant trends of increasing abundance for seven of the nine finfish RIS populations and for blue crab. The decline in abundance of blueback herring is a coastwide phenomenon that began in the mid-1960s (a decade prior to the Station's initial operations) and, therefore, can not be attributed to Salem's operation. Because the Delaware Estuary is at the northern extent of the geographic range of spot, its occurrence in the Estuary is erratic. Also, because spot is an ocean-spawning species, its distribution is primarily influenced by oceanic conditions rather than conditions in the Delaware.

The integrated assessment found that several factors contribute to Salem's lack of impact on the RIS populations. Entrainable life stages of the freshwater spawning species (i.e., American shad, alewife, blueback herring, white perch and striped bass) inhabit areas upriver or in tributaries to the Bay, and therefore are generally not present in abundance in the vicinity of

[68] The erroneous contentions by some commenters that PSEG is legally required to offset fully whatever intake losses may occur after installation of BTA at the intake and that it is also required to show that the conservation measures will achieve such offset are discussed below, § VIII C.

Salem. For most RIS, the fish in the Estuary are only a small portion of a huge coastal population, and only a fraction of those in the Estuary are in the vicinity of Salem. Those fish that are cropped by the Station are at very young life stages, which naturally have a very high mortality rate. Almost all of them would die naturally, with or without the effects of Salem.

The predictive evaluation addressed potential effects of future operations of Salem. It was based upon and integrated the results of the biothermal models used to address future effects of the thermal plume and the results of the spawning stock models used to address the population level effects of future entrainment and impingement at the intake. Results from these analyses show that the effects of Salem would be too small to adversely affect RIS populations or jeopardize the ability of any of the finfish RIS species to sustain desirable recruitment levels. These predictive assessments employ improved analytical tools and draw on a larger body of information than was available in previous modeling of Salem's potential effects. The result of the new predictive assessments found, as did the earlier assessments, that Salem's intake and thermal discharge would not adversely impact the RIS populations nor harm the balanced indigenous community of the Estuary. Their conclusions are the same as those of the retrospective assessments, which show that even after 22 years of operations, there is no evidence that the Station has caused adverse effects on the RIS populations or the balanced indigenous community.

The cumulative effects evaluation also took into account the fish production benefits of the fish ladder installations and wetlands restoration activities undertaken by PSEG, other thermal discharges, the interaction of heat with other pollutants, and also integrated the effects of other human influences in the RIS stocks, including the role of pollution control regulation in improving the Estuary's water quality, and the benefits of strengthened fisheries management.

The integrated cumulative effects assessment concluded, based on many different, independent data sets, using several different benchmarks of adverse environmental impact, and using a number of different assessment methodologies, that the Station intake is not having and will not have an adverse environmental effect and that the Station's operations as a whole have not adversely affected, and will not adversely affect, the populations and biotic community of the Estuary. That conclusion is especially robust because as discussed previously, independent studies, using different methods and different lines of evidence, reached the same consistent conclusion.

Many of the criticisms by ESSA, and by commenters, on the Application's conclusion that the Salem intake is not having AEI rest on a common supposition: notwithstanding different and consistent results of the several independent studies and analyses presented in the Application, each of which finds no adverse effect from the Salem intake on the aquatic populations and community of the Estuary, it still <u>might</u> be the case that the intake is having some effect that can not be detected by extensive data sets and the use of a variety of the most sophisticated and powerful methodologies currently available for assessment of Salem. This hypothesis is inherently impossible to refute. Its proponents offer no means by which the hypothesis could either be validated or falsified. Accordingly it is useless, indeed meaningless.

The possibility that the intake <u>might</u> be having an AEI despite all of the evidence to the contrary is also legally irrelevant because the burden is not on the permittee to show that a CWIS is not having an AEI. Rather, as shown above, the burden is on the permitting agency to show AEI before requiring additional BTA measures under authority of Section 316(b). As the permitting precedent makes clear, this burden is not satisfied by simply invoking a hypothetical possibility that individual intake losses may be adversely effecting populations or communities, even though all of the relevant data and state-of-the-art analytical techniques show no such effect.

I. Conclusion

Neither the NJDEP, nor ESSA, nor any commenters has shown that the Salem CWIS is having an AEI, the prerequisite to imposing any additional BTA requirements pursuant to Section 316(b). AEI consists of adverse impact by a cooling water intake on populations or communities of aquatic life. NJDEP's effort to sidestep this requirement by adopting a single fish definition of AEI is contrary to controlling Section 316(b) precedent. NJDEP has not attempted to show and has not determined that Salem is having an AEI on the aquatic populations or community of the Estuary. Notwithstanding the criticisms of the Application studies advanced by ESSA and certain commenters -- criticisms which are in any event insubstantial -- the commenters have failed to establish that the Salem intake is having an adverse impact on the populations or community of the Estuary.

Indeed, the extensive data and analysis presented in the several different, and independent retrospective and predictive studies presented in the Application show affirmatively that Salem is not having such an Adverse Environmental Impact. Accordingly, there is no legal authority under Section 316(b) to impose additional intake controls on Salem.

VI. ASSUMING ARGUENDO ADVERSE ENVIRONMENTAL IMPACT FROM SALEM'S INTAKE, THE DRAFT PERMIT REQUIREMENTS ARE, AS NJDEP DETERMINED BTA FOR SALEM

The Draft Permit, based on NJDEP's position that loss of even a single fish constitutes AEI, requires PSEG to submit to NJDEP a proposed study and/or redesign of the intake fish return sluice and sampling pool and conduct and submit to NJDEP a study of the feasibility of a multi-sensory hybrid fish technology system that might include a number of technologies as components, to be studied individually and in various combinations at the intake. 66-70; Permit Part IV G.2.b, G.5.a; FS pp. 33, 50, 66-70. NJDEP determined that "the Station's existing once-through cooling system in conjunction with the existing Permit intake flow system limitation, an enhanced fish return system, and the study and potential implementation of a multi-sensory hybrid" fish protection technology system is BTA. FS p. 77. In adopting these proposed requirements, the Department included in the Draft Permit the statement that: "It is important to note that the Department is committed to requiring implementation of any cost-effective alternative intake protection technologies that will minimize impingement and/or entrainment effects based on the results of these studies." Draft Permit Part IV, G.5.b.

As explained in Section V of these Comments, PSEG believes that the Department's interpretation of AEI is legally erroneous and that the evidence of record does not show that Salem's intake is causing AEI under the standard established by the controlling Section 316(b) precedent, which requires a showing of harm to populations or communities. PSEG, however, recognizes the concern of the Department and some commenters over the potential for AEI from the Salem intake, and accepts and intends to implement the Draft Permit requirements regarding intake modifications and technology studies, subject to certain modifications as recommended below and in the Specific Comments (Part Two).

Even were it assumed, arguendo, that the Salem intake is causing AEI, the record provides no basis for imposing any additional Section 316(b) BTA measures beyond those required in the Draft Permit. Contrary to the suggestion of USEPA Region III, NJDEP fully and properly evaluated all potential additional intake technology measures that might be feasible for Salem based on the extensive information and analysis presented in the Application and in the ESSA Report. The record shows that there are no additional or alternative intake technologies or other fish protection measures that are currently available for installation at the Station that would provide fish protection benefits at a cost that is reasonable in relation to the benefits afforded and would thus qualify as BTA for Salem.

A. In Making BTA Determinations, The Permitting Agency has the Burden of Proving that a Technology is Available and Appropriate for a Given Source and That Its Costs (Both Environmental and Economic) Are Reasonable in Relation to the Environmental Benefits Afforded

A NPDES permitting authority that has shown that an intake is causing AEI and seeks to impose additional CWIS technology requirements pursuant to Section 316(b) has the burden of establishing that the technology in question is the "best technology available" for minimizing adverse environmental impacts from a given source. See Application, Appendix D - § V.A.

As recognized by NJDEP, BTA decisions must be made on a case-by-case basis. FS p. 65. See also USEPA 1977 Section 316 Guidance at 4. (The environment-intake interactions in question are highly site-specific and [BTA determinations] must be made on a case-by-case basis.) In order to be considered as "available" under Section 316(b), an intake technology must be feasible and appropriate for the individual source in question, based on a facility-specific consideration of the engineering and biological suitability of alternative intake technologies, the environmental benefits that they would provide, and their economic and environmental costs. As NJDEP correctly stated, decisions concerning BTA "require a case-by-case determination and should include an evaluation of economic considerations. BTA is intended to mean the best technology available commercially at an economically practicable cost and, further, that the cost of the technology not be wholly disproportionate to the environmental benefit to be gained." FS p. 65. See also FS p. 69; Seacoast Anti-Pollution League v. Costle, 597 F.2d 306 (1st Cir. 1979)(upholding the USEPA Administrator's ruling on this point); Application, Appendix D § VI.A; Anderson & Gotting, Section 316(b) at 57.[69]

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69 Consistent with this well-established principle, USEPA advised NJDEP, in connection with the 1990 Salem Draft Permit (which would have required a closed-cycle cooling retrofit) that Section 316(b) includes an economic component in evaluating BTA. USEPA's comments specifically referenced the "wholly disproportionate" standard. USEPA Region II (Comments on proposed Permit No. NJ0005622 Renewal) Jan. 14, 1991.

Section 316(b), which directs regulators to evaluate and select intake technologies with a view to reducing "adverse environmental impact," requires that BTA determinations consider not only economic costs of alternative intake control technologies but also the adverse environmental effects that they may have. Application, Appendix D-§ VI.C. The consideration of all of the environmental implications of intake technologies, negative as well as positive, is required by NEPA as well. Application, Appendix D-§ V.1-3, Schoenbaum & Stewart, Conservation Measures. These negative effects include, for example, increased energy consumption and adverse environmental impacts that could result from retrofit of closed-cycle cooling, which would necessitate generation of replacement power by fossil-fueled sources. In making BTA determinations, permitting authorities must also take into account the benefits to aquatic populations of permit-required conservation measures, such as wetlands restoration and fish ladders, in evaluating intake technology requirements relative to the extent of any net adverse environmental impacts that remain after such benefits are taken into account. Schoenbaum & Stewart, Conservation Measures at 107-108, 158, 164; Anderson & Gotting, 46-49.

USEPA's recently reaffirmed 1977 Section 316(b) Guidance recommends, p. 13, that permitting agencies use a "stepwise thought process" for evaluating BTA, beginning with a consideration of possible modifications to the existing screening system, then considering the possibility of increasing the intake size, then consider relocating the intake, and "finally" considering reducing intake capacity to a point that may necessitate installation of closed cycle cooling. Thus, applicable guidance refutes the claims by USEPA 70/ and Riverkeeper 71/ that closed-cycle cooling is the preferred or presumptive option. The Guidance provides that a permitting agency must proceed incrementally, beginning with screen modifications; closed-cycle cooling is the last option to be considered, not the first. Further, under the "wholly disproportionate" standard, in evaluating successively more ambitious and costly intake options, the permitting agency must consider whether the additional costs are justified by the incremental benefits. Thus the claim by USEPA Region III that the "reference point for best technology is closed cycle cooling" is fallacious and is flatly inconsistent with currently applicable USEPA Guidance.

B. PSEG, ESSA, and NJDEP Fully and Appropriately Considered A Wide Range of Potential New or Alternative Technology Controls and Other Fish Protection Measures for Application at the Salem Intake.

In accordance with Section 316(b) permitting precedent and guidance, PSEG's Application includes a Section 316(b) Demonstration that provides a comprehensive evaluation of potential intake-related technologies and intake flow modifications for potential application at Salem. PSEG's expert studies identified all potential fish protection options, eliminated those options with no or limited proven biological effectiveness at CWIS, and made a detailed evaluation of the applicability of the remaining alternatives to Salem. See Application, Appendix § F-VIII and Attachments F-3, F-5, F-6 and F-7.

70/ Letter from Bradley Campbell, USEPA Region III to Robert Shinn, NJDEP dated January 19, 2001.

71/ Public Hearing Transcript, dated January 23, 2001, page 121.

A total of 29 potential fish protection options were initially identified in PSEG's study, based on a comprehensive review of the most current literature and communications with knowledgeable regulatory, and utility personnel. This compilation was made without regard to the potential applicability to Salem of the measures included. Each of these options was considered in a preliminary screening, based on effectiveness in protecting fish, stage of engineering development, and comparative factors. On the basis of this screening, four potential intake technologies (wedge-wire screens, dual-flow fine mesh screens, modular inclined screens, and a strobe light/air bubble curtain combination), were also selected for detailed evaluation. [72/] Three flow modification schemes (seasonal flow reductions, revised refueling outage schedules, and closed-cycle cooling retrofit) were also selected for detailed evaluation.

Thus, seven of the 29 options initially identified for study were selected for additional detailed evaluation in the Demonstration. An eighth option, sound deterrents, had already been thoroughly studied by PSEG, as discussed below in subsection C. The PSEG evaluation eliminated the remaining 21 possibilities options from further study because, without regard to particular conditions at Salem, they showed limited or no proven biological effectiveness for application. PSEG then conducted a detailed evaluation of the seven options (other than sound deterrents) selected for further study in the Section 316(b) Demonstration. (Application, Appendix F) The results of the evaluations of the four intake modification options are summarized in Subsection C, along with the results of PSEG's sound deterrent studies. The results of the evaluations of closed-cycle cooling retrofit and the flow modification alternatives are discussed in Subsections D and E, respectively. Claims by USEPA and USFWS and other commenters that relevant intake technologies were not adequately considered in the renewal process or that NJDEP should have required implementation of certain measures as BTA for Salem are discussed in Subsection F. In accordance with Section 316(b) precedent and guidance, PSEG's evaluations of the alternatives studies in the Section 316(b) Demonstration included an analysis of their costs and benefits in order to provide the evidentiary foundation for application of the wholly disproportionate standard for BTA. Issues regarding the cost-benefit analysis, including certain concerns raised in the ESSA Report and PSEG's response (which presents updated cost information) are summarized in subsection G.

As discussed further below, the ESSA Report provided an extensive review and analysis of the PSEG studies and evaluations of CWIS technologies and other fish protection measures. It did not conclude that any of these alternatives was suitable or appropriate for implementation as BTA at Salem at present. It recommended further studies of certain CWIS technologies and a study and potential modification of the existing intake fish return system with the goal of enhancing the survival of impinged fish. On consideration of the Section 316(b) Demonstration and the ESSA Report, NJDEP did not find that any other intake technologies or other fish protection measures such as flow modification, are BTA for Salem. It included in the Draft Permit as BTA requirements for additional studies of certain technology options and intake screen fish return modifications.

72/ As noted below, PSEG maintains that flow limitations or modifications are not a "technology" relating to the "location, design, construction or capacity" of cooling water intake structures and hence may not be required pursuant to Section 316(b).

C. No New or Additional CWIS Technologies are Currently BTA for Salem; NJDEP's Draft Permit Requirements for Studies of Certain Potential Technologies Should Be Adopted with Certain Modifications

1. The Record Demonstrates that there is Presently No CWIS Technology that is BTA for Implementation at Salem; All Potential Options were Appropriately Studied by PSEG and Reviewed by ESSA and NJDEP

As summarized above, the Section 316(b) Demonstration presented in the Application provides an evaluation of many different CWIS technologies and other measures to protect fish. The Demonstration selected the four most promising options (wedge-wide screens, dual-flow fine mesh screens, modular inclined screens, and strobe light/air bubble curtain combination) for more detailed evaluation.

PSEG's detailed evaluation of wedge-wire screens concluded that there would be enormous problems in installing such screens at a facility of Salem's size and estuarine location, and that even if these problems could be overcome, the screens would be subject to serious problems of fouling and blockage from sediment and debris. Application, Appendix F-§ VIII. Accordingly, this option was eliminated from further consideration.

The Demonstration's evaluation of dual-flow wire mesh screens found that there were substantial design and operational hurdles to application of this alternative to Salem and uncertainties over the benefits that it might provide even if successfully implemented. Application, Appendix F-§ VIII. The evaluation found that modular inclined screen technology was in an early stage of development, that it had limited capacity to increase fish survival at Salem, and would cause increased losses of blue crab at the Salem intake. Application, Appendix F-§ VIII. The evaluation of a combination barrier, consisting of both strobe lights and an air bubble curtain, concluded that it might be biologically effective at Salem. The evaluation, however, noted concerns that the relatively high turbidity levels in the Estuary in the vicinity of the Station could compromise the effectiveness of this alternative, and also noted significant uncertainties as to how species in the area of the Salem station would respond to a combination strobe light/air bubble installation. The evaluation concluded that substantial additional research would be needed to determine the species and conditions for which this technology would be effective. Application, Appendix F-§ VIII. The evaluation accordingly concluded that none of these three technologies is available and suitable for installation at Salem at the present time.

PSEG's evaluation of these three intake technology options also included a study of their costs (construction and operating costs) and their environmental benefits (in terms of the value of increased commercial and recreational fishing harvests attributable to reduced intake losses), assuming that the technologies could be successfully installed and operated at Salem. Application, Appendix F-§ IX. The analysis concluded that the costs of the strobe light/air bubble curtain would be 7 times greater than the benefits, the costs of dual-flow fine mesh screens would be 9.9 times the benefits, and that the benefits of modular inclined screens would be negative because the value of the additional losses of some species (notably blue crab) caused by installation of this technology would exceed the benefits of reduced losses of other species.

The evaluation accordingly concluded that the costs of these technologies would be wholly disproportionate to any benefits provided.

Based on these evaluations, the Section 316(b) Demonstration concluded that none of the four intake technology options selected for detailed study is BTA per Salem.

PSEG's Application also concluded that sound deterrent technology is not currently BTA for Salem. In accordance with 1994 Permit requirements, PSEG conducted extensive laboratory and *in situ* testing of the potential to use sound deterrents to repel fish from the Salem intake. See Application, Appendix G and Attachment G-7. As NJDEP has determined, these studies complied fully with Permit requirements. FS pp. 46-47. PSEG concluded that the studies showed promise but that it was not possible to design an effective sound deterrent system for Salem without further investigations.

ESSA conducted an extensive review of the analysis of intake technology options in PSEG's Application and of relevant literature and other sources of information on CWIS fish protection technologies. ESSA did not find that there was any technology available and appropriate for implementation at Salem at present. In the Fact Sheet, p. 67, NJDEP summarized ESSA's conclusions regarding the four intake technologies (other than sound deterrents) that had been examined in detail by PSEG:

> Wedge-Wire Screens – Although this technology is being used elsewhere (e.g. J.H. Campbell Plant Unit 3 – Lake Michigan, and Eddystone Station – Philadelphia Electric), its potential for application at Salem would be low. Salem's cooling water flow rate is more than five times the rate where this technology is presently used, and there are real concerns about biofouling and clogging with this technology at Salem.
>
> Dual-Flow Fine Mesh Screens – No fine mesh screening systems currently in use operate at flow velocities typical of Salem CWS, nor do these existing installations appear to deal with the same level of debris loading as at Salem . . . . This system does not appear to offer any significant advantages over the present Ristroph screen system already in place at Salem GS."
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> Modular Incline Screens (MIS) – These screens were originally developed for application at hyrdoelectric plants, and have never been used at a once through-cooling facility. . . . Furthermore, MIS have only been evaluated in the lab or in small-scale testing, and there are no plans of which we are aware for this system to be installed at an operating fossil/nuclear station with a once-through cooling system. The application of this system for Salem has a lot of question marks."
>
> Strobe Light/Air Bubble Combination – Strobe light/air bubble combinations have been studied extensively. Like other behavioral system such as sound (as tested at Salem), there is a species specific response, and a strobe light/air bubble system will not work for all 11 RIS at Salem (neither will sound along). There is evidence, however, that this system will work for several species found at Salem. However, its use as a sole deterrent system at Salem would be limited. To be

considered at Salem GS, a strobe light/air bubble system must be used with other technologies as part of a hybrid system.

ESSA also conducted an extensive review of PSEG's sound deterrents studies and results. ESSA Report, § 3. NJDEP summarized ESSA's evaluations in considerable detail in the Fact Sheet pp. 47-50. It noted that ESSA had found that PSEG's "investigators did a thorough job in data collection and analyses." FS p. 50. ESSA found that there were "considerable inconsistencies" in test results. ESSA concluded that "we cannot recommend sound as a single deterrent system for excluding all RIS species" at the Salem intake, although it noted that the 1994 PSEG tests "were positive on, the issue of ultrasound for repelling alosids." Id. 73/ ESSA's conclusions regarding intake technologies were summarized by NJDEP as follows, FS p.68:

> In conclusion, ESSA states "An improved "fish defense system" using multi-sensory or hybrid technologies is recommended for further study at Salem GS. This recommendation is based on the observation that sound along has shown limited success as a deterrent at Salem (the notable exception being ultrasound based in the 1994 cage tests, and external literature), Other systems should be integrated with sound to better reduce fish impingement. Initially, this integration should focus on behavioral systems since these are less costly and easier to implement than physical systems. However, if behavioral systems fail to significantly reduce impingement, then the more costly alternatives would need to be considered . . . ."

NJDEP reviewed the PSEG intake technology studies and ESSA's evaluations of those studies, FS pp. 66-70. Based on its review of the Section 316 Demonstration and the ESSA Report, NJDEP did not find that any CWIS technology qualified as BTA for implementation at Salem. It concluded that PSEG should be required to conduct a study of multi-sensory hybrid fish protection technology as a part of BTA. FS pp. 50, 69-70; Draft Permit IV.G.5. NJDEP concluded that sound deterrent technologies should be studied further as one possible component in such a multi-sensory hybrid system. NJDEP provided that the study should include, as potential components of a hybrid system, strobe light technology, air bubble technology, sound deterrent, and light attraction technologies. It further provided that these components should be studied individually as well as in various combinations. It also provided that, with respect to sound deterrents, far-field attraction and potential acclimation should also be studied. Based on ESSA's recommendations, NJDEP also required a proposed study and/or redesign of the existing intake screen fish return sluice and sampling pool. FS p. 33; Draft Permit IV G.2.b. As already noted, the Draft Permit states that the Department "is committed to requiring implementation of any cost-effective alternative intake protection technologies that will minimize impingement and/or entrainment effects." Draft Permit Part IV p.9. Assuming, arguendo, that the Salem intake is causing an AEI and that NJDEP accordingly has legal authority under Section 316(b) to

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73/ PSEG's response to ESSA's review is provided in the PSEG Response to ESSA, Section V.

require additional BTA measures at Salem, its BTA determinations are consistent with applicable law and well-supported by the evidence of record.

2. The Draft Permit BTA Requirements for Studies of Potential Intake Technologies and Modifications are Reasonable and Should be Adopted

Putting aside the legal issue of NJDEP's Section 316(b) authority, the Draft Permit provisions for studies by that PSEG of a hybrid multi-media fish protection technology system and of intake fish return modifications for potential implementation at Salem are reasonable and will appropriately address concerns over the potential for adverse impact from the Salem intake. Subject to the modifications recommended herein, NJDEP should adopt them and PSEG intends to implement them.

a. Intake Screens and Fish Return System

PSEG made significant improvements to the Ristroph Traveling Screens at the Salem intake pursuant to the 1994 Permit in order to further reduce impingement losses. NJDEP noted the positive impact of the Ristroph screen modifications when it quoted ESSA as follows, FS p. 32:

> The Ristroph Screen modifications are innovative, and represent BTA at the screen for reducing fish mortalities. (ESSA Report: Executive Summary, page viii)

As NJDEP also noted, ESSA went on to state that the "effectiveness of the Ristroph Screens for improving fish survival will vary with species. Frail species will likely have higher mortality than more robust ones." Id. As noted by NJDEP, FS p. 32, ESSA concluded that improvements to the design and operation of the fish return system would likely increase survival of impinged fish. Based on ESSA's evaluation, NJDEP included requirements in the Draft Permit, Part IV.G.2.b, regarding further study and enhancement, as follows:

- Fish mortality of the fish return system shall be evaluated independently from the Ristroph screens to determine mortality rates as fish re-enter the estuary. In addition, impingement mortalities associated with the fish sampling pool shall be further investigated including a comparison of flow velocities for the fish return sluice versus the impingement sampling sluice. The permittee shall submit a ranking of best to worst (i.e. most vulnerable or frail) Representative Important Species (RIS) for which the Ristroph travelling screens are most effective at minimizing mortality; and

- Based on the results of i., the permittee shall submit a proposed study and/or redesign of the fish return sluice and sampling pool where a biologist with expertise in the area of fish behavior shall specify flows, velocities, and depth profiles to minimize mortalities. Emphasis should be placed on reducing potential mortality of susceptible species.

Although the survival rates reported at Salem are among the highest recorded for traveling screens at any power plant, including those reported for species considered to be fragile, PSEG recognizes that the existing fish sampling pools may not be the optimal design for the collection of fish without stress or possible injury, and generally agrees with the Draft Permit requirements for the study of additional fish return system enhancements. [74] PSEG is concerned, however, with the schedule for completion of the studies set forth in Draft Permit IV.2.b.iii, which requires that all of the study results be reported within 180 days. PSEG proposes modifications to provide for development of a proposed work plan for a study or potential steps to minimize the stresses associated with the fish return sluice and sampling pool before undertaking such a study, along with other appropriate modifications as set forth and justified in PSEG Comments on Draft Permit Terms and Conditions and Fact Sheet, pp. 11-13.

b. Further Study of Intake Fish Protection Technologies

PSEG also supports the provisions in Draft Permit Part IV, G.5.a for conduct by PSEG of a series of assessments and studies of designated intake fish protection technologies, to be studied individually as well as in various considerations as a hybrid system. PSEG further supports the ESSA recommendation that the technologies should have a targeted effectiveness of at least a 70% reduction in loss for select species/lifestages. [75] PSEG would, however, support

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74/ The observations in ESSA's Report (§ 3) on possible enhancements to the fish return system are, however, based on a fundamentally flawed understanding of the system's operation and should not control implementation of these requirements. For example, ESSA notes its concern with the actual mortality of fish at the point of discharge to the river. It supposes that the existing fish return system causes returned fish to abruptly hit the Estuary waters when they exit the system, inducing trauma. ESSA's supposition is incorrect. The existing system returns the fish below the water surface. Further, ESSA suggests a number of ways to sample at the discharge of the fish return trough which are not practically feasible. ESSA's failure to obtain readily available information, either through observation or data request from PSEG, has led it to posit problems with the current intake that do not in fact exist. Further, ESSA recommends that hydraulic engineers and biologists be engaged for any intake modifications. In fact, engineers worked in conjunction with biologists to design Salem's fish screen and return system and incorporated state-of-the art standards for the safe collection and transport of fish. Thus, PSEG has already used the approach recommended by ESSA and intends to continue to use it in the future. These and other aspects of ESSA's Report that might bear on implementation of the Draft Permit requirements relating to the fish return system are discussed in PSEG's Specific Comments on Draft Permit Terms and Conditions and Fact Sheet.

75/ See ESSA Report, § 3. PSEG believes, however, that a number of the assumptions, conclusions and suggestions made in the ESSA Report regarding the relevant technology options to be studied do not adequately consider or appreciate the particular circumstances of the Salem Station and its location or reflect misunderstandings or undue optimism regarding the potential application of certain technologies at Salem in the manner envisaged by ESSA. It also believes that there are ways in which the studies as envisaged and recommended by ESSA can be improved and made more relevant and realistic for Salem. See PSEG Response to ESSA, Section V; PSEG Comments on Draft Permit Terms and Conditions and Fact Sheet, pp. 27-29.

any promising multi-sensory hybrid only on the assumption that it would be subjected to the same detailed evaluation and cost\benefit analysis applied to the other alternatives presented in the Application, consistent with the BTA requirements of Section 316(b).

D. Retrofit of Closed-Cycle Cooling Is Not BTA at Salem

Retrofit of Salem to closed-cycle cooling is not BTA because the environmental and economic costs of such retrofit would be wholly disproportionate to the benefits.

The detailed evaluation of fish protection alternatives presented in the Application, the Section 316 Demonstration examined retrofit of Salem to closed-cycle cooling through use of natural draft and mechanical draft wet cooling towers. This evaluation included a full examination of the massive construction problems and operational implications associated with retrofit of such cooling towers at Salem, a facility built during the 1970s for open-cycle cooling. The evaluation included a comprehensive cost-benefit analysis, which considered the costs to society of the resources that would have to be committed to ripping out the existing cooling system and constructing a new cooling system including cooling towers. The evaluation also considered the increased operating costs of closed-cycle cooling. It further included the costs to society resulting from lost power generation at Salem due to shutdown of the Station for retrofit construction and permanent derating of the Station due to the reduced operating efficiencies caused by cooling towers. These costs to society of lost power generation that were included in the study included lost energy value, lost capacity value, and environmental costs due to increases in air emissions from fossil fuel plants that would be used to generate the power to replace the power lost at Salem due to cooling tower retrofit. As in the case of the other fish protection alternatives evaluated, the benefits of cooling towers consisted of the value of the increase in commercial and recreational fishery harvests that would result from reduced intake losses, on the highly conservative assumption that all of the additional fish produced would be caught.

The results of the cost-benefit analysis presented in the Application (Appendix F § IX) showed that closed-cycle cooling is not BTA for Salem because its costs are also wholly disproportionate to the benefits that would be provided. The total costs of closed-cycle cooling are $712.0 million for natural draft towers and $849.2 million for mechanical draft towers. The benefits from each are the same: $58 million. These figures yield net benefits of negative $654.0 million for the natural draft towers and negative $791.3 million for mechanical draft towers. The cost-benefit ratios for the natural draft and mechanical draft towers are 12.3 and 14.7, respectively.

In sum, the evidence of record demonstrates that retrofit of closed-cycle cooling, whether through the use of wet cooling towers or dry cooling, is not BTA at Salem because the environmental and economic costs to society of retrofit would be wholly disproportionate to the environmental benefits provided. Because of the high costs of closed-cycle cooling in relation to benefits achieved, USEPA and state permitting authorities have consistently refused to require

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As set forth in these Comments, PSEG recommends certain modifications to the Draft Permit schedule for reporting the study results.

retrofit of closed-cycle cooling. See Application, p. 166 and notes 99, 100. Accordingly, NJDEP properly declined to require closed-cycle cooling in issuing the 1994 Permit and in proposing the Draft Permit. [76]

E. Flow Reductions or Seasonal Refueling Outage Shifting are Not BTA for Salem

A permitting authority may not require a source to implement seasonal flow reductions or to reschedule refueling outages pursuant to Section 316(b) because such measures are not a "technology" relating to the "location, design, construction or capacity" of a cooling water intake structure. See Application, Appendix D-§ VI.D. Even if such measures qualified for consideration as BTA, they may not be required at Salem because their costs would be wholly disproportionate to any environmental benefits afforded.

1. Seasonal Flow Reductions are Not BTA For Salem

PSEG's Section 316(b) Demonstration evaluated a number of alternative scenarios for reducing power generation at Salem on a seasonal basis in order to reduce intake flows during periods of high biological productivity in the Estuary. The detailed evaluation of flow modification options presented in PSEG's Section 316(h) Demonstration included six different seasonal flow reduction scenarios, based on reductions of 10%, 20% and 45%, each with two

76/ During the January 2001 public hearings several comments were made recommending that NJDEP require retrofit of Salem to dry cooling. See VI.F, infra. Dry cooling systems are now widely used only in new combined-cycle power plants, is mainly because such plants typically have only one-third of the power generated by steam-electric plants and thus requiring a significantly smaller cooling water system. Installation of natural-draft dry cooling towers at Salem would be a unique project, never before executed on this scale. It would require detailed evaluation of tower design to make the best use of modern structural practices. The retrofit would require detailed evaluation of the low pressure turbines for continued operation at the higher backpressures or to determine if costly replacement of the turbines would be required. Even if these problems could be solved, the thermodynamics of a natural-draft dry cooling tower would impose large penalties on Salem's generation and heat rate. Retrofit of direct-acting dry cooling systems at Salem would be impractical because it would require complete removal of the existing condensers, abandonment in-place of the existing circulating water system, relocation of virtually all mechanical and electrical equipment located on the ground floor of the turbine building, demolition of the Administration Building and relocation of portions of the switchyard. This would result in an extended multi-year outage of both units to complete all of the site alterations. Even if retrofit of some type of dry cooling at Salem were practicable in engineering terms, the construction, lost energy, and lost capacity costs of such an endeavor would be significantly greater than the costs of retrofitting wet closed-cycle cooling at Salem, while the additional environmental benefits that would be provided would be minimal. Since it has already been determined that he costs of retrofitting Salem to wet closed-cycle cooling would be wholly disproportionate to the environmental benefit provided and that accordingly such retrofit is not BTA for Salem, it follows a fortiori that retrofit of dry cooling would involve costs that are even more disproportionate to benefit and that accordingly dry cooling is not BTA for Salem. See Attachment V-A.

different heat discharge variables (holding the ΔT constant at 15.75°F and allowing ΔT to vary up to a maximum of 21.6°F). To provide the greatest potential benefit from reductions in entertainment and impingement, the assessment scheduled these flow reductions during a 13-week period in the summer, the period of highest biological productivity. ESSA considered revised outages as having "potential for application at Salem." ESSA Report, p. 45, FS, p. 67. ESSA's Report, however, noted a number of unresolved issues regarding use of seasonal low reductions at Salem. 77/

The cost-benefit assessment of these alternatives included the costs to society of lost energy and lost capacity and additional maintenance costs. The benefits consisted of increased commercial and recreational fish catches attributed to reductions in losses of fish at the intake. The cost-benefit analysis found that seasonal flow reductions impose extremely high costs in relation to the environmental benefits they might achieve. As set forth in Application, Appendix F-IX Figure 9, the total cost of flow reduction scenarios ranges from $33.7 million for a 10% reduction in flow allowing ΔT to vary to $864.8 million for a 45% reduction holding ΔT constant. The environmental benefits of the flow reduction scenarios range from $2.0 to $25.4 million. The cost-benefit ratios range from 14.5 to 34. Appendix F-§ IX, Figure 17. Accordingly, seasonal flow reductions are not BTA for Salem because their costs are wholly disproportionate to their benefits.

2. Rescheduling Refueling Outages is Not BTA for Salem

The detailed evaluation in the Section 316(b) Demonstration of fish protection options also included rescheduling the refueling outages at Salem from the current spring/fall cycle to a summer/winter cycle. Currently each Salem unit is required to undergo a refueling outage after 18 months of operation at 70 percent or greater capacity. Refueling outages are generally scheduled to occur when they are most cost-effective, based on electrical demand and unit availability. Because of Salem's role in the PJM electricity distribution system (the Station's base load generation capacity represents a large percentage of the system baseline capacity) the electricity Salem produces is especially important to meeting system demand in the summer and winter peak demand periods. Accordingly, refueling outages for the Salem units are currently scheduled on a spring/fall cycle. A seasonal change to the outage schedule resulting in a summer/winter outage cycle would cause outages to occur during summer periods of greater biological productivity, but these periods are also ones in which peak demand for electricity

77/ ESSA's Report stated, p. 45, that ". . . more quantitative data on fish entrainment/impingement issues with respect to timing is required to better define the period when an option such as seasonal flow (reduction) (sic) could be used to maximize reductions in entrainment/impingement." ESSA also noted that: "The Salem station represents a complex of nuclear power generation technologies with many interacting and interdependent components. The alternatives that involve reduced cooling water flows must give special consideration to the implications for maintenance and safety at the station of altered operating temperatures. The tolerances of station technologies and materials to elevated temperatures must be included in any consideration of reduced cooling water flows. The application discusses these concerns, and significantly reduced cooling water flows may not be feasible in practice because of safety considerations." Id., p. 55.

occurs. Rescheduling outages to these periods would mean that Salem's contribution to the PJM would not be available during periods of peak demand, necessitating that the power be generated elsewhere.

The Application presented a cost/benefit analysis of changing to a summer/written outage schedule with rescheduled outage in the summer occurring in week 24. This schedule was selected with the objective of maximizing the estimated reduction in overall losses and hence the benefits component of the cost-benefit analysis. The analysis found that this rescheduling would impose costs of $181.7 million, all of which would be attributable to the value of lost power. By contrast, the benefits of this alternative in terms of increased fisheries harvests would be only $15.3 million, yielding a cost-benefit ratio of 11.9. This alternative would thus produce a net negative benefit of $166.4 million. Its costs are wholly disproportionate to any benefit that might be obtained from this alternative; accordingly, this alternative is not BTA for Salem.

Subsequent to the filing of the Application, NJDEP requested that additional refueling outage schedules be analyzed. The Department initially requested additional cost-benefit analyses that focused on maximizing reduction in losses for weakfish and bay anchovy. This analysis resulted in an evaluation of outage periods that started in weeks 25 and 26. The results of this evaluation were provided by PSEG to NJDEP by letter dated July 28, 1999. Subsequent to its initial request, NJDEP asked for additional refueling outage alternative scenarios to enable the Department to assess sensitivity of costs and benefits to outage scenarios during the late spring/summer period. This request resulted in consideration by PSEG of a number of outage schedules during the week 20 to week 26 period. Altogether an additional 6 rescheduled outage periods were considered in the supplemental analyses requested by NJDEP. PSEG provided NJDEP a summary report including results from all of these analyses by letter dated July 28, 2000. The results from the supplemental analyses showed a range of cost-benefit ratios from 18.4 for the alternative refueling outage schedule that begins on week 26 to a cost-benefit ratio of 5.6 for the alternative refueling outage that begins on week 21. [78/]

F. Claims By USEPA Region III, USFWS and other Commenters That Intake Technology Options Were Not Adequately Considered in the Renewal Proceedings or Should Have Been Required by NJDEP For Implementation at Salem Lack Merit

Comments filed by USEPA Region III suggest that new or modified intake technologies for the protection of fish were not adequately considered in connection with the Permit

78/ The full assessments of these additional analyses can be found in: "Response to Request for Supplemental Analyses – Letter to Assistant Commissioners Hart and Wild from R. E. Selover, Analysis of Costs and Benefits to a Revised Fueling Schedule for Salem Generating Station, July 28, 2000"; and, "Supplemental Response to Request for Information – Letter to Assistant Commissioners Hart and Wild, from R.E. Selover, September 14, 2000, transmitting three attachments: Attachment I: Potential Biases in Benefit Estimates Associated with the Week 21 Refueling Outage Schedule; Attachment II: Effect of Shifting Salem Outage on Electric Supply System; Attachment III: Impacts of Revised Salem Refueling Schedules on Wholesale and Retail Electric Markets renewal. 79/ Specifically, USEPA Region III stated that "it is not clear that NJDEP has fully evaluated all available options." It also stated that: "The reference point for best technology is closed cycle cooling." It referred NJDEP to the 1977 Section 316(b) rulemaking for potential adoption of regulations for BTA determinations for new facilities. USEPA concluded that: "In the absence of a full technology review and documentation by NJDEP, EPA Region III will consult with our Delaware partners, the FWS and other Federal and State agencies to consider urging a formal objection to the permit."

As demonstrated by the summary of the extensive consideration of CWIS technologies by PSEG, ESSA, and NJDEP provided above, USEPA Region III's suggestion that intake technology options were not adequately considered is baseless. Indeed, one wonders whether Region III even bothered to read the record. Contrary to USEPA Region III's insinuation, the record provides "a full technology review and documentation." of potential BTA options for Salem. As shown in the Fact Sheet, NJDEP fully considered this evidence and analysis, including ESSA's recommendations. See FS pp. 66-70. The Demonstration considered an extraordinarily wide array of options, 29 in all. Its analysis was carefully reviewed by ESSA. The ESSA Report provided extensive information and evaluation regarding intake technologies and other fish protection option. ESSA did not identify any additional new technology options, other than potential modifications of the existing intake fish return system, but did recommend consideration of certain combinations of certain technologies. Based on this extensive documentation and analysis, NJDEP considered all of the most promising intake technology options, but was unable to conclude that any were suitable for application at Salem. NJDEP required studies of certain technologies (all of which had been identified and discussed by PSEG and ESSA) and combinations thereof, as well as a study and/or enhancement of the existing Salem fish return system, an option identified by ESSA. Further, NJDEP stated its commitment to require adoption at Salem of any cost-effective alternative intake technologies that would minimize impingement and/or entrainment effects at the intake. NJDEP's determinations regarding intake technologies are amply support by the record.

USEPA Region III did not point to any evidence in the record or offer any evidence of its own that might cast doubt on NJDEP's determinations. It did not identify to any intake technology options potentially suitable for application at Salem that were not considered in the Section 316(b) Demonstration, the ESSA Report, or NJDEP's Fact Sheet but that should have been considered. It referred generally to certain supplements to the USEPA 1977 Section 316(b) Guidance and to the pending USEPA rulemaking, but did not point to any suitable options discussed in the Guidance documents or in the rulemaking proceedings that should have been considered in connection with renewal of the Salem Permit and were neglected. Its claim that closed cycle cooling is the "reference point" for BTA is erroneous and contrary to USEPA's 1977 Section 316(b) Guidance, whose continued applicability to Section 316(h) determinations to was reaffirmed in a memorandum from USEPA headquarters to the Water Division Directors of all USEPA Regions on December 28, 2000, three weeks before USEPA Region III issued its comments on the Draft Permit. Contrary to USEPA's claims regarding closed cooling, there is no single CWIS technology serves as the "reference point" for BTA determinations. As USEPA's 1977 Section 316(b) Guidance makes clear, all such determinations are to be made

79/ Letter from B. Campbell to R. Shinn, dated January 19, 2001.

case-by-case, taking into account the characteristics of the Facility in question, the nature of the affected waters and their biota, the effects of the facility's intake, the availability of alternative technologies, and their benefits and costs. The Guidance does not provide any "reference point" technology for such determinations, and does not identify closed-cycle cooling as such. Under the "stepwise" approach to evaluating alternative technologies recommended in the Guidance, p. 17, closed cycle cooling is the last option to be considered, not the first. NJDEP's BTA determinations and Draft Permit measures are fully supported by the extensive record and are eminently reasonable. USEPA's innuendoes to the contrary are frivolous.

USFWS recommends that NJDEP "promote interim implementation" of sound deterrent systems at the Salem intake, "require implementation of any multi-sensory hybrid system that demonstrates effectiveness in reducing impingement and entrainment and is not cost-prohibitive," and based on the results of the hydrodynamic study of the CWIS, require the placement of an effective diversion system (e.g., extended jetties) in front of the CWIS." Although it is unclear just what modifications to the Draft Permit USFWS is advocating, its unelaborated recommendations have no support in the record (a deficiency not repaired by anything provided in USFWS comment), are highly imprudent, and should not be adopted. See PSEG Response to USFWS Comments, Attachment VI. With respect to sound, USFWS is apparently recommending installation of some form of sound deterrent system in advance of completion of the further studies of sound deterrent used, alone in and combination with other technologies, required by the Draft Permit. The present record, as NJDEP properly recognized, FS p. 50, does not establish that any sound deterrent technology is available and suitable for installation at Salem at the present time. The purpose of the further studies proposed by NJDEP is to determine whether such a technology can be identified and developed further, to the point that it might be appropriate for implementation at Salem. Before adoption of any such technology as BTA for Salem, it would be required to pass the "wholly disproportionate" cost/benefit standard, a requirement ignored by USFWS. Further, installing a given (and untested) sound deterrent technology immediately without further studies creates a significant risk that substantial resources will be expended in installing a technology that will prove ineffective and/or incompatible with other sound deterrents or other intake technologies which are subsequently found by NJDEP to be BTA for Salem, in which case it might have to be removed. With respect to multi-sensory hybrid technology systems and jetties, USFWS is apparently recommending "conditional conditions," i.e., that the Draft Permit require PSEG to implement these measures at some indefinite future point on the basis of wholly undefined criteria. Given the current lack of any evidence that these options will prove to be BTA for Salem (including complying with the wholly disproportionate standard) at any point in the near future, [80] any such speculative, indefinite, and potentially open-ended permit requirement would be unjustified and arbitrary. PSEG knows of nothing in applicable Section 316(b) guidance or permitting precedent that would support such a requirement. USFWS points to none. Accordingly, there is no merit in the suggestions advanced by USFWS regarding intake technology measures.

A number of speakers at the Public Hearings and commenters asserted that Salem should be required to retrofit to wet cooling towers or to dry cooling because this would ensure

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80/ PSEG's Response to ESSA, Section V.

reductions in fish losses by 95% (cooling towers) or 99% (dry cooling). For example, the Delaware Riverkeeper, (Statement of Maya van Rossum, Jan. 23, 2001 Public Hearing) stated that: "These two technologies, cooling towers and dry cooling, would minimize Salem's fish kills and therefore they set the standard that must be achieved under the law." Another commentor, Mr. Tony Totah, Clean Ocean Action (Statement at January 23, 2001 public hearing) indicated that "the best way to minimize the negative environmental impact of the cooling water intake system from the power plant is to minimize the amount of water that is withdrawn from the Bay. The best technology that has been developed is the closed cycle cooling system towers. It's a proven technology that reduces the amount of water needed by 95%." Most of the commenters recommending these alternatives, however, entirely failed to confront the enormous economic and environmental costs of closed cycle cooling retrofit, or to show error in the conclusion from the cost-benefit analyses that the costs of retrofit would be holly disproportionate to the environmental benefit, and that accordingly, closed-cycle cooling retrofit is not BTA for Salem. [81]/

NJDEP, on a full review of the Section 316(b) Demonstration and the ESSA Report, was unable to find that there is any additional intake technology measure that is at present BTA for adoption at the Salem intake. It concluded that a study of a multi-sensory hybrid intake technology system, including strobe light/air bubble combination technology, sound deterrent, and light attraction technologies, to be studied individually and in combination, should be required as a component of BTA. FS pp. 69-70. It required that the study of sound deterrent include study of far field attraction behavior or potential acclimation, and that it address concerns raised by ESSA concerning certain aspects of the sound deterrent studies conducted by PSEG pursuant to the 1994 Permit. FS p. 50. Further, based on ESSA's Report, the Department included in the Draft Permit Special Conditions that PSEG investigate fish mortalities associated with the current intake screen fish return system and sampling pool and submit a proposed study and/or redesign of the fish return sluice and sampling pool. FS p. 53. These determinations by NJDEP are fully supported by the record and are reasonable. Commenters, including in particular USEPA Region III, that question NJDEP's decisions regarding BTA are unable to point to any current CWIS technology that is suitable for implementation at Salem at a cost that is reasonable in relation to its fish protection benefits and that accordingly should have been required by NJDEP as BTA, or to any technology that might reasonably qualify as BTA for Salem that was not considered in the renewal process.

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[81]/ The option of retrofitting Salem for dry cooling is discussed at Note 8, supra and in Attachment V.A. As shown there, the costs of retrofitting Salem to dry cooling would be even greater than retrofit to wet cooling, even assuming dry cooling retrofit at Salem would be feasible from the viewpoint of engineering, construction, and safe operation of the Station.

Certain commentees did not attempt to minimize the costs of closed cycle cooling retrofit by expressing the cost in terms of the increase in the average residential consumer's monthly utility bill or by amortizing it over a long period. As discussed below, these strategem are unavailing. However the costs are ultimately distributed, the fact remains, as shown by the cost-benefit analyses, that retrofit of closed cycle cooling would represent an enormous waste of scarce societal resources.

G. ESSA's Criticisms of the Application's Cost-Benefit Analysis Are Baseless

Consistent with the "wholly disproportionate" standard for determining BTA, PSEG's Section 316(b) Demonstration presented a detailed analysis of the social costs and social benefits of additional fish protection alternatives at Salem, including the four intake modifications that survived the technical screening process described above, closed cycle cooling retrofit, and two flow modification schemes, seasonal flow reduction and revised refueling outage schedules. The results of this detailed and comprehensive cost-benefit analysis indicated that none of the additional fish protection alternatives has social benefits that exceed its social costs. For all alternatives, the social costs greatly exceed the social benefits; the ratio of costs to benefits ranges from 6.6 for one of the seasonal flow reduction alternatives, to 34.0 for another of the seasonal flow reduction alternatives. The cost-benefit analysis presented in the Demonstration includes extensive documentation of the objectives of the evaluation, the data and methods used, and the results and conclusions reached. The cost-benefit analysis in the Application was 45 pages long (including 8 tables and 19 figures) and was accompanied by 110 pages of attachments that provided background information and detailed descriptions of the data and methodologies used.

ESSA commented on various aspects of the cost-benefit analysis in the Application and provided recommendations for additional analysis or documentation. See ESSA Report, Section 4. A careful review of these comments indicates that the criticisms are baseless and the recommendations for additional documentation and analysis are not justified because they would not add to an understanding of the likely costs and benefits of implementing additional fish protection alternatives at Salem. [82]/

ESSA's critique does not fundamentally challenge, or even take issue with, the data, methods and conclusions of the Salem cost-benefit analysis. ESSA does not recommend that other data sources be used, or that other methodologies be used to assess costs and benefits, nor does it contend that alternative data or methodologies would alter the conclusions of the study.[83]

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[82] The lack of any substantial merit in ESSA's comments and recommendations regarding the cost-benefit analyses presented in the Demonstration is shown in greater detail in PSEG's Response to ESSA, Section VI.

[83] Some speakers at the Public Hearings suggested that the costs of closed-cycle cooling retrofit are not unduly large because PSEG might amortize the costs of retrofit over a 30-year period, or because the costs are not large in relation to PSEG revenues, or because they would represent a relatively small increase in residential customers' utility bills. See, e.g., Statement of Norm Cohen, January 23, 2001, Public Hearing, transcript p. 81; statement of Paul Williams, id., p. 110; statement of May van Rossaum, January 25, 2001, Public Hearing transcript p. 112. These claims are inapposite because they ignore the central principle and purpose of cost-benefit analysis, which is to evaluate not only the costs to society of a proposed course of action but also its benefits to society and compare the costs against the benefits in order to assist decision makers in determining whether it would be prudent to expend scarce societal resources to implement the proposed action as opposed to devoting these resources to alternatives. None of the speakers advocating closed cycle cooling retrofit addressed the Application's analysis of the benefits of closed-cycle cooling retrofit or sought to compare the costs of retrofit to those

Indeed, at one point, ESSA acknowledges that its concerns would not affect the overall conclusions of the cost-benefit assessment. ESSA Report, § 4. Thus nothing in ESSA's Report disturbs the fundamental conclusion that the costs of each and all of the alternatives studied would be wholly disproportionate to the benefits.

Virtually all of ESSA's comments relate to documentation issues and ESSA's contention that the methods and assumptions in the cost-benefit analysis were not clear and, in particular, that ESSA was unsure whether costs were correctly measured as social costs or incorrectly measured as private costs that would accrue to PSEG or particular groups. This contention is hard to justify, given the detailed information regarding the cost-benefit analysis provided in the Applications, two lengthy in-person meetings and conference calls between the PSEG experts who conducted the analysis and ESSA, and detailed written clarifications and explanations regarding cost-benefit analysis that were provided by PSEG to ESSA prior to issuance of the ESSA Report. [84]/ Virtually all of the comments in the ESSA critique of the cost-benefit analysis were addressed in these extensive discussions and documentation. In particular, it is clear in the Demonstration as well as in the additional materials that the costs measured in the Demonstration's cost-benefit analysis are social costs rather than costs that accrue only to a particular private group.[85] The few criticisms raised in the ESSA Report that were not addressed by PSEG in these prior discussions and materials generally have an academic or theoretical orientation and hypertechnical character that is completely inappropriate in the practical context of applied cost-benefit analysis for regulatory decision-making and that ignores the guidelines that have been developed by the USEPA and other regulatory agencies for such cost-benefit assessments. [86]/ The extensive list of references provided at the end of the ESSA Report cost-benefit review section includes virtually no references to USEPA guidelines or to actual cost-benefit analyses for Section 316(b) studies.

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benefits. All of the remarks dealt only with the incidence of the private costs of retrofit based on whether some of these costs are borne by the Company or by ratepayers. Whatever the incidence of costs on private groups, the cost-benefit analyses presented in the Demonstration show that retrofit of closed cycle cooling would represent an enormous waste of society's scarce resources in relation to the benefits to society that would be provided.

[84] PSEG's Response to ESSA's Presentation of Preliminary Findings from Its Review of PSE&G's March 1999 Permit Renewal Application for Salem Generating Station, pp. 7-20 (May 17,2000).

[85] The final sentence of the ESSA Report chapter on the cost-benefit analysis, Report, p. 69, states that "the proper perspective of the CBA is to measure costs in terms of net changes in consumer rates." Changes in consumer rates, however, are private costs to consumers and do not necessarily represent costs to society. Accordingly, ESSA's own statement appears to contradict ESSA's (proper) contentions elsewhere in its Report that costs should be measured from a societal rather than a private perspective.

[86]/ See e.g., USEPA, Guidelines for Preparing Economic Analyses (September, 2000).

On consideration of the Section 316(b) Demonstration (Application, Appendix F, Sections VIII and IX) and the ESSA Report, NJDEP did not question the results of the cost-benefit analysis or include in its Draft Permit any of the ESSA recommendations for additional documentation. The extensive and detailed cost-benefit analysis of fish protection alternatives at Salem submitted by PSEG provides ample support for the conclusion that none of the additional fish protection alternatives evaluated is BTA for Salem.

H. The Draft Permit Requirements, In Conjunction With Salem's Existing Intake, are BTA for Salem

As summarized above, a wide array of potential new or additional intake technologies and other fish protection measures including closed cycle cooling retrofit and flow modifications were thoroughly considered and evaluated in the PSEG Section 316(b) Demonstration. The Demonstration concluded that none of the 29 alternatives considered were BTA for Salem, either because they were not suitable for application at Salem, or did not show sufficient assurance of environmental benefit, or because their environmental and economic costs would be wholly disproportionate to their benefits. The ESSA Report also provides an extensive discussion of intake alternatives and reaches similar conclusions. The Report did not recommend any alternative for present adoption at Salem. Instead, it recommended further study of a hybrid multi-sensory fish protection system and a study of modifications to the existing Salem intake fish return system.

NJDEP considered the various intake technology and other alternatives presented in PSEG's Section 316(b) Demonstration and the ESSA Report and was unable to find that any of them is, at present, BTA for Salem. FS pp. 66-70. It included in the Draft Permit a requirement for further study by PSEG of a multi-sensory hybrid fish protection technology system, including studies of sound deterrent technologies and other technologies identified by ESSA as warranting further investigation. NJDEP also included in the Draft Permit a requirement study of potential modification of the existing intake fish return system in order to enhance survival of impinged fish, as recommended by ESSA. The record demonstrates that USEPA Region III's claim that intake technology options were not adequately explored in the renewal proceedings is frivolous and the suggestions by USFWS that PSEG be required to install sound deterrents or (on a conditional basis) other intake measures are without merit. Submissions by commenters that Salem should be retrofitted to closed-cycle cooling or dry cooling are likewise meritless. Flow modifications are also not BTA per Salem because they would involve costs that would be wholly disproportionate to their benefits. NJDEP's determinations are amply supported by the administrative record. Thus, none of these measures is BTA for Salem. Accordingly, as concluded by NJDEP, FS p. 77, Salem's existing cooling water intake structure, in conjunction with the Draft Permit requirements for studies of potential additional intake technology measures and of potential modifications to the intake screen fish return system, is BTA for Salem under Section 316(b) and will appropriately minimize any potential for adverse impact from the Salem intake.

VII. THE PROPOSED CONTINUATION IN THE DRAFT PERMIT OF THE CONSERVATION MEASURES ORIGINALLY PROPOSED BY PSEG AND ADOPTED BY NJDEP IN THE 1994 PERMIT IS CONSISTENT WITH APPLICABLE LAW, WILL PRODUCE SUBSTANTIAL BENEFITS TO THE AQUATIC POPULATIONS AND THE ECOLOGY OF THE ESTUARY, AND HAVE BEEN AND WILL BE IMPLEMENTED WITHOUT ADVERSELY AFFECTING THE ENVIRONMENT OR HUMAN HEALTH

The Draft Permit requires PSEG to continue to implement the wetlands restoration and preservation measures required in the 1994 Permit in accordance with the Management Plans for the restoration sites. FS p. 42. It also requires PSEG to continue the fish ladder measures required in the 1994 Permit, including operation, monitoring, and fish stocking activities. FS p. 46.

These provisions are appropriate and should be adopted, subject to certain modifications and clarifications. [87]/. They will appropriately serve to minimize further any potential for adverse impact from Salem on the greater populations of the Estuary and will provide a host of other environmental benefits that will persist far beyond the useful life of the Station.

A. The Salem Renewal Permit Should Continue Without Changing the Successful Conservation Measures Proposed by PSEG and Adopted by NJDEP in the 1994 Permit in Order to Minimize Further Any Potential for Adverse Impact from the Salem Intake

A permitting authority may not unilaterally require, pursuant to Section 316(b) a source to adopt conservation measures such as wetlands restoration, fish ladders, fish stocking, or construction of artificial reefs because such measures are not a "technology" relating to the "location, design, construction or capacity" of a cooling water intake, as NJDEP acknowledged in issuing the Draft Permit. NJDEP 1994 Response to Comments, Response No.3. However, applicable law and long-standing permitting precedent authorize the inclusion of conservation measures in permits pursuant to Section 316 (b) determinations when such measures are proposed or accepted by the permittee and are determined by the permitting agency to be environmentally appropriate. See Application, Appendix D, Attachment D-1.; Stewart & Schoenbaum, Conservation Measures at 158. Anderson & Gotting, Section 316(b) at 47-49.[88]

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[87]/ PSEG recommends that certain modifications to the Draft Permit provisions relating to wetlands restoration and fish ladders be adopted in the final Permit, and that other issues regarding monitoring and study requirements be addressed in NJDEP's Response to Comments. These recommendations are set forth in PSEG specific Comments on Draft Permit Terms and Conditions Part IV.G.3, Part IV.G.4, Part IV.G.6. and Part IV.G.12; and FS pages 37, 40, 42, 51 and 52.

[88] In accordance with these principles, the wetlands restoration and fish ladder provisions in the Draft Permit are lawful because PSEG accepts and will implement the Draft Permit measures subject to the modifications proposed in PSEG Specific Comments on Proposed Terms and Conditions and Fact Sheet and because NJDEP has determined that they are environmentally appropriate.

Furthermore, a permitting authority must take the fish production and other environmental benefits of such measures into account in determining, pursuant to Section 316(b), whether an intake is having an adverse environmental impact and whether permit conditions (including both BTA provisions and conservation measures) will appropriately minimize adverse environmental impact or the potential for such impact. See Appendix D-§ V.D.; Stewart & Schoenbaum, Conservation Measures at 164.

The extensive conservation measures required in the 1994 Permit, including the far-reaching program of wetlands restoration and conservation and the installation of fish ladders, were proposed by PSE&G in 1993 to meet NJDEP's concern over the potential for adverse impact from Salem's cooling water intake. NJDEP adopted these provisions in the 1994 Permit because of their environmental and economic advantages over retrofit of closed-cycle cooling, which NJDEP had originally proposed in accordance with the recommendation of its consultant Versar. The environmental impact of Station operations must be evaluated in light of the positive effects of these conversation measures on the Estuary and its aquatic populations.

The expectation of PSEG in proposing and of NJDEP in adopting the conservation measures was that naturally functioning marshes and the increased habitat made available by fish ladders would enhance aquatic populations and minimize any potential for adverse impact from Salem's intake. These expectations have been amply vindicated by experience. Marsh restoration is proceeding in accordance with the requirements of the Permit and the NJDEP-approved management plans. Although restoration is still in progress, the restored marshes are already producing significant food and habitat benefits for the aquatic community of the Estuary, including the RIS populations. PSEG has installed three more fish ladders than the five required by the Permit; the impoundments that have been made accessible by the fish ladders are being stocked and are beginning to be used by river herring that migrate to the Estuary. The benefits currently being provided by the restored marshes and the fish ladders will increase in the future. The conservation measures clearly serve to protect and maintain the fish and other aquatic populations of the Estuary, and also provide a wide range of other environmental benefits that will continue long after the Station's useful life.

When NJDEP endorsed and adopted the conservation measures, it was understood by all that the measures would be implemented over a substantial time frame, extending beyond the 1994 Permit's five-year term, as the Permit provisions regarding the conservation measures reflect. PSEG has taken substantial steps to implement successfully the wetlands restoration and fish ladder measures in accordance with the requirements of the 1994 Permit. Additional implementation measures must be taken, in accordance with the plan laid down in the 1994 Permit. Some commenters, however, have claimed that the restoration measures that are being undertaken at the sites dominated by *Phragmites*, which are proceeding in full compliance with Permit requirements, will not succeed or are otherwise undesirable. Some commenters oppose continued spraying of glyphosate to help restore the sites dominated by *Phragmites* to *Spartina* and other desirable marsh grasses. They claim that glysophate poses undue risks of harm to health and the environment, even though it has been approved for use by EPA and by the Permit. Opponents and some skeptics of the *Phragmites* restoration effort contend that PSEG should be required to abandon the effort and acquire or fund acquisition of additional wetlands as well as upland buffers in other locations, or fund additional fish ladder construction. As shown below, these claims and proposals find no justification in the law or the evidence of record, which show that the *Phragmites* restoration is proceeding in compliance with the success criteria in the Management Plans. The record does not provide any basis for concluding that restoration at these sites will not succeed. The arguments advanced by opponents and skeptics of restoration at the *Phragmites* sites do not provide evidence sufficient to conclude that it can not succeed. Nor does the record provide any basis for concluding that application of glyphosate at these sites poses any material risk to human health or the environment. There is accordingly no basis for any of these commenters' proposals to the conservation measure provisions of the Permit.

B. NJDEP Has Properly Determined That PSEG's Wetlands Restoration Program is on a Trajectory for Success in Compliance with Permit Conditions

The conservation measures in the 1994 Permit include a requirement that PSEG implement a program to restore, enhance and preserve a minimum of 8,000 acres of wetlands adjacent to the Delaware Bay Estuary and an additional 2,000 acres of wetlands or 6,000 acres of upland buffer. The Permit further requires PSEG to impose conservation restrictions on the restored wetlands and upland buffers in addition to the approximately 4,500 acres of land known as the Bayside Tract, located in Greenwich Township, Cumberland County, New Jersey.

Specifically, the Permit requires PSEG to secure access or control over the lands subject to restoration, enhancement and/or preservation. All lands must be subject to conservation restrictions to assure their continued protection from development. PSEG then was required to design Management Plans. The Management Plans set forth the framework in which the land management and restoration process will be designed and implemented by PSEG to restore the structure and function of the degraded wetlands and apply preservation measures to associated upland buffers. Specifically, the Management Plans provide an overview of existing conditions, the proposed design, the schedule for implementation, and operations and maintenance provisions. Management Plans were designed in consultation with a Management Plan Advisory Committee ("MPAC"). The Management Plans were reviewed and approved by NJDEP and thereafter were incorporated as a condition of the Permit. The Permit requires implementation of the approved Management Plans, which implementation shall continue with respect to maintenance during any period of time the permit is extended.

PSEG is successfully restoring five sites in New Jersey and two sites in Delaware[89] in accordance with the approved Management Plans. These sites include three previously diked salt hay farms, located in Commercial, Dennis, and Maurice River Townships in New Jersey. The remainder of the sites are those that, prior to restoration, were dominated by the common reed, *Phragmites australis* ("*Phragmites*").

[89]Among the lands along the Delaware shoreline adjacent to the Delaware Estuary identified by DNREC and PSEG as suitable areas for wetland restoration and enhancement were five separate wetlands sites dominated by *Phragmites*: the Lang Tract, Silver Run, The Rocks, Cedar Swamp, and Woodland Beach. Each of these sites has been restored with funds provided by PSEG. Consistent with the NJDEP requirements for creditable acres under the 1994 Permit. PSEG and DNREC determined in the spring of 1999 that PSEG would focus its restoration efforts on two sites (The Rocks and Cedar Swamp) and that DNREC will continue restoration efforts on the remaining three sites.

At the salt hay farms, normal daily tidal flow has been restored through a program of channel enhancement and excavation and dike breaching. Restoration construction was completed in accordance with the schedules approved in the Management Plans in October 1996 at the Dennis Township site, March 1998 at the Maurice River Township site, and November 1997 at the Commercial Township site.

At the *Phragmites*-dominated sites, the sites are being restored by reducing monocultural stands of *Phragmites*, thereby minimizing the undesirable ecological conditions associated with *Phragmites* and fostering the growth of *Spartina* and other desirable marsh species. In particular, the program employs a multi-phased approach that included baseline field data collection, initial *Phragmites* control through application of an herbicide (Rodeo® with a surfactant), additional field data collection, and supplemental *Phragmites* control using additional herbicide application and/or alternate technologies investigated as part of PSEG's test area program[90]. Restoration activities were completed in accordance with the schedules in the approved Management Plans in September 1999 at the New Jersey *Phragmites*-dominated wetland restoration sites and in June 2000 at the Delaware sites.

The Management Plans establish hydrologic and vegetation success criteria against which to judge the ability of the sites to contribute to the productivity of the estuary. Interim and final success criteria were established based on conditions observed at nearby natural marshes.

The final vegetation and hydrologic criteria are:

- No less than 95 percent of the marsh plain will be colonized by desirable vegetation;
- *Phragmites* coverage reduced to less than 5 percent of the total vegetated area of the marsh plain (less than 4 percent of the total marsh); and
- Open water and associated intertidal mud flat constituents of the restored sites will be targeted to be less than 20 percent of the total marsh area, with a potential range up to 30 percent of the total marsh area at the Maurice River Township site.

These end-points are expected to be attained no later than the twelfth year of monitoring. A two year lag period is prescribed for the salt hay farms, while a one year lag period is prescribed for the *Phragmites*-dominated sites.

Interim success criteria were adopted to assure that conditions during and immediately following restoration activities were moving the wetlands toward successful restoration.

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90 The test area program includes approximately eighty (80) test areas where quantitative data are gathered and analyzed annually to evaluate alternative technologies for *Phragmites* management. The test areas include a variety of treatments, including mowing, multiple mowing, microtopography modifications, seeding, grazing, and selective Rodeo® with a surfactant application. The treatments are implemented both singularly, in combination, and at various times throughout the year. The test area program is described more fully in Section VII.D.4.

Interim hydrologic criterion will be satisfied if normal tidal flow has been restored at the end of three years following completion of initial site engineering. Interim vegetation success criterion is satisfied when at least forty-five percent (45%) of the marsh plain coverage by desirable vegetation is attained. For the salt hay farm sites, this criterion is expected to be satisfied after seven growing seasons. For the *Phragmites*-dominated sites, this is expected to be satisfied after six growing seasons. PSEG is undertaking a rigorous data collection effort to assess the status of its marsh restoration activities in relation to these criteria and to nearby reference marshes.

In its March 1999 Application, PSEG evaluated the success of its restoration program against the applicable management plans criteria, concluding that each of its restoration sites was on a trajectory for success; *i.e.*, progressing steadily toward compliance with the interim and final success criteria. *See* Appendix G and its Attachments. since submission of the March 1999 Application, PSEG has continued to implement the Management Plans at its restoration sites and has submitted reports documenting progress at those sites. *See* PSEG's Specific Comments on proposed Terms and conditions and Fact Sheet, Comments on Fact Sheet Part XII, Contents of Administrative Record; PSEG 2000, Biological Monitoring Program 1999 Annual Report. NJDEP considered this supplemental information in addition to the March 1999 application when reaching its conclusion in the Fact Sheet, FS pp. 40, 42-43, that PSEG has fulfilled all Permit requirements related to the wetlands restoration.

NJDEP determined in the Fact Sheet FS page 42, that by restoring these sites, the Permit requirements pertaining to land acquisition and development have been met. FS, p. 42. Further, relying on the most recent vegetation data (from the 1999 growing season), NJDEP determined all restorations sites are in compliance with the success criteria, with at least nine percent (9%) coverage of *Spartina* and other desirable marsh vegetation per year. FS p. 40. NJDEP also set forth the compliance date on which each site is expected to meet the final success criteria. FS p. 40. [91]/

The enormous groundbreaking efforts by PSEG to achieve this success have been recognized by numerous independent scientists, who enthusiastically support the inclusion of these wetland restoration requirements in the renewal permit to allow for the continued enhancement of Delaware Estuary fisheries. Among these experts is Dr. Ruth Patrick from the Academy of Natural Sciences of Philadelphia, where she is the Curator of the Department of Limnology and the occupant of the Francis Boyer Chair.[92] Transcript of Public Hearing January 23, 2001, page 29. Dr. Patrick has extensive experience studying estuaries and coastal waters, including the conduct of research concerning the Delaware Estuary dating as far back as the 1940s. Id. at 29-30. Dr. Patrick stated that PSEG's wetland restoration program "has proven that coastal wetlands can be successfully restored on a large-scale basis and that the scientific

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[91]/ As noted in PSEG's specific comments on Proposed Terms and Conditions and Fact Sheet, comments on Fact Sheet, p. 40. Interim Vegetative Criteria and Final Success Criteria dates provided in the Fact Sheet are incorrect.

[92] Dr. Patrick has also served on many Presidential committees and has received many honorary degrees and the National Medal of Science of the United States of America. Transcript of Hearing, January 23, 2001, pp. 29-30.

approach and principles employed are valid and therefore transferable to other restoration efforts." Id. at 31. To that end, Dr. Patrick recognized the advancements in science of wetland restoration and understanding of marsh ecology resulting from PSEG's wetland restoration program. Id.

J. Fred Grassle, Director of the Institute of Marine Coastal Sciences, Rutgers University, focused on the fish response to the restorations while reaffirming Dr. Patrick's characterizations of the PSEG wetland restoration program. Transcript of Public Hearing January 25, 2001, page 73-78. In particular, Dr. Grassle referenced Dr. Ken Able's extensive research which demonstrates rapid fish response to the restoration such that the species composition, abundance, and growth in the restored sites were similar to natural reference marshes. Id. at 76.

These accolades were echoed by, among others, Richard Horwitz, Senior Biologist at the Academy of Natural Sciences of Philadelphia;[93] Jim Applegate, Professor of Natural Resources at Cook College, Rutgers University;[94] Susan Ford, Research Professor at Rutgers University Institute of Marine and Coastal Sciences;[95] J. Burger, Professor of Biology, Rutgers University;[96] Mary Allessio Leck, Professor of Biology, Rider University;[97] and Joseph K. Shisler, President of Shisler Environmental Consultants[98].

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[93] Dr. Horwitz stated the program serves as a model and has confirmed the importance of *Spartina* marshes to productivity of bay fishes. Transcript of Public Hearing January 23, 2001, pages 36-40.

[94] Dr. Applegate notes that the changes in the marshes as a result of the restoration have been "profound and consistent with the increased quality estuarine health." Transcript of Public Hearing January 23, 2001, page 41.

[95] Dr. Ford noted that the restored marshes are behaving like undegraded reference marshes in terms of plants, fish and other wildlife all within a year or two of restoration. Id. at pp. 70-71.

[96] Dr. Burger characterizes the PSEG wetland restoration program as "one of the largest, most extensive, and most important experiments of its kind in the country," "a truly amazing effort to restore a critical and important habitat" and a success with habitat recovering at "amazing speed." Letter from J. Burger, Distinguished Professor of Biology, Rutgers University to Debra Hammond, Chief, Bureau of Point Source Permitting, NJDEP, Jan. 18, 2001.

[97] Dr. Leck commented that PSEG's restoration program is a model and the research resulting from it will be invaluable in helping to evaluate the potential impacts of human alteration of landscapes, comparing its scope to the federally funded International Biome Programs of the late 1960s and early 1970s. Letter from Mary Allessio Leck to Debra Hammond, Chief, Bureau of Point Source Permitting, NJDEP, January 9, 2001.

[98] Dr. Shisler affirmed that the restoration program has been documented as effective. Transcript of Public Hearing January 23, 2001, page 96.

1. The Salt Hay Farms Have Been Successfully Restored

At the time of the March 1999 Application, PSEG's wetlands restoration program was in the process of successfully restoring natural and productive structure and function to the degraded wetlands. At the salt hay farm sites, normal daily tidal flow had been restored through a program of channel enhancement and excavation and dike breaching, and natural geomorphology was developing rapidly. The sites had been colonized by desirable vegetation, and this vegetation was expanding across the restored areas. The productivity of the returning desirable vegetation and algal communities was comparable to that measured in nearby healthy reference marshes. Based on this evidence, NJDEP stated in the FS, p. 75 that "the evidence is clear that the restored marshes are quickly coming to have the form and function of 'natural' marshes based on a comparison of restored versus reference marshes."

Accordingly, in the FS p. 40, NJDEP endorsed PSEG's conclusion in the 1999 Application that the available data and information demonstrate that the diked salt hay farms are on a trajectory for successful restoration. FS p.40. Monitoring conducted at the end of the 1999 growing season continues to support that finding.[99]

The vegetation success criteria for the salt hay farms project a seven year time frame to meet the interim success criteria and a twelve year time frame to meet the final success criteria. [100/] The Dennis Township Site, where construction was completed in 1996, has already satisfied all of the interim vegetation success criteria and is within a percentage point of meeting the final success criteria after only three growing seasons. The Maurice River Township Site, where construction was completed in 1998, has satisfied the interim success criteria after only two growing seasons. The Commercial Township Site, where construction was completed in 1997, continues along the projected pathway for restoration in line with interim success criteria. In issuing its Draft Permit, NJDEP reviewed this most recent data to confirm continued compliance with the Permit terms. *See* FS p. 100 at Table 2.

In addition to vegetation success, natural tidal inundation has generally been restored at all the salt hay farm sites in satisfaction of the interim hydrologic success criteria. Engineered tidal channels have initiated natural estuarine processes that support the establishment of a

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[99] 1999 Site Status Report for Submission to the NJDEP – Land Use Regulation Program, U.S. Army Corps of Engineers and Management Plan Advisory Committee, Dennis Township Salt Hay Farm, Cape May County, New Jersey, June 30, 2000; 1999 Site Status Report for Submission to the NJDEP – Land Use Regulation Program, U.S. Army Corps of Engineers and Management Plan Advisory Committee, Commercial Township Salt Hay Farm , Cumberland County, New Jersey, June 30, 2000; 1999 Site Status Report for Submission to the NJDEP – Land Use Regulation Program, U.S. Army Corps of Engineers and Management Plan Advisory Committee, Maurice River Township Salt Hay Farm , Cumberland County, New Jersey, June 30, 2000.

[100/] As noted in PSEG's Specific Comments on Proposed Terms and Conditions and Fact Sheet, Comments on Fact Sheet, p. 40. Interim Vegetative Criteria and Final Success Criteria dates provided in the Fact Sheet are incorrect.

system of subtidal and intertidal mud flats and smaller, or higher order, creeks that are characteristic of a fully functioning marsh system.

2. Restoration Construction at the *Phragmites* Sites Is Recently Completed and Preliminary Data Indicate Substantial Restoration Progress

In issuing the Draft Permit, NJDEP also reviewed the most recent vegetation data to conclude the *Phragmites* restoration sites are in compliance with the Permit conditions. FS p. 40.[101/] Restoration construction activities were completed in accordance with applicable Management Plan schedules in September, 1999, at the New Jersey *Phragmites*-dominated wetland restoration sites and in June, 2000, at the Delaware sites. In the case of these sites, the Management Plans specify a one-year lag following the completion of restoration implementation activities before the interim vegetation success criteria become applicable. Thereafter, the Management Plans anticipate a twelve-year restoration period. For all *Phragmites*-dominated sites, 2000 is the first full growing season following completion of restoration efforts and is the prescribed lag year. In accordance with the Management Plans, no meaningful evaluation of the *Phragmites*-dominated sites relative to the success criteria will be appropriate until the completion of the 2001 growing season. Notwithstanding, as recognized by NJDEP it in its compliance determination, FS p. 40, restoration has already made considerable progress at the restoration sites. Based on data collected after the 1999 growing season,[102] *Phragmites* reduction from pre-restoration conditions at the four *Phragmites*-dominated sites ranged from 33% to 76% with corresponding increases in desirable vegetation.

The substantial progress of restoration is no less evident at the Cohansey River Watershed Site than at the other PSEG *Phragmites* restoration sites. Notwithstanding, in the Fact Sheet, NJDEP credits the restoration acreage at the Cohansey River Watershed Site at only 2:1, noting that *Phragmites* occupied 45% of the marsh plain at the Site when restoration activities commenced. FS p. 42. The Department's credit for the Cohansey River Watershed site at a 2:1 ratio, however, fails to acknowledge the very properties of *Phragmites* that have made the restoration of these sites necessary.

101/ As noted in PSEG's Specific Comments on proposed Terms and Conditions and Fact Sheet, Comments on Fact Sheet, Table 2, the status of vegetative cover for wetland restoration sites for *Phragmites*-dominated wetland restoration sites data contained within Table 2 is incorrect.

102 1999 Site Status Report for Submission to the NJDEP – Land Use Regulation Program, U.S. Army Corps of Engineers and Management Plan Advisory Committee; Alloway Creek Watershed *Phragmites*-Dominated Wetland Restoration Site , Salem County, New Jersey, June 30, 2000; 1999 Site Status Report for Submission to the NJDEP – Land Use Regulation Program, U.S. Army Corps of Engineers and Management Plan Advisory Committee; Cohansey River Watershed *Phragmites*-Dominated Wetland Restoration Site , Cumberland County, New Jersey, June 30, 2000; PSEG 2000, Biological Monitoring Program 1999 Annual Report.

PSEG should receive full 1:1 credit for restoration of this site. As detailed in Application, Exhibit G-2-6, *Phragmites* is a versatile plant that can adapt to a wide range of habitats and outcompete other vegetation.[103] Because of these attributes, *Phragmites* has expanded rapidly across many marsh areas in the less saline environments of the Delaware Estuary. *See* Application, Exhibit G-2-17. At the Cohansey River Watershed Site, *Phragmites* increased from approximately 41 acres in 1962 to 420 acres in 1996. *See* Application Exhibit G-2-17, Table 1. This expansion represents a ten fold increase in *Phragmites* over approximately 30 years.

NJDEP cites the fact that *Phragmites* occupied 45% of the marsh plain at the Cohansey River Watershed Site in 1996 to justify its 2:1 credit. FS p. 42. Yet, it is irrefutable that *Phragmites* would have continued to rapidly expand throughout the marsh plain. Using the same rate of expansion that occurred from 1962 to 1996 (7.3%/year), approximately two-thirds (2/3) of the marsh plain would have been dominated by *Phragmites* vegetation in 2001 absent treatment by PSEG. The rapid shift towards increased *Phragmites* at the Site was thwarted because of PSEG's restoration efforts. Had no restoration activities been undertaken, the progression towards an increased quantity of *Phragmites* would have continued. Subsequently, habitat losses would have mounted and the contribution of the site to the fishery resources of the Delaware Bay would have diminished. Given the documented ecological and physiological ability of the plant to expand and the rapid expansion documented at the site, NJDEP should award PSEG full credit for the restoration activities at the site.

3. NJDEP Should Define Restoration Acreage "Failure" in the Context of the Management Plans and Should Consider Alternate Replacement Acreage Scenarios That Reflect Actual Contributions to Fish Production for the Delaware Estuary

The Draft Permit states that "the Department may require the permittee to acquire additional lands to serve as 'replacement acreage' for any acreage deemed 'failed' by the Department." Draft Permit Part IV, p 8. In its Response to Comments document, NJDEP should define "failure" for purposes of this provision so that the expectations of the agency are known to the permittee. Clarification of the criteria for any NJDEP determination of restoration failure is needed because a number of commenters have claimed (incorrectly) that restoration at some sites has already failed or will inevitable fail and that NJDEP should accordingly require PSEG to acquire replacement acreage.

Furthermore, NJDEP should define failure in accordance with the NJDEP-approved Management Plans. The Management Plan success criteria are based on conditions observed in nearby natural references marshes and take into account relevant ecological processes. The Management Plans were developed in consultation with MPAC, whose representatives include

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[103] *Phragmites* has the ability to alter its own habitat to reduce stress and provide for its own expansion. The ability of the plant to move oxygen to rhizomes and roots in anoxic sediments enables it to rapidly expand within the marsh plain. Its dense culms and thick litter layer can act to slow water and enhance sediment deposition, increasing the elevations of the marsh plain and ultimately providing for a habitat more conducive to its own growth and expansion.

independent and regulatory scientists with expertise in wetlands ecology and processes and coastal engineering. These experts agree that the success criteria established in the Management Plans define the ability of the site to contribute to the productivity of the Estuary. Accordingly, the success criteria are the most defensible and appropriate measure on which to judge whether or not restoration has succeeded.

As described above, the restoration efforts at all sites are in compliance with the success criteria; thus, at this time, there is no failure of restoration nor is there any reason to anticipate such failure. If at some time in the future a restoration site fails to meet the success criteria and it is determined that Management Plan Adaptive Management remedies[104] will not resolve the failure, there may be a need to consider replacement acreage.

Any consideration of replacement acreage should recognize the reasoned suggestions of independent environmental groups that were offered during the comment period. These suggestions reflect considered and informed views regarding the types of replacement acreage that will effectively enhance estuarine processes that support the fisheries.

For example, The Nature Conservancy ("TNC") noted that wetlands restored on either side of the estuary equally benefit fish production. From an ecological perspective, fish produced on the Delaware side of the Bay use the Estuary the same as fish produced on the New Jersey side. Consequently, should replacement acreage be necessary, PSEG should be entitled to restore acres suited for restoration whether in New Jersey or Delaware. This acreage, moreover, should include lands subject to PSEG's ongoing restoration activities that presently are excluded from consideration toward the 10,000 acres due to the current Permit's constraint on the number of acres that are creditable in the State of Delaware.[105]

TNC, as well as the New Jersey Conservation Foundation, New Jersey Audubon Society, the Association of New Jersey Environmental Commissions, New Jersey Environmental Lobby, and Citizens United to Protect the Maurice River and its Tributaries, Inc., further noted in their comments that uplands significantly benefit wetlands. The importance of upland and tidal marsh preservation to the long-term sustainability of estuarine processes is increasingly widely

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[104] Adaptive Management is a framework for identifying and meeting environmental management goals by an iterative process of monitoring and engineering response. In Adaptive Management, expectations for how a restored area will recover its structure and function (recovery trajectories) are derived from an understanding of basic ecology and site specific conditions. Failure to meet these expectations in a particular period will trigger an adaptive management response, beginning with additional information gathering and ending with additional restoration engineering as warranted based on findings.

[105] PSEG is restoring 599 additional acres of wetlands at The Rocks and Cedar Swamp, both of which are subject to an approved Management Plan and are protected by Delaware Declarations of Restrictions and Covenants. The 599 acre of restoration area at The Rocks and Cedar Swamp meet all of the criteria established for other restoration sites and are in addition to the 10,000 acres mandated by the NJPDES Permit.

recognized.[106] The functions of upland buffers are so important that the United States Army Corps of Engineers has recognized that preserving vegetated buffers may provide more benefits to the local aquatic environment than replacing an impacted wetland, 64 Fed. Reg. 139 (2000).

PSEG has provided for the funding for the preservation of 1,452 acres of upland buffer areas in Delaware. In terms of benefits to the Delaware Estuary, these uplands contribute the same environmental and ecological functions as their counterparts in New Jersey that are credited at a 3:1 ratio and, accordingly, should be recognized if replacement acreage is required.

Furthermore, whether in New Jersey or Delaware, the 3:1 credit ratio for upland acreage should be reconsidered as recommended by TNC to provide an incentive for preservation of uplands. Given the fundamental nature of the relationship between upland buffers and adjoining wetlands, it would be most appropriate to credit upland buffers as essential, quantitative contributors to wetland functional values. Recognizing the necessity of properly situated upland buffers and in keeping with TNC's recommendations, PSEG suggests the following replacement acreage credit:

- Additional uplands in the headwaters of the Maurice River Basin, portions of which have been designated as "Wild and Scenic," should be credited at 1:1. These uplands provide critical water quality maintenance values and are integral to the functioning of the adjoining wetlands and waterways which is directly related to the maintenance of fish populations. [107]

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[106] Healthy, intact, broad, upland buffers are integral components of healthy wetland landscapes. In fact, upland buffers are absolutely critical to the functional value of wetlands (Lee and Gosselink 1988). Lack of such buffers, or lack of quality in buffers that are present, is reflected directly in reduced functional quality of adjoining wetlands (South Florida Water Management District 1997). The buffers serve as physical and biological ecotones, providing habitat diversity and assuring the functional integrity of the ecosystem at the landscape scale (Sampson et al. 1996). The water quality protection functions provided by upland buffers have been exploited in riparian and estuarine conservation programs in many places, notably in "critical areas" protection programs in New Jersey and Maryland. Water quality protection values accrue from upland buffers throughout watersheds, but are particularly important in headwaters areas, where streams are smaller, flows are lower, and pristine conditions are more likely to occur. Upland buffers adjacent to coastal wetland provide an area for wetlands migration when sea level rises, ensuring the continued presence and functionality of coastal wetlands.

[107] *See* Comments of Sally Dudley, Executive Director, Association of New Jersey Environmental Commissions, Feb. 16, 2001 (noting that the preservation of uplands buffers in the headwaters of the Alloways Creek watershed should have a positive effect on water quality in the Creek and Estuary); Comments of Jane Morton Galetto, President, Citizens United to Protect the Maurice River and its Tributaries, Inc., Feb. 12, 2001 (endorsing TNC's suggestion that acquisition and preservation of upland acreage in the Maurice River Basin be a priority); Comments of David F. Moore, former Executive Director of the New Jersey Conservation Foundation and former Chair of the Tidelands Council, Feb. 8, 2001 (urging consideration for the protection and restoration of tributary riparian corridors and headwaters); Comments of Don

- Any areas that can be acquired and conserved/preserved (including *Phragmites*-dominated wetlands) that enhance ecosystem linkage should be credited at 1:1, whether wetland or upland. These would include existing wetlands and uplands that would fill "gaps" in the "greenway" surrounding the Delaware Estuary. The more linkage between open areas, the more effective they are in providing important ecological functions that translate into increased fish production.

- In recognition that *Phragmites* may have some positive values and in consideration of the benefits associated with long-term preservation of these lands, any portions of existing restoration sites where *Phragmites*-dominated wetlands fail to be adequately restored should be credited at 2:1.[108]

- Other wetlands on the Delaware Estuary shoreline not part of the greenway should be credited at 2:1.

- Any freshwater wetlands in the Delaware Estuary watershed that are acquired and conserved/preserved should be credited at 1:1. Freshwater wetlands (particularly those dominated by forest habitats) are especially sensitive and valuable ecosystems.[109] These wetlands maintain water quality upgradient from coastal wetlands.

- Any areas of discontinuous, non-buffer uplands acquired and preserved/conserved should be credited at 3:1. Protection of wetland uplands will be of lesser value if

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Kirchhoffer, Project Manager for the New Jersey Conservation Foundation, Transcript of Hearing January 25, 2001, page 165-66 (supporting expanding lands considered as replacement acreage to include forested wetlands and upland buffers within the watershed along headwater streams to maintain the water quality in the Delaware Estuary); Comments of Richard Kane, Vice President of New Jersey Audubon Society, Transcript of Hearing January 25, 2001, page 60 (pointing out that uplands adjacent to the marshes and along the tributaries contribute to long-term water quality and improved conditions for fish).

[108] Although dense, monotypic stands of *Phragmites* negatively impact aquatic production, they may offer some value for limited species of birds and wildlife and possibly may have water quality and shoreline maintenance values. It has been used as a habitat buffer in the overall design of recently completed restoration projects (Clark, 1990).

[109] *See* Comments of Sally Dudley, Executive Director, Association of New Jersey Environmental Commissions, Feb. 16, 2001 (stating that "permanent preservation of additional wetlands, especially forested floodplain wetlands will provide essential water quality functions, natural flood storage, base stream flow and vital nurseries for the [sic] habitat, especially fish spawning activities"); Comments of Don Kirchhoffer, Project Manager for the New Jersey Conservation Foundation, Transcript of Hearing January 25, 2001, page165-66 (supporting expanding lands considered as replacement acreage to include forested wetlands and upland buffers within the watershed along headwater streams to maintain the water quality in the Delaware Estuary).

water quality is compromised from streams feeding the wetlands and estuary. Uplands in the Delaware Estuary watershed remote from the wetlands but within the watershed contribute in general to ecological value of the landscape as a whole.

C. PSEG's Wetlands Restoration Program Has and Will Continue to Benefit Significantly Fish Populations and Provide Other Environmental Benefits

The evidence of record shows that PSEG's wetland restoration program is already substantially benefitting the fish populations of the Delaware Estuary and will provide such benefits at even higher levels in the future, continuing long beyond the life of the Station.

1. The Importance of Wetlands Habitat for Fish Populations is Now Widely Acknowledged

PSEG recognized that tidal wetlands provide food and critically important habitat for recreationally and commercially important fish when it offered its wetland restoration proposal in 1993. NJDEP quickly recognized the fish production benefits of wetlands restoration when it included wetlands restoration provisions in the 1994 Permit. In the Fact Sheet, NJDEP set forth in detail the rationale for the wetlands restoration measures adopted in the 1994 Permit and continued in the Draft Permit:

> The wetlands restoration program is a very important component in minimizing entrainment and impingement effects, especially as it relates to restoration of fish populations. . . . An increase in the area of saltmarsh will lead to increased growth in marsh grasses which will lead to an increased food supply for fishes. This increase of saltmarshes required in this Special Condition will also result in an increase in the amount of living space (habitat) available for the various species of fishes.
>
> The species at issue at Salem (white perch, spot, weakfish, bay anchovy, and opossum shrimp) are all consumer organisms in the Delaware Estuary food web. Wetland systems in the Delaware Estuary provide foraging and refuge habitat, serve as nursery areas for early life stages and juveniles, and provide direct food resources. For these reasons, increased wetlands in the Delaware Estuary support production of the species at issue, wetlands restoration and enhancement will minimize the effects of Salem-related losses by increasing productivity of these species. Wetlands restoration and enhancement also benefits the other species dependent on the productivity derived from the wetlands. . . .
>
> Wetland production (estimated by the aggregated food chain model) was related directly to the estimated biomass lost by the Station's operations. This loss was used to estimate the wetlands

> restoration acreage required to adequately minimize the effects of Salem's losses by increasing the population of these species. . . . Conservative assumptions were incorporated in these calculations.
>
> The Department determined in its July 20, 1994 permit that PSE&G's proposal to restore or enhance a minimum of 10,000 acres of wetlands in the Delaware River Basin (which includes wetlands and upland buffer acreage) is adequate to minimize the effects of Station-related operations to assure the protection and propagation of the balanced indigenous population. FS p. 34-35.

The wisdom of the course taken by NJDEP in 1994 is repeated in the 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act (the "Sustainable Fisheries Act amendments") See Pub. L. 104-297 (1996). Congress stated:

> . . . one of the greatest long-term threats to the viability of commercial and recreational fisheries is the continuing loss of marine, estuarine, and other aquatic habitats. Habitat considerations should receive increased attention for the conservation and management of fishery resources of the United States. (Stedman and Brown 2000.)

Recently, fisheries biologists with the National Marine Fishery Service ("NMFS") published a review article titled *Catching the Link Between Wetlands and Fisheries Management*. (Stedman and Brown 2000.) The authors point out that:

> Fish use wetlands as nursery areas, spawning grounds, feeding areas, and refuge from predators. The wetland vegetation, the rich detritus, and the shallow water provide unique functions that benefit many fish. Approximately three-quarters of the commercial fish landings in the United States consists of species that depend on estuaries and their wetlands. Id.

They conclude that fisheries and wetlands historically have been managed as independent entities, and that this approach has been a mistake. The wetlands restoration efforts successfully undertaken by PSEG with the endorsement of NJDEP represent a significant step towards correcting this mistake.

2. PSEG's Restored Wetlands Demonstrate the Link Between Wetlands and Fish Production

As NJDEP anticipated in 1994 when it included the restoration in the Permit, the far-reaching program of wetlands restoration undertaken by PSEG is providing significant benefits to fish production, even though the restoration process is still at a relatively early stage. In the Fact Sheet, NJDEP affirms that "the evidence is clear that the restored marshes are quickly coming to have the form and function of 'natural' marshes based on a comparison of restored versus reference marshes." FS p. 75. NJDEP further notes "the evidence shows that the restored marshes are producing food that is eventually consumed by upper-level predators, which would include many of the commercially and recreationally important RIS." FS p. 76.

In the space of only a few years, the former diked salt hay farm sites are producing benefits for fish production that are equal to or even greater than those provided by nearby natural *Spartina* wetlands used as reference sites. The studies show that the restored marshes are being used by the same fish, and in the same numbers, as the reference marshes, and are providing food to RIS species, including weakfish caught in the open Estuary. Comprehensive monitoring data document extensive use of the marsh plain and rivulets by small fishes and use of larger tributaries by predator fish.[110] The evidence dramatically refutes the claims of the critics and skeptics of the restoration program, who claimed that it was unproven and experimental and could never succeed. The evidence fully vindicates the expectations of PSEG in proposing and the NJDEP in adopting the wetlands restoration program.

At the *Phragmites* sites, the larger tidal creeks supported functioning fish assemblages prior to restoration and, because of the early stage of restoration, would not be expected to show a dramatic response to restoration in the near term. Notwithstanding, data indicate that the abundance of fish in small marsh creeks generally remained steady or increased as the restoration of these sites progressed. Data regarding abundance of resident fish species which use the marsh plain indicate increased abundance of mummichog in *Spartina* habitats (Application, Exhibit G-3-13). As further discussed below, as restoration of the *Phragmites*-dominated sites progresses, *Phragmites* is replaced by *Spartina* and other desirable species, and the habitat reverts to more natural conditions, fishes will be able to use the sites more effectively for feeding, reproduction and nursery.

PSE&G undertook several comprehensive studies to determine whether, in fact, restored marsh successfully augments the aquatic food web, and provides habitat for reproduction, feeding, growth and refuge for numerous species of fish and other estuarine fauna. See Application, Appendix G. These studies were focused on the restored salt hay farms because they are further along in the restoration process. PSEG's studies showed that by 1998, the seasonal occurrence, abundance, and size of blue crabs in the restored marshes were similar to or greater than that of the reference marsh. Studies at the Dennis and Commercial Township sites found that the abundance of several fish species, including Atlantic croaker, bay anchovy, spot, striped bass, weakfish, and white perch in large marsh creeks was greater than or equivalent to abundance at the reference site. Detailed analysis of the food habits of young mummichog, bay anchovy, spot, weakfish and white perch, and of adult striped bass and white perch, indicate that individuals in the restored and reference marshes eat equivalent food in equivalent amounts. The studies found that fish were using the restored marshes for habitat for reproduction, feeding and

[110] In fact, a number of comments demonstrate that fishermen and laymen routinely observe abundant fish utilization of the sites. *See* Comments of Captain George Kumor; Comments of Jane Morton Galetto, President, Citizens United to Protect the Maurice River and its Tributaries, Feb. 12, 2001; Comments of Marie A. Curtis, Executive Director, New Jersey Environmental Lobby, Feb. 2, 2001; Comments of Ronald D. Riggins, Sr., Mayor, Maurice River Township, Jan. 31, 2001.

growth on the same basis as the reference marshes. Indicia of fish survival indicated similar function between restored and reference marshes.

PSEG's studies included state-of-the-art stable isotope studies, which showed that weakfish, bay anchovy, and white perch were using food derived from *Spartina* marshes. The weakfish specimens included those caught at the mouth of the Estuary, confirming that the energy generated by the *Spartina* marshes accrues to the benefit of higher-level predators in open waters. As noted by NJDEP:

> . . .[T]here is evidence from the stable isotope analysis that top predator fish which migrate through the Estuary to the open coast carry with them the imprint of the energy flow from the marsh vegetation to the highest trophic level. Thus, the evidence shows that the restored marshes are producing food that is eventually consumed by upper-level predators, which would include many of the commercially and recreationally important RIS. FS p. 76

Studies show that the restored marshes are producing food and other benefits for fish, including fish that return to the open Estuary, and are being used by them on the same basis as the reference marshes. PSEG also conducted studies that sought to estimate a portion of the fish production benefits of the restored salt hay farm marshes. PSEG measured the detrital production from the restored salt hay farm sites in order to assess whether it was consistent with the aggregated food chain model estimates that were used in establishing the acreage requirements in the 1994 Permit. As noted by NJDEP:

> . . .[T]he aggregated food chain model, which was used in estimating acreage prior to the issuance of the present permit, was a general model that did not attempt to provide a detailed depiction of the energy flows in tidal marshes on the Delaware. Nevertheless, PSE&G contends that data collected from the restored marshes show detrital production on a per acre basis at a rate roughly equivalent to that used in the aggregated food chain modeling to support the acreage calculation for the July 20, 1994 NJPDES permit. FS p. 76

PSEG's studies examined the detrital production that the restored salt hay farm sites and *Phragmites*-dominated sites are contributing to the Delaware Estuary. Detrital monitoring for standing crop biomass was initiated by PSEG in 1995 at selected wetland restoration sites and reference marshes and has continued annually since that date. Monitoring of those portions of the restored sites that are already dominated by *Spartina* shows levels of biomass production indistinguishable from those at the reference marshes and near the high end of the range of peak season biomass reported for *Spartina* in salt marshes along the Atlantic coast. Application, Exhibit G-2-4. The contribution of this biomass to the Estuary for the benefit of its aquatic populations will increase in the future as restoration progresses.

Another set of PSEG studies used bioenergetics analysis to estimate, on a quantitative basis, a portion of the increased fish production in the Estuary attributable to the restored salt hay farm marshes that function in the same fashion as natural reference marshes. FS p. 76. Such estimations are inherently difficult because of the multiple pathways by which the energy generated in the marshes is transferred and the complex character of the open estuarine ecosystem. As noted by NJDEP:

> Marsh restoration and the revival of the river herring runs are not yet fully complete and a widely acceptable common metric for quantifying all of the increased production is not readily at hand. Nevertheless, despite these constraints, it is important to consider the available evidence relevant to assessing the fish production benefits of these measures. FS page 77

The bioenergetics analysis was used to estimate a restricted portion of the marsh productivity based on evaluations of fish captured in the marsh by the monitoring program and on growth by predators feeding on fish produced in the tidal marsh. This approach does not account for most of the marsh production energy pathways, and involves serious sampling problems. As noted by NJDEP:

> . . .[B]ioenergetics modeling can be used to provide some indication of the marsh productivity. Though not a specific requirement of the July 20, 1994 permit, the permitee conducted a bioenergetics analysis for the salt hay farms to gain quantitative insight into the productivity of the marsh. The bioenergetics approach relies on fish captured in the marsh by the monitoring programs as well as on growth by predators feeding on fish produced in the tidal marsh. The bioenergetic method has limitations. This approach does not account for detrital export-based production which is important in Delaware Bay. Both small invertebrates and very early life forms of fish pass through the monitoring nets and are lost to the bioenergetics calculations. Similarly, the larger fish are able to avoid the gear. Finally, the restoration of the salt hay farms is not complete. FS p. 76.

Despite these inherent limitations, which result in omission of a great part of the fish production benefits of the marshes, the bioenergetics studies estimated substantial production from the tidal marshes. The bioenergetics analysis was done independently for 1997 and 1998 and, in each year, a high and low estimate was provided based on differing estimates of the catchability of the fish. Id. The low amount for the finfish RIS occurred in 1998 when production of 159,120 kg wet weight was calculated; the high figure of 475,288 kg occurred in 1997. Id. Blue crab were particularly abundant in 1998 with high estimate at 273,168 kg as against a low figure in 1997 of 28,128 kg. Id. The total for all species combined varied from a low of 196,477 kg in 1998 to a high of 945,996 kg in 1997. Id.

Thus, the studies conducted at the restored wetland sites confirm, in the specific context of the Delaware Estuary, the important and increasingly widely recognized benefits provided by wetlands, including restored wetlands, to fish production.

3. Continued Elimination of Dense Stands of *Phragmites* as a Result of Restoration Will Improve Fish Habitat and Increase Fish Production

Many commenters have questioned the need to restore *Phragmites*-dominated wetlands, citing various alleged values of these wetlands such as metals sequestering, erosion control, and providing food and habitat for terrestrial organisms and birds. Certain of these commenters, however, also acknowledged that the value of a particular wetland system depends on which wetland function one seeks to maximize. Consistent with the focus of the Permit, PSEG's primary restoration management objective is to increase aquatic production in the Delaware Estuary. While *Phragmites* may have some environmental value when it is a component of a natural, integrated plant landscape, there is substantial evidence, contrary to some commenters allegations, that the basic processes of *Phragmites* growth and development have significant adverse impacts on local fish habitat, and that monocultures of *Phragmites* contribute significantly less to aquatic production than do marshes that are dominated by *Spartina* and other desirable marsh species. *See* Application, Attachment G-2, Attachment Exhibit G-3, G-2-6. Specifically, *Phragmites* reduces contributions to fish production by:

- Filling in small rivulets and tributaries on the marsh plain that provide fish access to the marsh;

- Increasing the bank slope of tidal creeks and channels, reducing fish access to the marsh plain and eliminating beneficial habitat for algae, benthic organisms, fish and other aquatic organisms; and

- Significantly reducing the amount of sunlight reaching the marsh plain (and consequently reducing the amount of algal production – an important energy source in the marsh plain food chain) because of the height of *Phragmites* and the persistence of the previous year's leaf litter among the dense stands.

Thus, the potentially favorable attributes of *Phragmites* marshes touted by certain commenters are irrelevant when the primary restoration goal is to increase fish production. In fact, certain of the so-called favorable attributes by commentators above further decrease fish habitat at the restoration sites. For example, the rapid marsh accretion characteristics of a *Phragmites*-dominated marsh that make it less susceptible to erosional forces associated with sea level rise are the same characteristics which act to limit fish access to the marsh.

4. PSEG's Wetlands Restoration Program Is Producing a Host of Ancillary Environmental Benefits, Recognized and Endorsed by Third-Party Commenters

In addition to providing significant benefits to fish production and the aquatic community of the Estuary, generally, the restored marshes also support populations of birds and other animals that are of international significance. As noted by NJDEP:

> . . .[T]he marshes are an important food and habitat support to other wildlife, particularly birds. Both the Ramsar Convention and The Nature Conservancy have recognized the significant

> importance of the marshes of Delaware Bay to migratory birds-shore birds, ducks and geese, raptors and songbirds, as well as colonial wading birds. FS p. 76.

More than 100,000 acres of wetlands in the Delaware Estuary have been designated as wetlands of international importance by the RAMSAR Convention, and The Nature Conservancy has included the Delaware Bay wetlands in its "Last Great Places Program." The Delaware salt marshes are critical refueling stops for many species of shore birds and for migratory waterfowl and songbirds, as well as important habitat for raptors and colonial nesting wading birds. PSEG's marsh restoration and preservation efforts have added nearly 32 square miles of tidal marshes to the Estuary, expanding this vital ecological resource. The restoration of the marshes along the Estuary will provide new habitat for the bird populations that use the Estuary in the course of their migration from South America to Canada. Among the beneficiaries are the large concentration of shore and wading birds, more than 30 species of which forage in freshwater and salt marshes in the Estuary during their spring migration.

The restoration and conservation measures implemented by PSEG pursuant to the Permit were carefully designed to provide habitat and protections to foster threatened or endangered species. For example, the development of high marsh islands and zones at the salt hay farms will provide suitable habitat for such species as northern harrier, black rail, and short-eared owl. These high marsh areas will also provide nesting areas adjacent to the wetter low marsh zones, where black rails can feed during low tide periods and short-eared owls can feed and roost. The upland edge will also produce habitats that should favor use of these sites by the American bittern. Finally, a total of twenty osprey nesting platforms were built and are maintained at the restoration sites and the Bayside Tract.

The six boat launches, miles of nature trails and boardwalks, observation platforms and educational materials, along with increased economic activity for southern New Jersey, are additional public benefits provided by PSEG's wetland restoration program. The numerous new public use facilities installed by PSEG at the wetland restoration sites and the Bayside Tract are providing public access to thousands of acres of vast, natural areas for a broad range of diverse public uses such as environmental education, nature study, hunting, fishing, trapping and other recreational uses.

Third party commenters have applauded these benefits, including benefits to wildlife, increased fishing and sporting opportunities, superior ecotourism facilities and environmental education opportunities, and control of mosquito populations. For example, Dr. J. Burger, Distinguished Professor of Biology from Rutgers University, has taken an inventory of the birds and other animals at the restored sites, observed their foraging behavior, and has "noted with satisfaction that PSE&G [sic] efforts seem to be succeeding."[111] Dr. Burger specifically notes that herons, egrets, gulls, and shorebirds use the sites in abundance. Because of the benefits to wildlife of all kinds and the excellent access facilities constructed by PSEG, sportsmen and

[111] Letter from J. Burger, Distinguished Professor of Biology, Rutgers University to Debra Hammond, Chief, Bureau of Point Source Permitting, NJDEP, Jan. 18, 2001

fishermen support the renewal of the permit.[112] These same attributes provide significant ecotourism opportunities. Many commenters have cited the excellent facilities, including nature trails, observation platforms, floating platforms, boat ramps, and historic buildings.[113] The environmental education opportunities are similarly praised. These benefits extend beyond the educational signs, literature and resource kits being provided to the public to the intrinsic value the restoration holds in educating the public on the critically important role of protecting healthy wetlands.[114]

Finally, the restoration has significantly reduced the mosquito population. Judy Hansen, the Superintendent of the Cape May County Mosquito Commission and past President of the New Jersey Mosquito Control Commission and the American Mosquito Control Commission, reported that the Dennis Township restoration has dramatically reduced the numbers of adult mosquitoes, as evidenced by traps located adjacent to the marsh, and has correspondingly significantly reduced the use of pesticides to control mosquitoes. Transcript of Hearing January

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[112] *See* Comments of George P. Howard, Executive Director, New Jersey State Federation of Sportsmen's Clubs, Inc., Feb. 19, 2001; Comments of The Dutch Neck Busters Hunt & Fishing Club, Feb. 15, 2001; Comments of Captain George Kumor.

[113] *See* Comments of Cindy O'Connor, Executive Director, Wetlands Institute, Feb. 21, 2001; Comments of Jane Morton Galetto, Citizens United to Protect the Maurice River and its Tributaries, Inc., Feb. 12, 2001; Comments of Julia M. Somers, Executive Director, Great Swamp Watershed Association, Feb. 12, 2001; Comments of Ronald D. Riggins, Sr., Mayor, Maurice River Township, Jan. 31, 2001; Comments of Jay Laubengeyer, Assistant State Director, The Nature Conservancy of New Jersey, Public Hearing Transcript January 25, 2001, page 84; Comments of Franklin E. Parker, The Trust for Public Land, Jan. 25, 2001; Comments of Al Tulini, New Jersey State Chairman, Ducks Unlimited, Inc., Jan. 24, 2001; Comments of Dr. James Turke, Director, Salem County Historic Society, Transcript of Hearing January 23, 2001, pages 89-92; Comments of William Palmer, Executive Director, Water Resources Association of the Delaware River Basin, Transcript of Public Hearing January 23, 2001, page 45; Comments of Mary Allessio Leck, Professor of Biology, Chair, Hamilton-Trenton Marsh Education Committee, Rider University, Jan. 9, 2001; Comments of Captain George Kumor.

[114] Comments of Cindy O'Connor, Executive Director, Wetlands Institute, Feb. 21, 2001; Comments of Ronald D. Riggins, Sr., Mayor, Maurice River Township, Jan. 31, 2001; Comments of Franklin E. Parker, The Trust for Public Land, Jan. 25, 2001; Comments of Jack Hufty, Director, Community Outreach, Salem County Vocational and Technical Schools, Transcript of Public Hearing January 25, 2001, page 55; Comments of Al Tulini, New Jersey State Chairman, Ducks Unlimited, Inc., Jan. 24, 2001; Comments of Jim Applegate, Professor of Natural Resources at Cook College, Rutgers University, Transcript of Hearing January 23, 2001, page 41; Comments of William Palmer, Executive Director, Water Resources Association of the Delaware River Basin, Transcript of Public Hearing January 23, 2001, pp. 44-45; Comments of Joseph P. Shisler, President, Shisler Environmental Consultants, Transcript of Public Hearing January 23, 2001, page 97; Comments of Mary Allessio Leck, Professor of Biology, Chair, Hamilton-Trenton Marsh Education Committee, Rider University, Jan. 22, 2001; Comments of Ella F. Filippone, Executive Administrator, Passaic River Coalition, Jan. 16, 2001.

25, 2001, at 35 Similarly, the mosquito population has been reduced in the area of the Maurice River Township site. Comments of John Feltes, former Mayor of Maurice River Township and Director of Public Works for Cumberland County. Id. at 184-85. Mr. Feltes, who oversees the Cumberland County Mosquito Control Division, emphasized that mosquito control is essential to keep the West Nile Virus under control in South Jersey.

D. PSEG's Wetlands Restoration Program Has Not Caused Adverse Effects to Human Health or the Environment

Some commenters and some individuals who spoke at the public hearings expressed concerns about adverse effects of the restoration program. These concerns include fears about adverse impacts on the horseshoe crab populations and on sensitive ecosystems. Opposition to the spraying of herbicides in connection with the restoration of the *Phragmites*-dominated sites has been voiced by some who claim that it poses unacceptable risks to public health and the environment. The evidence of record shows, however, that these concerns are not supported by the facts, and that restoration is succeeding in a manner that is protective of the environment, public health, and neighboring properties.

1. PSEG Has Not Caused Adverse Impacts on Neighboring Properties

Neighbors of the PSEG restoration sites and host communities recognize PSEG as a good neighbor who has been responsive to their needs and who has not caused adverse impacts on neighboring properties, but rather has enhanced their communities. For example, Ronald Riggins, Sr., the mayor of Maurice River Township, stated that PSEG "has been open and honest with us, has been responsive to our concerns, and has gone beyond permit requirement [sic] to provide certain guarantees and protections for our community."[115] Similarly, George Garrison, the Mayor of Commercial Township, characterizes the working relationship with PSEG as outstanding with open dialogue, even when problems have arisen. Transcript of Hearing January 25, 2001 at 78-80. Such sentiments were affirmed by others who commented or spoke at the public hearing.[116]

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[115] Letter from Ronald D. Riggins Sr., Mayor, Maurice River Township to Deborah [sic] Hammond, Chief, Bureau of Point Source Permitting, Jan. 31, 2001.

[116] The sentiments of Mayor Riggins were echoed by John W. Feltes, Jr., who was the Mayor of Maurice River Township during restoration design and construction. Transcript of Hearing January 25, 2001 at 183-85. Dr. Susan Ford, who is a research professor at Rutgers University Institute of Marine and Coastal Sciences, works at the Haskin Shellfish Research Laboratory in Bivalve, which is adjacent to the Commercial Township restoration site. Transcript of Hearing January 23, 2001 at 69-70. Dr. Ford also serves on the Community Involvement Committee for the site. Id. Dr. Ford states that PSEG has been a good neighbor who is committed to dealing with the concerns of local people. Id. PSEG was also recognized as a good neighbor by George and Anna Kumor, who own three properties adjacent to the Maurice River Township site. Letter from George and Anna Kumor to Debra Hammond, February 22, 2001.

2. Restoration of the Salt Hay Farms Has Increased Horseshoe Crab Spawning Habitat and Has Not Adversely Affected the Populations

PSEG's restoration activities did not, contrary to popular impression, cause the strandings of horseshoe crabs at the Maurice River Township site. The strandings were due to breaches resulting from natural causes in the historical perimeter dikes at the site prior to ownership by PSEG. In fact, as acknowledged by NJDEP in the Fact Sheet, PSEG has fixed the hydrologic problems resulting from these natural breaches. Today, because of PSEG's efforts, horseshoe crab strandings have been essentially eliminated and spawning habitat has been increased. FS p. 41. Indeed, the NJDEP has recognized the Maurice River Township Salt Hay Farm Wetland Restoration Site as favorable horseshoe crab spawning habitat in its proposed regulations governing horseshoe crab management. 33 N.J.R. 453 (Feb. 5, 2001).

In the early 1990s, the historic salt hay farm perimeter dikes breached at the Maurice River Township site. As a consequence, the water became ponded on flood tides and could not drain with the ebb tides due to a lack of tidal tributaries. The majority of the site was underwater for extended periods of time and began to exhibit erosional features typical of naturally breached marshes that are slow to restore, similar to Moores Beach East, an adjacent site. These site conditions resulted in the stranding of thousands of horseshoe crabs annually on the unvegetated marsh plain.

In consultation with Drs. Carl Schuster and Mark Botton, experts in horseshoe crab ecology, PSEG resolved this situation through modifications to site drainage, including the addition of new tidal channels and the widening and deepening of existing channels. This work was conducted between the 1997 and 1998 horseshoe crab spawning seasons. PSEG has monitored the Maurice River site through studies in which actual horseshoe crab counts, egg density evaluations, and egg survival tests are used to determine the impact of restoration activities on horseshoe crabs at the site. PSEG 1999 Application, Exhibit G-2-12; PSEG Comments on Draft NJPDES Permit, Attachment IV.A. During the 1998 horseshoe crab spawning season, the number of dead or stranded horseshoe crabs within the Maurice River Township site (hundreds to perhaps a few thousand) was modest in comparison to the in excess of 100,000 crabs which were estimated to have died in 1996 and 1997 due to stranding and gull predation on open bay beaches. *See* Application, Exhibit G-2-12. Coupled with studies conducted by Limuli Laboratories (1995) that demonstrate the ability of a horseshoe crab to return to the Bay from the interior portions of the site as supported by general observations documented by spawning season photography, it is clear that horseshoe crab habitat conditions at the Site have drastically improved since PSEG completed its restoration activities.

The studies conducted in 2000 confirm that the improvements resulting from PSEG marsh restoration activities have significantly reduced strandings of horseshoe crabs from pre-restoration conditions. *See* Attachment IV-A. Mortality of horseshue crabs within the marsh restoration area remains very low, below mortality rates observed on the open bay along Thompsons Beach. While the Maurice River Site continues to harbor a significant population of horseshoe crabs, the conditions created by PSEG's restoration activities allows those crabs to utilize the site and successfully return to Delaware Bay. In fact, horseshoe crabs are using the site successfully for spawning. Thus, PSEG's restoration efforts have benefited and continue to benefit horseshoe crab habitat development and preservation along the Delaware Bayshore.

3. PSEG's Use of Herbicide with a Surfactant, in Accordance with EPA and NJDEP Regulatory Approvals, Has Not and Will Not Cause Adverse Ecological or Human Health Effects.

A number of commenters expressed concerns regarding health and environmental risks assertedly posed by PSEG's use of the herbicide Rodeo® with a surfactant to control *Phragmites*. These concerns are unwarranted and have no factual basis in the record or elsewhere. PSEG chose Rodeo® because of extensive, favorable ecological and human health studies and because of its widespread and successful use in the United States and around the world. Glyphosate, the active ingredient in Rodeo®, is fully registered with the USEPA as an active ingredient. Its uses include agricultural, industrial, ornamental garden and residential weed management. Its toxicological profile relating to both human health and the environment has been reviewed by USEPA in 1986, 1993, 1999 and 2000. The most recent USEPA review was published in the Federal Register in September 2000. Other national regulatory authorities, the United Nations World Health Organization and independent scientists worldwide have also published the results of extensive reviews of glyphosate. All of these reviews support the conclusion that Rodeo® with a surfactant can be used in the PSEG marsh restoration program without risk of harm to human health or the environment. Leonard Ritter, Ph.D., and Keith Solomon, Ph.D., two recognized scientists considered as authorities in both the human health and ecological impacts of the use of Rodeo® with a surfactant, have reviewed the data supporting the use of glyphosate in the PSEG program and concluded that there are no adverse public health or environmental impacts from PSEG's use. *See* Attachment IV-B; Application, Exhibit G-2-10 Part II; Application, Exhibit G-2-10 Part III. In consideration of the toxicological profile and the relatively minor quantities of glyphosate used by PSEG in comparison to other uses in New Jersey, *see* Attachment IV-B, it is clear that the use of Rodeo® with a surfactant in the PSEG wetland restoration program does not pose an unacceptable risk of harm to human health and does not pose a significant ecological risk.

4. PSEG's Test Area Program Is Designed to Benefit Fish Production in the Delaware Estuary and Should Be Continued

Certain commenters oppose the continuation of PSEG's test area program for assessing measures to restore wetlands sites dominated by *Phragmites*.[117] These commenters believe that

[117] The test area program includes approximately eighty (80) test areas where quantitative data are gathered and analyzed annually to evaluate alternative technologies for *Phragmites* management. The test areas include a variety of treatments, including mowing, multiple mowing, microtopography modifications, seeding, grazing, and selective Rodeo® with a surfactant application. The treatments are implemented both singularly, in combination, and at various times throughout the year. The selection of combinations is systematic and well-defined. The program is set up to provide duplication of treatments with isolation of specific treatment methodologies. Control areas are included to compare the efficacy of the treatment to areas where no treatment has occurred. An extensive monitoring program has been developed to evaluate the effect of various treatments. *See* October 12, 2000 Plan of Action for Microtopography at the Alloway Creek Watershed Wetland Restoration Site and supporting correspondence from G. Bickle (PSEG) to K. Broderick (NJDEP) and J. Boyer (USACE); October 4, 2000 correspondence from G. Bickle (PSEG) to K. Broderick (NJDEP) and J. Boyer

the existing *Phragmites* vegetation on the test areas should be retained because it is environmentally preferable and because they object to the conditions at the test areas during the testing, which is a temporary activity of limited duration. At bottom, these commenters simply disagree with NJDEP's judgment, based on the scientific evidence of record, that the restoration of sites dominated by *Phragmites* to *Spartina* and other marsh species that will provide superior benefits to fish populations. These commenters simply fail to recognize the lesser value of *Phragmites* marshes to fish production and the significant advances in the science of marsh ecology resulting from the program.

The test area program is the expansion of the test plot program described in the Application. The program was developed with the advice of MPAC scientists. Extensive portions of the Alloway Creek Watershed Wetland Restoration Site are subject to an unparalleled undertaking to determine the relative efficacy of different techniques, alone and in combination, for the long-term control of *Phragmites*. The test area program seeks to address NJDEP's restrictions on herbicide use as discussed in the Fact Sheet, page 40, and concerns raised by some individuals regarding PSEG's continued use of Rodeo® with a surfactant to manage *Phragmites*. The program is being conducted under the scrutiny of independent scientists and provides a scientific approach to *Phragmites* management by developing information in a carefully documented and systematic manner to determine that combination of treatments that most effectively controls *Phragmites* and promotes the development of desirable marsh vegetation. All activities have been approved by NJDEP and are being conducted in accordance with NJDEP and United State Army Corps of Engineers permits. The information obtained from the test area data will be used to guide further restoration activities.

PSEG's commitment to finding effective means to manage *Phragmites* could result in "not only a significant scientific achievement but also a huge public benefit for future land management." Statement of Don Kirchhoffer, Project Manager for New Jersey Conservation Foundation, Transcript of Public Hearing January 25, 2001, page 165. *See also* Comments of Cindy O'Connor, Executive Director of Wetlands Institute, Feb. 21, 2001 (recognizing desirable development of state of the art wetland restoration technologies). Accordingly, many knowledgeable commenters seek to have the test area program continue. *See* Comments of Jane Morton Galetto, President, Citizens United to Protect the Maurice River and its Tributaries, Inc., Feb. 12, 2001; Statement of Jay Laubengeyer, Assistant State Director, The Nature Conservancy of New Jersey, Transcript of Public Hearing January 25, 2001, page 85; Statement of Richard Horwitz, Senior Biologist at the Academy of Natural Sciences of Philadelphia, Transcript of Public Hearing January 23, 2001, page 38.

(USACE) revising March 28, 2000 Test Area Plan of Action; June 30, 2000 Plan of Action for Cohansey River Watershed Restoration Site and supporting correspondence from G. Bickle (PSEG) to K. Broderick (NJDEP) and J. Boyer (USACE); June 12, 2000 Plan of Action – 2 for Alloway Creek Watershed Wetland Restoration Site and supporting correspondence from G. Bickle (PSEG) to K. Broderick (NJDEP) and J. Boyer (USACE); April 26, 2000 correspondence from G. Bickle (PSEG) to A. Wendolowski (NJDEP) and J. Boyer (USACE) in support of Experimental Test Area Plan of Action; March 28, 2000 Plan of Action for Experimental Test Areas at Alloway Creek Watershed Wetland Restoration Site and supporting correspondence from G. Bickle (PSEG) to A. Wendolowski (NJDEP) and J. Boyer (USACE).

The record provides no basis for discontinuing the test area program, which is advancing knowledge about desirable and effective strategies for wetlands restoration and promises significant environmental benefits.

E. Installation of Fish Ladders Are Providing and Will Continue to Provide Environmental Benefits

PSEG has installed a total of eight fish ladders on tributaries of the Delaware Estuary in order to restore spawning runs and provide habitat for river herring, three more than the five required by the Permit. Studies to date show that the ladders are properly located and designed, that fish are able to pass upstream through them, that spawning is successful, and that juvenile growth is occurring. PSEG began stocking the areas above the ladders with fish in 1998. As noted by NJDEP:

> . . .[M]ore than 700 acres of impoundments are being made available for river herring spawning as a result of the installation of fish ladders. The production of juvenile herring varies in such ponds and lakes. PSE&G anticipates that the ponds will produce between 2,564 and 338,350 kg of forage fish which would be consumed by predators such as striped bass and weakfish. In addition, approximately 200,000 adult river herring should return to the Estuary annually where they will be available for fishery harvest or for spawning. FS p. 76.

Benefits of the ladders in enhancing fish production are only beginning to be realized because of the life history of river herring (spawning occurs between three to six years from birth) and the circumstance that the ladders have only been operational for a few years. A total of 733 acres of additional habitat have been made available by the installed ladders. In addition to producing substantial numbers of additional adult river herring that will return to the Estuary, the newly accessible impoundments will also produce substantial additional forage for the predator species in the Estuary. The estimated range of potential juvenile production is 736,665 to 4,194,959 fish; it is likely that actual juvenile production will be near the higher end of the estimated range. Bioenergetics studies using the delayed consumption estimate method found that between 5,882 and 33,498 kg of striped bass and weakfish would be produced as a result of these predators' consumption of this increase in juvenile herring production.

F. PSEG Is Not Required to Ensure or to Demonstrate that the Fish Production Benefits of the Wetlands Restoration and Fish Ladder Measures Equal or Exceed Individual Losses at the Salem Intake

These comments rest on a wholly fallacious premise, namely that PSEG is obliged to take measures to offset whatever losses occur at the Salem intake after best available technology measures are installed. To the contrary, nothing in the Clean Water Act provides for or mandates such a requirement. Section 316(b) requires the adoption of BTA measures, but the requirement of minimization is not an absolute one. As previously discussed, the environmental and economic costs to society of technology measures must be assessed, and measures whose costs are wholly disproportionate to their environmental benefits are not BTA. Thus, the concept of minimization of losses employed in Section 316(b) is a relative one. See Application, Appendix D VI.C, D. Because of these circumstances and the limitations of intake technologies to protect fish, intake losses - in some cases, losses that are numerically large - inevitably remain even after full compliance with Section 316(b) requirements.[118] Nothing in Section 316 or other provisions of the CWA requires that sources adopt additional measures to offset or otherwise such residual intake losses.[119]

Furthermore, the 1994 Permit does not require that PSEG offset all Salem intake losses, or demonstrate that implementation of the wetlands restoration and fish ladder measures achieve any such offsets. The Permit establishes specific and detailed requirements for the marsh restoration activities and fish ladder installations and their implementation. As shown in the Application, PSEG has fully complied with these requirements. The Permit does not require that these measures produce fish equivalent to losses at the Salem intake, or that PSEG measures the fish produced by the intake or demonstrate their equivalence. NJDEP has made this point abundantly clear, FS page 77:

> PSE&G was not required to estimate fish production at its wetland restoration sites as part of the July 20, 1994 permit. The Department recognized at that time the many factors, variables and limitations to measuring productivity of the wetland restoration sites and of the fish ladders. On page 45 of the Response to Comments document in the July 20, 1994 NJPDES permit, the Department states:
>
> The Permittee would not be required to demonstrate how many fish of each species have been generated from the restored wetlands. Such a demonstration would not be practicable given the many environmental variables that influence fish populations in the Delaware Estuary. Accordingly, the restoration program does not include fish abundance indices or Rather, the Permittee is required to demonstrate that it has restored the requisite acreage of wetlands from which, based on the best scientific evidence

[118] Such losses do not equate to AEI. Even if they did, offsets would not be required or appropriate. As stated in the USEPA 1977 Section 316(b) Guidance, page5: "Regulatory agencies should clearly recognize that some level of intake damage can be acceptable provided that damage represents a minimization of environmental impact." Moreover, as shown above, Salem's existing intake is not causing an AEI.

[119] As shown above, § VI A, permittees may voluntarily propose or accept conservation measures in order to reduce any AEI that may be occurring or to minimize any potential for adverse impact from an intake. Permitting agencies may include such measures in permits if they are environmentally appropriate. In accordance with this practice, PSEG voluntarily proposed the conservation measure in 1993 to address public concern over the potential for adverse impact from the cooling water intake, and NJDEP included them in the 1994 Permit.

> available, it is logical and appropriate to conclude that there will be increased productivity of fish in the Estuary.
>
> The Department required the best technology available pursuant to Section 316(b) and then separately, based on the permittee's proposal, incorporated the wetlands restoration conditions and fish ladder conditions. Thus, the permittee's compliance with Section 316(b) does not depend on a certain level of productivity. FS p. 77.

It is of course true that PSEG proposed and NJDEP accepted the conservation measures in the expectation that they would produce additional fish and thereby address the potential for adverse environmental impact from Salem's intake. Further, as NJDEP has noted in issuing the Draft Permit, FS page 35, the wetlands restoration acreage was selected through conservative use of an aggregated food chain model, with the aim of generating sufficient biomass. As NJDEP also acknowledges, however, FS page 77, there are a number of difficulties in making such estimations. At present, it is not scientifically feasible to determine the number and type of additional fish produced as a result of the food and habitat benefits provided by the restored wetlands. In the Draft Permit, NJDEP has taken the appropriate course of requiring PSEG, as a condition of permit renewal, to undertake further studies of the biomass produced by the restored wetlands and the fish ladders and relate the estimations developed to estimations of biomass loss at the intake.

In summary, applicable law does not require Salem to offset losses at the existing intake, which NJDEP has determined to be BTA for minimizing AEI, through wetlands restoration or other measures, much less demonstrate that any such offset has or will be achieved by its implementation of the Permit conservation measures. PSEG proposed and will continue to implement the conservation measures in order to address concerns over the potential for adverse environmental impact from the Salem intake. PSEG will continue to study the environmental benefits that the conservation measures provide and estimate, to the exent practicable, the extent of biomass or other benefits produced, in accordance with the Draft Permit requirements. There is no basis in law or fact to impose additional requirements on PSEG. The contentions of the commenters are without merit.

G. Conclusion

The wetlands restoration and fish ladder provisions in the Draft Permit are lawful and appropriate, will serve to further minimize any potential for adverse impact from Salem and should be adopted with modifications recommended herein. These measures are already producing substantial fish production benefits for the population of the Estuary as well as a whole range of other benefits for the environment and the public. The record provides no basis for concluding that restoration at the *Phragmites* sites can not succeed, or for discontinuing the use of glyphosate in connection with such restoration. Claims by some commenters that PSEG is obliged to offset all losses at the intake and demonstrate that the wetlands restoration and fish ladder measures achieve such an offset are groundless. There is no basis in law or in the facts of record to require PSEG to acquire or fund the acquisition of additional wetlands and/or upland buffers or to install or fund the installation of additional fish ladders.

VIII. THE NJDEP'S PROPOSED REQUIREMENTS FOR MONITORING AND STUDIES OR ANALYSES ARE GENERALLY REASONABLE

A. NJDEP's Proposed Requirement in Part IV G.6. that PSEG Develop and Implement an Improved Biological Monitoring Program for Salem is Generally Reasonable and Consistent with Applicable Law [Consistency with permitting precedent and guidance to be confirmed]

1. The types of studies proposed for inclusion are reasonable

As stated by the Department in the Fact Sheet (p. 60), fisheries monitoring data is an integral part of the Section 316(b) Determination. Although the Department has determined that the permittee has complied with the bay-wide monitoring requirements set forth in the Biological Monitoring Program, the Department has determined that improved biological monitoring is needed to further enhance the general understanding of the fish populations in the Delaware Estuary. As a result, the Department has required that an improved biological monitoring program be developed for the EEPOC's consideration and the Department's approval as a condition of this NJPDES permit.

The types of studies and study enhancements proposed by the Department are generally appropriate and consistent with the improved Biological Monitoring Program ("BMP") that PSEG proposed to the Monitoring Advisory Committee (MAC) in a meeting held on June 22, 2000. As required by Special Condition Part IV G.a.i., PSEG must seek technical advice from EEPOC regarding the improved BMP and details concerning the types of studies proposed by and, ultimately, approved by the Department are not defined at the present time.

As PSEG has indicated in Part Two, the Permittee, however, has concerns about two types of studies or evaluations proposed by the Department in Part IV G.a.i. The Draft Permit conditions require a review and discussion as to the appropriateness of the representative important species (RIS). While PSEG is not opposed to any such review and discussion, any evaluation or reconsideration of RIS for purposes of evaluating potential adverse impacts of cooling water structures must be made in the context of applicable USEPA guidance.

The Department has also proposed ("continued") abundance monitoring for juvenile passage of river herring at the fish ladder sites. As discussed in Part Two, PSEG is concerned that monitoring for emigrating juvenile river herring at the fish ladder installations prior to successful establishment of an adult spawning run is premature and may result in additional mortality to the emigrating juveniles.

2. Any re-consideration of RIS should be made in the context of Applicable USEPA Guidance

The Department is asking PSEG to consider the inclusion of Atlantic silverside and Atlantic menhaden as RIS for the purposes of Section 316(a) and 316(b) of the Clean Water Act (Fact Sheet, p. 61). The inclusion of additional species to Salem's RIS list is unwarranted for the reasons presented below, but any evaluation or reconsideration of RIS for purposes of evaluating potential adverse impacts of cooling water structures must be made in the context of applicable

USEPA guidance. USEPA's "Guidance for Evaluating the Adverse Impact of Cooling Water Intake Structures on the Aquatic Environment: Section 316(b) P.L. 92-500" (hereafter "USEPA 1977"), page 17, states that: "... since all species which are critical, representative, etc. cannot be studied in detail, some smaller number ... may have to be selected." The USEPA also states that in selection of critical aquatic organisms for intake studies, the following should be considered: commercially or recreationally important; threatened or endangered; critical to the structure and function of the ecological system; potentially capable of becoming a nuisance species; necessary in the food chain; and high potential susceptibility to impingement or entrainment. (USEPA 1977, page 16) Furthermore, the statement is made "...Often, but not always, the most useful list would include mostly sensitive, fish, shellfish, or other species of direct use to man..."

The Application (Appendix F, III.D., Appendix C, Species Specific Reports, Appendix E, VI.D.2 and Table VI-4) provides details on the criteria and rationale for the selection of the 12 RIS for Salem. The selected RIS meet the criteria listed by EPA (1977). The addition of two more species would require revisions to the sampling program that may adversely effect the continued availability of data for the present RIS species and could disrupt the long-term data record that presently exists and will be necessary for future evaluations of potential adverse effects associated with cooling water withdrawal.

3. Given the Proposed Obligations set forth in Part IV G.12 of the Draft Permit, PSEG Must have Overall Responsibility for the Conduct of the Monitoring Program

As required by Part IV G.a.i of the Draft Permit, a request for continuance of the Section 316(a) variance along with the basis for its continuance must be submitted at the time of application for future renewal permits. In order to assess whether "the aquatic population associated with the Station has changed', "whether the measures required under the Special Conditions have assured the protection and propagation of the balanced indigenous population", and "whether the technical knowledge of stresses caused by the cooling system has changed" PSEG must retain overall responsibility for conduct of the monitoring program. Only by retaining over responsibility and conducting the monitoring program, can PSEG assure that the required data in sufficient quantity and quality be available to meet the burden established by the Draft Permit.

Furthermore, the Department states in Part IV G.a.ii of the Draft Permit that the Department's Section 316(b) determination upon reissuance of the NJPDES Permit will "include, but not be limited to, an evaluation of whether technologies, their costs and benefits, and potential for application at have changed." PSEG has an obligation upon reissuance to provide the necessary data and information for the Department to conduct this evaluation. The types of data and information required for this Section 316(b) evaluation can only properly be collected and analyzed by PSEG.

4. Certain Aspects of the Proposed Schedule Should be Modified

The Draft Permit proposes that PSEG submit an improved Biological Monitoring Program Work Plan to the Department within 90 days from the effective date of permit (Part IV G.6.a.ii). The Draft Permit also requires that the improved Biological Monitoring Work

Plan be submitted to the EEPOC for technical advice prior to submission to the Department for approval (Part IV G.a.i). In accordance with Draft Permit condition Part IV G.3.d.ii, PSEG must submit a complete list of EEPOC members to the Department for approval within 90 days from the effective date of the permit.

In consideration of the schedule for establishment of EEPOC and the requirement for EEPOC review of the improved Biological Monitoring Work Plan, PSEG will be unable to satisfy both proposed permit conditions in accordance with the schedules proposed in the Draft Permit. PSEG requests that the Draft Permit be modified to require submittal of the improved Biological Monitoring Work Plan within 270 days from the effective date of the permit. This will allow sufficient time for establishment of the EEPOC and for consideration of the EEPOC's advice on the improved Biological Monitoring Work Plan.

B. NJDEP Should Clarify the Role of the Proposed EEPOC as set forth in Part IV.G.3d.

The NJDEP has determined that it is appropriate and beneficial to merge the present Management Plan Advisory Committee (MPAC) and the Monitoring Advisory Committee (MAC) under one oversight committee, namely the "Estuary Enhancement Program Oversight Committee" (EEPOC) and is proposing, by Specific Requirement G.3.d. to merge the existing advisory committees into a single committee. (Fact Sheet, p. 42). Based on the language in the Fact Sheet, PSEG understands that combined committee's purpose is ".... to provide technical advice to the permittee ....," PSEG requests that the Department change the name of the Committee to the Estuary Enhancement Program Advisory Committees ("EEPAC") to be more reflective of the committee's intended role as an advisory body.

C. NJDEP's Proposed Condition in Part IV G.8 that would Require PSEG to Conduct Expanded Analyses, Consistent with Recommendations of its Consultant, is Appropriate Given ESSA's Recommendations and the Comments Received on the Draft Permit. The Schedule for Completion of these Proposed Studies and Should, However, be Modified.

The ESSA Report is a lengthy, detailed review of selected portions of PSEG's Application. It offers many critical comments and recommendations regarding the analyses in PSEG's Section 316(b) demonstration, particularly regarding known and potential uncertainties in the data and analyses. As PSEG's Response to the ESSA Report details, however, only a few of the many critical comments and recommendations in the ESSA Report are potentially worthy of further consideration by NJDEP and PSEG; the majority of them are either erroneous or irrelevant with respect to evaluating the merits of PSEG's Section 316(b) demonstration. To ensure that NJDEP fully understands the highly technical reasons that most of ESSA's comments are erroneous or irrelevant, PSEG has prepared a detailed section-by-section Response to the ESSA Report that is presented in Part Three.

. ESSA's many highly technical and academic criticisms of particular methods and conclusions in the Application do not appear mindful of the reasonableness standard of review that, under applicable Section 316(b) regulatory guidance and precedent, is appropriate for the analyses supporting a Section 316(b) demonstration. As detailed in EPA's extensive 1977 Draft

Guidance for Section 316(b) demonstrations (USEPA 1977), which EPA has recently affirmed as the guidance currently applicable for existing plants (Cook 2000), an agency reviewing a Section 316(b) determination must do so mindful of the limits of scientific research, the importance of site-specific factors in evaluating impacts, and the need for informed professional judgment to address uncertainty.

There is no question that the data and analyses presented in PSEG's Application to support its assessments of best technology available and adverse environmental impact more than meet the level of scientific rigor articulated in the 1977 Draft Guidance and in the Seabrook decision.[120/] The ESSA Report includes many recommendations for the development of additional data or analyses where the purpose of the recommended analyses with respect to the Section 316(b) Demonstration is not clear. (See, e.g., ESSA's recommendations regarding additional cost/benefit analyses that would not add to the understanding or affect overall conclusions; ESSA's vague recommendation of analyses of "additional indicators" for the balanced indigenous community ("BIC") analysis without indicating how or why the analysis would improve the basis for NJDEP's Section 316(b) permit decision; ESSA's recommendations of additional discussions of uncertainty regarding PSEG's production foregone calculations when PSEG's conclusions did not depend on an inability to detect changes due to low statistical power and therefore further discussions would not improve the analysis. PSEG's research and analytical methods are consistent with expected norms and practices in the context of cooling water intake system permitting, and PSEG's findings are consistent with those of independent sources researching the same issues.

Once the NJDEP has had an opportunity to review and evaluate PSEG's detailed section-by-section Response to the ESSA Report, the Department may determine that an alternate list of additional analysis and evaluations from that proposed in Part IV G.8.a is more appropriate. Notwithstanding PSEG's Response to the ESSA Report, PSEG recognizes the Department's need to address reasonable and appropriate recommendations of its consultant that may produce information relevant to the NJDEP's review of PSEG's Section 316(b) Demonstration. PSEG, however, respectfully requests that any additional analyses be conducted in accordance with a Work Plan that PSEG will develop in conjunction with the Department and submit to the Department for review and approval.

Likewise, it is appropriate and the Department's obligation to ensure that the Permittee is not required to expend unnecessary resources in pursuit of irrelevant and academic exercises simply because they are recommended by their consultant. PSEG maintains that the results and conclusion it presented in the Application are valid and that the large majority of ESSA's recommendations are unwarranted.

120/ Of course, unlike Section 316(a), the burden of proof is on the regulatory agency when evaluating intake technologies under Section 316(b). *See* In the Matter of Public Service Co. of New Hampshire (Seabrook Station, Units 1 and 2), Case No. 76-7 (Decision on Remand Aug. 4, 1978) at 22 ("precise quantification of affected organisms was not required" in order to make a Section 316(b) determination).

Following the Department's review of PSEG's Response to the ESSA Report, PSEG will work cooperatively with the NJDEP to address those recommendations deemed to warrant further analyses or evaluation. The complex and highly technical nature of these analyses suggest that the Department's objectives can best be addressed through cooperative development of work plan prior to initiation of additional work. Because any required expansion of analysis with regard to entrainment sampling (Specific Requirement IV G.8.b) is integral to the types of additional analysis proposed in Specific Requirement G.8.a, PSEG requests that efforts to address the two Specific Requirements be combined

D. NJDEP's Proposed Condition in Part IV G.9 Should be Implemented Consistent With the Approach Described in PSEG's Comments.

Based on the recommendations of its consultant, the Department has included three requirements to evaluate potential hydrodynamic conditions at and in the vicinity of the Salem Station cooling water intake in the Draft Permit (Part IV G.9.a). As discussed in PSEG's Response to the ESSA Report (Section IV.B.3), PSEG has conducted extensive monitoring and modeling of the hydrodynamic conditions in the vicinity of the Station that were not considered in the ESSA review. Neither the hydrodynamic models nor the observations that are reported in these investigations show the existence of vortices or a persistent eddy of the spatial scale or duration proposed by ESSA that would result in the concentrated entrainment of organisms.

Notwithstanding PSEG's Response to the ESSA Report, PSEG recognizes the Department's need to address reasonable and appropriate recommendations of its consultant that may produce information relevant to the NJDEP's review of PSEG's Section 316(b) Demonstration.. PSEG, therefore, will submit its findings regarding the Study of Hydrodynamics to the Department within 180 days of the effective date of the Final Permit.

Specific Requirement G.9.b. of the proposed permit requires the conduct of studies to enhance PSEG's entrainment and impingement sampling. The present impingement and entrainment sampling programs, as conducted in accordance with the NJDEP-approved BMWP, are designed to account for potential variability in organism abundance associated with diel and tidal stage effects. The improved biological monitoring program developed in accordance with the proposed Special Condition G.6.a. will include components that address future impingement and entrainment sampling. As PSEG discussed with the NJDEP and the MAC on June 22, 2000, it is PSEG's intent to increase the number and frequency of samples for both programs to improve the precision of the estimates based on the sampling results.

Issues relating to the zone of entrainment and the flow hydrodynamics in the region of the intake have been addressed in the above response to proposed Specific Requirement G.9.a. The entrainment sampling program is designed to estimate the density of organisms that actually pass through the cooling water system, regardless of the entrainment zone, tidal stage, wind patterns or other factors. By sampling during all diel and tidal stages at an increased frequency, the proposed future program will provide estimates of impingement and entrainment density that account for variability relating to the episodic nature of the entrianment process and the hydrodynamics of the intake structure.

As addressed in PSEG's comments on proposed Specific Requirement G.9.a and G.9.b., the Study of the Hydrodynamics and the Study of Enhancements to Entrainment and Impingement Sampling will be two different programs with one conducted in accordance with a Plan of Study approved by the Department. PSEG requests that the Department separate the reporting requirements for these two studies to reflect the different schedules.

E. Any Implementation of NJDEP's Proposed Condition in Part IV G.12. Relative to Estimating Production Associated With Wetlands Restoration and Fish Ladder Sites Must Be Interpreted Consistent with the Regulatory History and Interpretation and Must Reflect Limitations of the State of the Science.

PSEG agrees with the Department that, although an "acceptable common metric" for quantifying all of the increased production from marsh restoration and the re-establish of river herring runs is not presently available, it is important to consider the available evidence relevant to assessing the fish production benefits of these measures. PSEG's Permit Renewal Application contains considerable data and information that demonstrate the marsh restoration and fish ladder installations have and will continue to provide substantial contributions to production in the Estuary.

Inclusion of any Specific Requirement in the Final Permit that would require PSEG to estimate overall fish production from the wetland restoration sites and the fish ladders; however, must be framed and implemented in accordance with the Department's consistent regulatory approach relative to the incorporation of the conservation measures in the 1994 Permit and its subsequent interpretation of that condition

As stated by the Department in the Fact Sheet accompanying this Draft Permit, "PSEG was not required to estimate fish production at its wetland restoration sites as part of the July 20, 1994 permit." (Fact Sheet, p. 77). As quoted in the Fact Sheet at 77, the Department's 1994 Response to Comments document issued with the Permit stated that "The Permittee would not be required to demonstrate how many fish of each species have been generated from the restored wetlands . . . . [and that] such a demonstration would not be practicable given the many environmental variables that influence fish populations in the Delaware Estuary." (p. 45). PSEG concurs with the Department's previously stated position that demonstration of how many fish of each species have been or will be generated from the restored marshes is not practical.

Furthermore, the installation of fish ladders was included in the July 20, 1994 permit on the basis that "implementation of this measure would provide long-term benefits to the Estuary fisheries through increased recreational and commercial fish opportunities..." (1993 Draft Permit Fact Sheet/Statement of Basis, p. 149). As stated by the Department In the Response to Comments document in the July 20, 1994 permit (Response No. 37), the Department did not require the construction of fish passages as an intake technology under Section 316(b). PSEG voluntarily proposed the construction of fish ladders and the Department required them in the Permit on that basis and on the basis that "they will further minimize the potential for adverse environment impact from the cooling water intake structure". The July 20, 1994 Permit did not contemplate that increased production from the installation of fish ladders could or would be compared to an analysis of losses at the intake structure.

Although it is not a requirement of the 1994 Permit and the technical tools to quantify increased production and to compare that production to biomass lost at the Station have not been fully developed by the scientific community, comments on this Draft Permit submitted by the USFWS and others continue to urge the Department to require PSEG to quantify the overall fish production from the restored wetlands and compare the production to the estimated biomass lost at the Station. Given the many environmental variables that influence fish production and populations in the Delaware Estuary, and the limited scientific ability to accurately quantify all of the increased production resulting from the restored wetlands and the fish ladder installations, there is considerable uncertainty as to whether or not a scientifically credible methodology can be developed to provide "estimates" of the increased production that are in the same units as an analysis of losses at the intake structure.

Nonetheless, PSEG recognizes the Department's need to address recommendations of other interested parties and, provided this proposed Specific Requirement is interpreted in accordance with the Department's regulatory approach relative to the incorporation of the conservation measures in the 1994 Permit, PSEG will apply the best and most current scientific approaches available to implement this proposed Permit Specific Requirement.

IX. NJDEP'S DRAFT PERMIT IS FULLY SUPPORTED BY THE ADMINISTRATIVE RECORD AND SHOULD BE ISSUED WITHOUT POSTPONEMENT

A. Like Other Regulatory Decisions in Complex Matters, Determinations under Section 316(b) are Governed By A Practical Evidentiary Standard of Reasonable Assurance Based on Professional Judgments

In permitting decisions pursuant to Section 316 of the CWA, as in other regulatory proceedings before administrative agencies, the governing evidentiary standard is one of reasonable assurance based on professional judgment. The administrative record must be sufficient to enable the agency, with appropriate reliance on professional judgments, to make relevant and necessary determinations with reasonable assurance of their correctness, such that its findings have a rational basis in the record. In the intensely practical business of regulation, evidentiary certainty and analytical perfection are neither feasible nor required for decisions, and professional judgment must play a substantial role in the resolution of uncertain or disputed issues. These wise and pragmatic principles are especially apt in administrative regulatory cases, such as those involving Section 316 determinations, that present myriad complex, technical, and, in many instances, contested issues.

The extensive evidence and analyses presented by PSEG in the Application easily satisfies, both in quality and quantity, the standard of reasonable assurance based on professional judgment and provides, together with the other evidence of record, a fully sufficient basis for the determinations made by NJDEP in the Fact Sheet and for issuance of the Draft Permit with the modifications recommended in this submission. Indeed, the Application far surpasses, in terms of both the completeness and the rigor of the studies presented, most if not all other permit renewal applications submitted pursuant to Section 316(b). The numerous comments in ESSA's Report of the studies presented in the PSEG Application completely disregard the reasonable assurance standard that governs regulatory decision making. Many, indeed most of ESSA's comments are by turns highly technical, excessively theoretical, impractical, or otherwise blink the realities of regulatory decision. As shown in detail in PSEG's Response to ESSA and as summarized below, § IX.B, ESSA's criticisms often disregard the practical limitations of both time and resources and almost completely ignore the central and essential role of practical professional judgment in resolving the highly complex factual and analytical issues presented in Section 316 determinations.

The basic principle that regulatory determinations by administrative bodies may and indeed often must rest on evidence and analyses that provides no more than a reasonable assurance of their correctness is reflected throughout USEPA's 1977 Section 316(b) Guidance, whose continuing applicability to Section 316(b) determinations was recently reaffirmed by USEPA. For example, the Guidance states, p. 4, that intake studies should include a projection of the long range effect of any damage caused by an intake "to the extent reasonably possible." (emphasis added) The Guidance further states, p. 6, that the process for evaluating existing intakes is to be "flexible." The Guidance acknowledges, p. 11, that the "exact point at which adverse impact occurs at any given plant site or water body segment is highly speculative and can only be determined on a case-by-case basis . . . ." (emphasis added) The Guidance states that the "best guidance that can be provided to agencies in this regard would be to involve professional resource people" in making such determinations. Id. (emphasis added) The Guidance recognizes that undue exactitude in making such determinations can not be expected, stating, p. 15, that the "magnitude of an adverse impact should be estimated" by reference to a wide range of factors. (emphasis added) The Guidance, p. 32, references the potential use of models to estimate impacts from entrainment but notes that "the time and costs involved will not be justifiable in many situations." It states that biological survey data must be "sufficient to permit analysis and reduction to assessment criteria which will be useful in reaching a judgment" on the existence of an adverse impact. P. 33 (emphasis added) The Guidance also recognizes, p. 39, that data from field studies do not ensure "certainty of results" in determinations of adverse impact, and because of the "difficulties" thereby presented it may be "necessary to base a determination of adverse impact on professional judgment by experienced aquatic scientists." (emphasis added)

Accordingly, the USEPA Guidance currently applicable to Section 316(b) determinations recognizes at many points the complexity of the issues presented in such determinations, the inevitable limits to the information, time, and other resources available for making such determinations, the impossibility of certainty, the need for pragmatic approaches to making decisions, and the inescapable need for and importance of practical professional judgment. The ESSA Report consistently ignores these authoritative precepts.

The USEPA Administrator's two decisions in the Seabrook case powerfully illustrate the standard of reasonable evidentiary assurance and caution against pursuit of theoretic perfection in Section 316 regulatory determinations. In his first decision, Seabrook I, [121]/ the Administrator concluded, p. 20, that in Section 316(a) cases, where the burden of proof is on the applicant for a

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[121]/ In the Matter of Public Service Co. of New Hampshire, Decision of the Administrator (USEPA, Case No. 76-7, 1976) (Seabrook Station, Units 1 and 2).

variance (rather than on the permitting agency, as is the case in Section 316(b) BTA determinations), the applicant must provide the agency with "adequate information" which is "the evidentiary showing needed to make a reasoned decision." The Administrator cautioned against imposing unreasonable evidentiary requirements in this context, observing that the Regional Administrator ("RA"), whose decision he was reviewing, "occasionally used some phrases which implied a higher standard of proof," for example by stating that information on the "whole marine ecosystem" may be necessary. Id. The Administrator also emphasized the role of professional judgment in making regulatory determinations, noting that while an agency may not "speculate as to matters for which evidence is lacking," a knowledgeable scientist can often reach appropriate judgments from evidence "with assurance based upon his knowledge and experience." Id. Further, "[n]o hard and fast rule can be made as to the amount of data that must be furnished." P. 21. "Data should not be required to be furnished simply because they are collectible." Id. The Administrator noted that the RA, in denying a Section 316(a) variance, had found that data as to the thermal tolerances of certain stages of RIS were not provided. The Administrator observed: "Though this is true, I find that, examining the data in the record in light of an informed scientific judgment, it is not necessary for [the applicant] to furnish further data . . . ." P. 21. The Administrator quoted with approval language from USEPA's Draft 316(a) manual which stated that: "mathematical certainty regarding a dynamic biological situation is impossible to achieve . . . . Accordingly, the [agency] must make decisions on the basis of best information reasonably attainable." P. 22 (emphasis added).

The practical and realistic approach taken by the Administrator with respect to evidentiary matters involving cooling water systems is also reflected in his rulings on the Section 316(b) issues in Seabrook I, where he reversed a BTA decision by the RA that had required relocation of the Seabrook Station's intake because of concerns over its impact or aquatic organisms. The RA had found that the impact of the intake in its current location "was unknown and could be significant." P. 37. The RA found, for example, that "there was inadequate information on actual migratory pathways in and out of Hampton Harbor." Id. In reversing the RA's decision, the Administrator, however, determined, p. 38, that:

> It is highly unlikely that studies of fish migration, which would be very expensive and time-consuming, would yield any useful information with respect to the best location for the intake structures. I cannot therefore conclude that they are required in this case.

The Administrator also refused to require relocation of the intake.

Thus, Seabrook I stands for the central principle that the practical judgment of professionals and regulators must play a key role in regulatory determinations under Section 316, that permittees and permitting agencies need not engage in "expensive and time consuming" studies to resolve uncertainties when experts in the field judge that they would not be of sufficient practical value in making regulatory determinations, and that the inevitable existence of uncertainties regarding the environmental effects of an intake does not justify imposing BTA regulatory requirements. This wise, pragmatic approach is conspicuously absent in the ESSA Report, which often implicitly adopts wholly unrealistic and excessively demanding standards of proof and analysis without ever stopping to consider whether such standards are necessary or appropriate for the regulatory decisions to be made. In these respects, the approach of ESSA's Report mirrors the approach taken by the Regional Administrator in Seabrook, which the Administrator properly found to be reversible error.

In Seabrook II, [122]/ the USEPA Administrator again considered the evidentiary standard for Section 316 determinations following a court remand of his previous Seabrook I decision on procedural grounds. The Administrator, at p. 22 of his opinion on remand, endorsed the following account of his rulings in Seabrook I:

> Precise quantification of the numbers of organisms that might be affected was simply unnecessary [for the Section 316(a) determination] in this case .... Similarly, precise quantification of affected organisms was not required in order for me to make a determination as to whether the technology embodied in the proposed cooling water intake structure represented "best available technology to minimize adverse environmental impact...."

In his decision on remand, the Administrator again granted Seabrook a Section 316(a) variance and refused to find, contrary to claims by environmental groups opposed to operation of the Seabrook Station, that relocation of the Station intake structure was required by Section 316(b). The Administrator found that relocation was not BTA because the costs of relocation would be wholly disproportionate to any environmental benefit afforded. In the course of his decision, the Administrator further considered the evidentiary standards and decisional approach that should be followed in Section 316 determinations. The Administrator's discussion, pp. 52-53, is so instructive and so pertinent to the instant proceeding and to ESSA's criticisms of PSEG's Application that it merits extensive quotation:

> There are on the record many statements to the effect that the applicant's marine and estuarine biological data collection and analysis were seriously deficient. The question that needs discussion is "deficient for what purpose?" The record strongly supports a finding that the data collection and analysis were deficient for many quantitative scientific purposes, such as do Mya arenaria larvae set in the same estuary in which they are spawned, are there separate stocks of O. mordax and P. americanus associated with the various estuaries along the littoral, and what are the absolute concentrations of various plankters as a function of time and place?
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> In the present case, however, answers to such questions are not essential for decision making. Rather, the data collection and analysis need to answer other questions in enough specificity, so that when taken with other evidence, such as the percentage of

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122/ In the Matter of Public Service Company of New Hampshire, Decision on Remand (USEPA, Case No. 76-7, 1978) (Seabrook Station, Units 1 and 2).

> available water critically affected by the plant, relevant regulatory biological conclusions can be drawn. Such questions are what stages of what species are present in areas likely to be affected by the plant's operation and what are the relative distributions, spatial and temporal, of such species and stages insofar as they relate to areas likely to be affected by the plant's operation? These two questions, in this case, are basically adequately answered by the data collection and analysis on the record as a whole when considered by experts in conjunction with hydrological and other considerations. ... One would always like more data. This record does not indicate that the sampling seriously failed to identify representative important species and the stages which the plant would impact more seriously. For this specific plant, the sampling done in identifying the potentially impacted species and stages thereof is adequate to permit qualified experts to draw conclusions upon which regulatory judgment may appropriately be based. (emphasis added)

After reaffirming his previous Seabrook I determinations, the Administrator refused to postpone his decision, rejecting claims by opponents of the Seabrook Station that further proceedings were necessary in order to gather additional information. "It is apparent that any further delay on my part in rendering a final decision in this matter will result in further administrative delay, uncertainty and expense." P. 59. The Administrator's decision was sustained by the First Circuit in Seacoast Anti-Pollution League v. Costle, 572 F.2d 872 (1st Cir. 1978). The Administrator's discussions in Seabrook II thus makes clear that the evidentiary standards for "data collection and analyses" necessary to support "regulatory judgments" are not the same as the more demanding standards that are often appropriate for "quantitative scientific purposes." Definitive answers to many of the questions that scientists pose and seek to solve "are not essential for decision making" in the regulatory context. Because of the need to avoid "administrative delay, uncertainty and expense," regulators do not have the luxury of postponing resolution of controverted issues pending completion of a full scientific inquiry. Accordingly, it is both necessary and appropriate that many issues in regulatory decisions like those presented under Section 316(b) be resolved based on the evidence that is currently available, considered "on the record as a whole," when it "is adequate to permit qualified experts to draw conclusions upon which regulatory judgment may appropriately be based." The ESSA Report repeatedly disregards these authoritative precepts.

There can be no question that the data and analysis presented in the Application easily satisfies the evidentiary standards set forth in applicable USEPA Guidance and in the USEPA Administrator's Seabrook decisions, which remain controlling precedent. PSEG's research and analytical methods are fully consistent with the decisional norms and practices validated in the Guidance and the Seabrook decisions, these norms and practices are widely followed in Section 316 permitting determinations. It is likewise apparent that many if not most of ESSA's criticisms of the Application and recommendations for further collection of data and further analysis are ignorant of and inconsistent with the principles endorsed in the Guidance and the Section 316 permitting precedent.

B. The Alleged Deficiencies in PSEG's Application Cited in ESSA's Report and By Some Commenters Do Not Justify Modification of the Draft Permit or Any Postponement of its Adoption

1. ESSA's Criticisms Focus on Minutiae, Ignore the Significance of the Multiple Independent Lines of Evidence and Analyses Conducted by PSEG, and are Inconsistent With the Standards Applied in 316(b) Permitting Decision

As detailed in PSEG's Response to the ESSA Report (Part Three of these Comments), relatively few of the many comments and recommendations in the ESSA Report warrant further consideration by NJDEP and PSEG. The majority of the comments are irrelevant or even erroneous, reflecting confusion regarding PSEG's Application or lack of knowledge of site-specific conditions. In any case, ESSA's comments fail to adequately consider applicable Section 316(b) standards. Thus, most of ESSA's criticisms are irrelevant with respect to evaluating the merits of PSEG's Section 316(b) Demonstration. To ensure that NJDEP fully understands the scientific and technical bases for PSEG's position that most of ESSA's comments are erroneous or irrelevant, PSEG prepared a comprehensive Response to the ESSA Report that contains an overview (PSEG Response Section I) and a detailed section-by-section response ("Detailed Technical Response") (Sections II-VII of PSEG's Response).

ESSA's approach to the task of reviewing PSEG's Application seems to focus on improving the degree of "scientific rigor" of the documentation. However, as is well established by relevant regulatory guidance and legal precedent, the goal of the Section 316(b) review process is to ensure that the data supporting a demonstration reasonably demonstrate compliance with Section 316(b), not to ensure that the highest level of theoretical perfection is achieved in every detail of the supporting technical documentation.

ESSA's review appears to lose sight of the important distinction between the legal requirement that compliance with Section 316(b) be reasonably demonstrated, and the academic goal of achieving technical perfection in that demonstration. In particular, ESSA's somewhat compartmentalized, highly academic approach to reviewing the Application fails to take into account how, as detailed in Section I.C.3.b. of PSEG's Response, the Application relies on the use of multiple lines of evidence, multiple data sources, and integrative interpretation by expert judgment as a scientifically appropriate and reasonable way to address uncertainties in the data and analyses. For the most part, the ESSA Report ignores the significance of these factors in reasonably addressing many of the concerns about uncertainty raised in the Report.

Importantly, despite ESSA's many comments and criticisms regarding the technical documentation associated with the Application, ESSA does not, in essence, challenge the Application's fundamental conclusions regarding Section 316(b) compliance. PSEG therefore continues its strong belief that the approach and conclusions of the Application are fully supported by solid scientific, engineering and economic analytical principles, and that the nature and scope of the material presented in the Application are fully consistent with relevant regulatory guidelines. Accordingly, NJDEP's determination that the Application successfully demonstrates Section 316(b) compliance is valid, and nothing in the ESSA Report effectively undermines this conclusion.

a. ESSA Provides a Highly Detailed Review of the Technical Documentation of PSEG's Application

As stated in the "Scope of Work" for the ESSA Report, NJDEP sought ESSA's assistance in reviewing "limited portions" of PSEG's Application (see "Scope of Work for ESSA Technologies Ltd. to Assist New Jersey Department of Environmental Protection" October 1, 1999; reprinted in ESSA Report, pages 157-159). It is clear from both the general and specific charges of the Scope of Work that NJDEP did not ask ESSA to evaluate the merits of PSEG's assessments regarding Adverse Environmental Impact ("AEI"), but only to evaluate the BTA assessment and selected technical portions of the analyses supporting the AEI assessment.

ESSA apparently viewed its goal under this Scope of Work as evaluating the "scientific rigor" of PSEG's many sources of data and multiple lines of analysis. ESSA expressly represents its task as one of identifying ways to "increase the scientific rigor of the present Permit Application and future applications" (ESSA Report, page 152), and expressly states that determining "the relevance and application of the results of the ESSA review to the requirements of Section 316(b) ... is outside the scope of ESSA's Terms of Reference" (ESSA Report, page 5).

Thus, the ESSA Report offers a series of highly detailed, compartmentalized analyses of the technical documentation associated with portions of the Application assessments and discrete portions of the AEI assessment. These academic, compartmentalized analyses do not generally reflect that ESSA's comments or recommendations are predicated upon or conditioned by the regulatory standards applicable in a Section 316(b) context for determining the level of scientific rigor that appropriately may be demanded of the analyses in the Application.

b. ESSA's Approach is Inconsistent with Regulatory Precedent Regarding Section 316(b) Demonstrations

ESSA's many highly academic criticisms of particular methods and conclusions in the Application do not appear mindful of the reasonableness standard of review that, under applicable Section 316(b) regulatory guidance and precedent, is the appropriate standard for the analyses supporting a Section 316(b) demonstration. For existing plants, the goal of the supporting analyses for a Section 316(b) demonstration is not perfection or certainty but rather to provide data and information that are "reasonable" and "reliable" in the particular circumstances. As detailed in Section I.D.2 of PSEG's Response, EPA's 1977 Draft Guidance for Section 316(b) demonstrations (USEPA 1977), which US EPA has recently affirmed as the guidance currently applicable for existing plants (Cook 2000), indicates that an agency reviewing a Section 316(b) determination must do so mindful of the limits of scientific research, the importance of site-specific factors in evaluating impacts, and the need for informed professional judgment to address uncertainty. In addition, legal precedent also affirms a standard of reasonableness, indicating that an agency must make Section 316 permitting decisions relying on the "best information reasonably attainable," so long as there are not critical deficiencies in the information. [123/]

123/ In the Matter of Public Service Co. of New Hampshire (Seabrook Station), Case No. 76-7 (June 10, 1977) at 22.

There is no question that the data and analyses presented in PSEG's Application to support its assessments regarding BTA and AEI more than meet the level of scientific rigor articulated in the 1977 Draft Guidance and in the Seabrook decision.[124] In contrast, ESSA's highly academic approach to evaluating the "scientific rigor" of PSEG's Application, which frequently asks for a level of supporting documentation that goes well beyond that typically provided in 316(b) demonstrations and other regulatory contexts such as fisheries management decision-making, is not consistent with the Section 316(b) precedent. ESSA's highly detailed, academic review of the Application's scientific rigor does not, however, alter the fact that the agency's legal obligation is to determine whether PSEG's data and analyses provide reasonably sufficient support for its Section 316(b) determination.

c. The Majority of ESSA's Criticisms Do Not Warrant Consideration by NJDEP or PSEG

The ESSA Report clearly provides assistance to NJDEP in evaluating the more technical portions of PSEG's Application. In addition, the ESSA Report provides certain valid, relevant comments or recommendations that offer reasonable suggestions for improving the technical merit of PSEG's Application. However, as is detailed at length in the Detailed Technical Response provided in Sections II-VII of PSEG's Response, the majority ESSA's comments are either irrelevant or erroneous and thus do not warrant further consideration by NJDEP or PSEG.

(1) Many of ESSA's Comments Reflect Lack of Understanding Regarding Aspects of the Application

Many of ESSA's comments reflect lack of understanding, or confusion, regarding aspects of the Application.

Many of ESSA's many comments about how uncertainty is documented or analyzed in the Application reflect a lack of understanding regarding the Application's fundamental approach. As detailed in Section I.C.3 of PSEG's Response to ESSA, PSEG's Section 316(b) Demonstration includes a vast variety of analyses, based on multiple lines of evidence and multiple data sources, that cover a wide range of topics related to the health of fish stocks of the Delaware Estuary and the effects of Salem on those stocks. An important part of PSEG's Section 316(b) Demonstration is the holistic synthesis of this vast array of data and information in the cumulative impacts assessment. PSEG recognized that considerable uncertainty would be associated with this information and data (as is always the case with data and information on aquatic populations) and that no single formula or procedure was available to analyze all relevant information and data in an integrated manner that would lead to unambiguous answers. For

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124/ Of course, under Section 316(b), the burden of proof is on the regulatory agency when evaluating intake technologies. See In the Matter of Public Service Co. of New Hampshire (Seabrook Station, Units 1 and 2), Case No. 76-7 (Decision on Remand Aug. 4, 1978) at 22 ("precise quantification of affected organisms was not required" in order to make a Section 316(b) determination).

these reasons, PSEG engaged stock assessment scientists with decades of experience conducting stock assessments for resource agencies to assemble and interpret the relevant information and data. The conclusions presented in PSEG's Application are based on the informed, professional judgement of these scientists.

The ESSA Report's somewhat compartmentalized, academic approach to reviewing the analyses in the Application for the most part ignores the significance of the Application's integrative, holistic approach when evaluating the technical merit or the defensibility of conclusions in the analyses. This is especially true with respect to ESSA's many and repeated calls for additional extensive uncertainty analyses. ESSA's approach seems to entirely ignore the regulatory precedents discussed above, especially USEPA's 1977 Draft Guidance for Section 316(b) demonstrations, that recognize the uncertainties of scientific research and the need for reasonable ways to address them, including the use of expert judgment.

In addition, sometimes ESSA mistakenly identifies what ESSA perceived to be incomplete discussions of issues or instances where PSEG's application inadequately addressed data uncertainty. To a great extent these comments reflect simply a lack of knowledge about where certain information is found in the Application. ESSA also frequently states that the discussions of some topics in some sections of the Application are incomplete, implying that the incomplete discussions reflect scientific flaws, when in fact the topics are discussed fully elsewhere in the Application.

(2) Many of ESSA's Criticisms Reflect Lack of Detailed Knowledge about Site-Specific Factors

Contrary to the 1977 USEPA Guidance, the ESSA Report ignores the importance of site-specific characteristics in evaluating research on technologies for effectiveness and engineering practicability (see PSEG Response V.E.1). For example, ESSA's discussion of Salem Station's "fish escape routes" reveals a lack of understanding of the Salem CWIS and how fundamental hydraulic principles operate there (see PSEG Response V.E.1.a(2)). Similarly, ESSA's recommendation that installation of a jetty could reduce organism entrainment and impingement similarly reflects a lack of familiarity with relevant site-specific conditions that render the recommendation ill-founded (see PSEG Response V.E.1.b.).

Further, the ESSA Report frequently suggests additional analyses that ESSA claims should be conducted that in fact are infeasible or irrelevant given site-specific conditions. Examples include the suggestion to sample fish for mortality after the fish have been returned to the Estuary (see PSEG Response V.B.3); and the recommendation that PSEG evaluate other indicators of ecosystem function and structure when evaluation of such indicators is not warranted by the site or applicable guidance (see PSEG Response VII.B.2).

Similarly, many of ESSA's recommendations for additional analyses frequently appear to be made without awareness of how other site-specific factors make it infeasible to conduct the analyses. For example, ESSA recommends calculating the marginal value of additional fishing trips when there are no studies available to do so (see PSEG Response VI.C.4.a.). ESSA also recommends additional studies in the trends analyses to separate the effects of the Station from other anthropogenic effects when such is not a goal of the trends analyses and when the data necessary to conduct such an analysis validly are not available (see PSEG Response VII.E.1.f). Generally, ESSA's suggested additional analyses would not produce meaningful answers, even if they could be successfully conducted.

(3) Many of ESSA's Criticisms Are Irrelevant in the Section 316(b) Context

As discussed in PSEG Response Section I.D.2, ESSA's approach – which focuses on improving the "scientific rigor" of the documentation in the Application – frequently results in comments and recommendations that are irrelevant to evaluating whether the analyses satisfy the standards associated with Section 316(b) demonstrations. The Detailed Technical Evaluation repeatedly identifies such irrelevant comments and recommendations. The most common type of such irrelevant criticisms in the ESSA Report are the many recommendations for the development of additional data or analyses where the purpose of the recommended analyses with respect to the Section 316(b) Demonstration is not clear. Examples include: ESSA's recommendations regarding additional cost-benefit analyses that would not add to the understanding or affect overall conclusions, discussed in Section IV; ESSA's vague recommendation of analyses of "additional indicators" for the balanced indigenous community ("BIC") analysis without indicating how or why the analysis would improve the basis for NJDEP's Section 316(b) permit decision, discussed in PSEG Response Section VII.D.5; ESSA's recommendations of additional discussions of uncertainty regarding PSEG's production foregone calculations when PSEG's conclusions did not depend on an inability to detect changes due to low statistical power and therefore further discussions would not improve the analysis, discussed in VII.C.5.b. Clearly, there is little basis for NJDEP or PSEG to further consider such recommendations.

(4) ESSA Could Have Resolved Many of its Concerns if ESSA had Consulted More Closely with PSEG Regarding Areas of Confusion

To assist NJDEP and ESSA in ESSA's review of the Application, PSEG made its staff and experts available to ESSA, at ESSA's request, to answer questions and provide clarification. While the ESSA Report acknowledges PSEG's cooperation and responsiveness during the review process, it does not reflect that ESSA availed itself of PSEG's offers to provide assistance to ESSA to address any questions or confusions that might arise in the course of the ESSA review or the extensive supplemental information PSEG provided to NJDEP for ESSA during the review process. For example, the ESSA Report does not reflect consideration of any of the extensive information that PSEG developed and submitted to NJDEP on May 17, 2000 in response to concerns that ESSA representatives had identified in a presentation of findings to NJDEP and to PSEG in April of 2000. There is no evidence from the ESSA Report that ESSA took any of this information into account, since many of the comments identified in the ESSA Report were fully addressed in PSEG's May submission.

In addition, in its Report, ESSA notes the possibility that it could have failed to find information which it cited as missing in the Application (see ESSA Report, page 152). This statement is somewhat surprising since, as noted, PSEG made all reasonable efforts to assist ESSA in understanding the organization and content of the Application, including giving a presentation to ESSA that exhaustively described the components of the Application, as well as making its experts available to meet in person or by conference call with ESSA to answer any questions that might arise, including answers to such basic issues as where to locate information in the Application.

2. ESSA's Recommendations Regarding "Biomass Lost to the Ecosystem" ("BLE") Lack Scientific Credibility and Do Not Warrant Consideration by NJDEP or PSEG

The ESSA Report introduces a concept ESSA refers to as "biomass lost to the ecosystem" ("BLE"). As represented in Figure VII-2 of PSEG's Response, which is derived from a figure in ESSA's Report and depicts the relationships between BLE and its component measures, BLE has two component measures: (1) production foregone (i.e., incremental growth lost to predators due to failure of impinged and entrained organisms to grow, also referred to as natural mortality foregone), and (2) the biomass of organisms entrained and impinged at the plant.

a. ESSA's Recommendation that BLE be Used as an Additional AEI Indicator Lacks Scientific Credibility and Is Inconsistent with Regulatory Guidance

ESSA's recommendation that PSEG include BLE as an additional AEI indicator in the cumulative impact assessment lacks scientific credibility and reflects a misunderstanding of PSEG's AEI approach and of USEPA guidelines and relevant regulatory guidance. PSEG pointed out the flaws of ESSA's proposed BLE indicator in the May 2000 Report, but the ESSA Report does not respond to or address PSEG's criticisms. As detailed in that May 2000 Report and more fully in Section VII.B.2.a. of PSEG's Response, ESSA's proposed biomass lost indicator is inconsistent with the ERA Guidelines and with PSEG's benchmark selection criteria.

Despite ESSA's characterization of its proposed BLE indicator as a valid risk assessment endpoint consistent with the ERA Guidelines, BLE fits neither the definition nor the criteria for endpoint selection defined in those Guidelines. The proposed BLE indicator does not describe an actual ecological entity such as a species, population, community, ecosystem, or habitat (see ERA Guidelines, Section 3.3.2), and thus BLE is a useless measure of effects.

Similarly, the BLE indicator does not satisfy PSEG's three benchmark selection criteria, which are: (1) A benchmark must be directly related to population or ecosystem health; (2) Regulatory and scientific precedents for the use of the benchmark must exist; and (3) It must be possible to establish objective criteria for interpreting the significance of measured or predicted impacts. ESSA's proposed indicator does not satisfy the second and third criteria. Whether it satisfies the first is also highly questionable, because the BLE methodology reflects a grossly simplistic conceptual model of the Delaware ecosystem that neglects many important biomass and energy transfer processes.

. ESSA's approach assumes that entrainment and impingement remove fish that otherwise could have been eaten by predators. However, a more realistic description of the biomass production process in the estuary, as discussed in Sections VII.B and VII.C of PSEG's Response, recognizes that the prey organisms that would have been consumed by the entrained or impinged fish are available for consumption by the survivors. Because of reduced competition and increased prey availability, the survivors grow more rapidly and suffer lower rates of natural mortality. Ultimately, a large fraction of the prey biomass lost due to the deaths of entrained and impinged fish may be recovered due to a compensatory increase in the prey biomass provided by the survivors. Moreover, fish production within the estuary is ultimately determined by primary production. The Station does not remove biomass from the ecosystem, and does not alter the productive capacity of the ecosystem. While the degree to which compensatory processes offset the direct effects of losses at the Station is unknown, the processes themselves are well documented in Appendix I of the Application. Thus, it is possible that the only biomass actually lost to the ecosystem is the biomass of the entrained and impinged organisms at the time of death ("biomass killed" in ESSA's terminology). Even this loss may simply be a transfer of biomass from the pelagic food web to the benthic food web, with no net loss in ecosystem productivity. ESSA's method of estimating "total biomass lost to the ecosystem" does not account for any of these fundamental ecosystem properties.

As a result of ignoring these biomass and energy transfer processes, ESSA's BLE indicator produces estimates of loss that are biased high and are not credible estimates of actual biomass lost. Thus, because ESSA's proposed BLE indicator is both scientifically invalid and inconsistent with both ERA Guidelines and PSEG's criteria for selecting benchmark indicators, ESSA's recommendation that PSEG include BLE as an indicator of AEI does not warrant further consideration.

b. ESSA's Recommendation that PSEG Expand Its Cost-Benefit Analyses to Address BLE Lacks Scientific Credibility and Would Not Materially Alter the Results of the Analyses

In evaluating the cost and benefits of alternative technology options, PSEG assessed the benefits of the technology alternatives in terms of the expected increases in fisheries catches that would be associated with their implementation. To do this PSEG used as an input of "pounds lost to the fishery." For commercially fished species, the input was based on estimates of catch foregone (i.e., pounds lost to the fishery due to failure of impinged and entrained organisms to grow). For non-commercially fished species, the input was based on estimates of production foregone (also referred to as natural mortality foregone, which is the incremental growth lost to predators due to failure of impinged and entrained organisms to grow).

ESSA argues that PSEG's cost-benefit analyses should instead, for all species, evaluate the economic value of the sum of (1) catch foregone, (2) production foregone, and (3) the biomass of the organisms actually entrained and impinged at the plant. ESSA refers to this tripartite measure as "total biomass lost." ESSA claims that, because PSEG's estimates of pounds lost to the fishery did not include all three of the components of total biomass lost for all species, the cost-benefit estimates presented in the Application are biased.

To demonstrate the alleged problem with PSEG's analyses, ESSA inappropriately compares PSEG's estimates of pounds lost to the fishery to ESSA's proposed total biomass lost estimates and claims that the actual total biomass of fish lost to the ecosystem is greater than stated in the Application. This is an illegitimate comparison. While it is true that PSEG's estimate of pounds lost to the fishery is less than half of ESSA's estimate of total biomass lost, this fact does not reflect any biases or problems with PSEG's calculations, but only that ESSA's measure inappropriately includes estimates of two additional components not included in PSEG's.

ESSA recommends that PSEG should add consideration of these additional components of loss to its cost-benefit analyses for the technology alternatives. Since PSEG's cost-benefit analysis already addresses the value of catch foregone, ESSA recommends that PSEG's analyses should include BLE to address the other two components of ESSA's total biomass lost measure. As detailed in Section VII.C.3. of PSEG's Response, ESSA's recommendation lacks scientific credibility. Further, if the expanded analyses were done correctly, the results would not differ materially from those of PSEG's method, and so there is no justification for ESSA's recommendation.

First, as PSEG has previously detailed, ESSA's methods for calculating total biomass lost are severely biased high because they fail to take into account density-dependent compensatory processes and other fundamental properties of ecosystems that act to offset the direct effect of losses due to Station operation (see discussion in Section VII.B.2. of PSEG's Response, and PSEG's May 2000 Report, Attachment II-C to these Comments).

While PSEG's estimates of pounds lost to the fishery are similarly biased high due to failure to address these compensatory and other properties, in selecting its methods for the cost-benefit analyses PSEG concluded that the overestimates of pounds lost to the fishery, and associated overestimates of benefits from the technology alternatives, would reasonably ensure that the resulting cost-benefit ratios were conservative. In contrast, the overestimation of losses in ESSA's total biomass lost approach would be unreasonably high due to the inclusion of the additional biased components. Thus, including the additional biased BLE estimates of loss in PSEG's cost-benefit analyses would dramatically, and unreasonably, increase the estimates of benefits as well as severely skew, and unreasonably lower, the cost-benefit ratios.

Moreover, incorporating these biased estimates of BLE directly into the cost-benefit analyses of technology alternatives, as ESSA appears to recommend, would be scientifically invalid and even further skew the cost-benefit ratios unreasonably low. Directly incorporating ESSA's BLE estimates into the cost-benefit analyses would essentially double count the value of BLE by ignoring three factors that affect the economic valuation of the BLE components: (1) the fraction of natural mortality that is due to predation by economically valuable species, (2) the trophic transfer efficiency of biomass moving up through the food chain, and (3) the fishery exploitation rate.

These three factors must be considered in any valid cost-benefit analysis incorporating the BLE estimates because production lost to natural mortality due to disease, starvation, or predation by invertebrates like jellyfish does not generate economic value. In contrast, production lost to natural mortality due to predation by economically valuable species could result in an increase in the biomass and harvest of economically valuable species, thereby generating economic value. Therefore, the fraction of natural mortality that is due to predation by economically valuable species must be taken into account. Second, only a fraction of the prey biomass consumed by a predator is turned into additional predator biomass. Third, since the benefits estimates are based on pounds of fish harvested, the fishery exploitation rate, which is the fraction of fish in a population that is harvested by the fishery, must be considered.

The only way to appropriately address the BLE estimates in the cost-benefit analyses would be by taking the above three factors into account to translate the component measures of BLE – i.e., production foregone and biomass impinged and entrained at the Station – into "equivalent catch foregone" measures.

PSEG calculated estimates of equivalent catch foregone that include all three of the components of total biomass lost identified by ESSA for the predator RIS. The results show that the inclusion of omitted components would not materially affect the cost-benefit analyses. The inclusion of the BLE components identified by ESSA would increase the total catch foregone estimate for the Base Case scenario (for all predator RIS collectively) by less than 8%. This calculation, which does not even address the biasing effects of the failure to account for density-dependent compensation in the estimates, underscores why ESSA's implied claim that PSEG's estimates of catch foregone are less than half what they should be in the cost-benefit analyses has absolutely no merit.

Thus, PSEG's analyses show that including ESSA's BLE components of biomass lost in the cost-benefit analyses, while it would still result in estimates biased high due to the failure to consider density-dependent compensation, would not materially affect PSEG's results if the calculation of the BLE components properly takes into account the relevant trophic transfer efficiencies. Therefore, even apart from the scientific invalidity of ESSA's BLE measures, there is no practical justification in the Section 316(b) context for ESSA's recommendation to expand PSEG's cost-benefit analysis to include them. (ESSA Report, page 101.)

3. NJDEP's Draft Permit Decision Appropriately Considers the ESSA Report

In PSEG's Permit Renewal Application and related filings, PSEG has provided prodigious amounts of information on environmental conditions in the Delaware Estuary as well as on the technical and economic characteristics of available technologies for additional fish protection at Salem. PSEG's approach and conclusions in all facets of the Application are sensible, defensible, represent solid scientific and economic analytical approaches, and meet or exceed what should be expected in Section 316(b) determinations.

a. Despite its Critical Approach, the ESSA Report Does Not Refute the Fundamental Conclusions in PSEG's Application

As thoroughly documented in the Detailed Technical Response in Sections II-VII of PSEG's Response, the ESSA Report does not effectively question any of the major conclusions and results of PSEG's Application regarding 316(b) compliance, and none of the concerns raised by ESSA provide any persuasive reason to change PSEG's conclusions and results in the Application.

Moreover, as is documented throughout Sections II-VII of PSEG's Response to the ESSA Report, PSEG's approach to assessing AEI is repeatedly shown to be consistent with relevant regulatory guidance, while ESSA's criticisms and recommendations are not. Further, PSEG's research and analytical methods are consistently shown to align with expected norms and practices in the context of cooling water intake system permitting, and PSEG's findings are consistently shown to align with those of independent sources researching the same issues.

b. NJDEP's Draft Decision Appropriately Adopts Certain of ESSA's Recommendations

PSEG's Comments on the terms and conditions of the NJDEP Draft Permit are presented as Part Two of these Comments. As those comments indicate, PSEG believes that, in issuing the Draft Permit, NJDEP appropriately respected the distinction between the ESSA Report's highly academic recommendations for technical rigor and the standards of reasonableness the agency must in evaluating the merits of PSEG's data and analysis for purposes of supporting the Section 316(b) demonstration. The NJDEP appropriately reviewed ESSA's Report and incorporated relevant recommendations in the draft Salem permit to address BTA compliance, the cost-benefit assessment of BTA, and the assessment of Station impacts. NJDEP's proposed terms and conditions impose substantial additional requirements that impose significant additional financial obligations on PSEG.

C. The Comments Filed, to Date Respecting Permit Renewal Do Not Justify Modification of the Draft Permit or Postponement of its Adoption

1. USFWS - Comments

a. Introduction

On June 30, 2000 the USFWS issued comments on PSEG's 1999 Renewal Application. On January 10, 2001, the Service issued comments on the Draft Permit. These documents commented on the adequacy of the impact assessment provided by PSEG to support its contention that the Station is not having an adverse environmental impact on the Delaware Estuary, on the quality of PSEG's monitoring program, on PSEG's compliance with terms and conditions of the 1994 Permit, and on the success of PSEG's Estuary Enhancement Program. In its January 10, 2001 letter, the Service commented on nine Special Conditions contained in the draft permit.

Although PSEG agrees with some of the Service's conclusions and recommendations, PSEG disputes many others. This attachment summarizes the Service's comments and PSEG's responses. A more detailed presentation of PSEG's responses to the Service's comments is found in PSEG's U.S. Fish and Wildlife Response Document, Attachment VI.

b. Summary of the Service's Comments

(1) Impact of Entrainment and Impingement

The Service characterized impingement and entrainment losses at the Station as being "high." The Service supported this statement with a table, attached to its June 30, 2000 comments on the Application, that included (1) entrainment and impingement loss estimates for

1998 (Appendix L, Tabs 8 and 9 of the 1999 Application), and (2) estimates of "base case" biomass lost taken from PSEG's Alternatives Analysis (Appendix F, Attachment 4).

In its January 10, 2001 comments on the draft permit, the Service cited a report prepared by Desmond Kahn of DNREC (Kahn 2000) as additional support for its assertion that the Station's effects are ecologically significant. In the cited report, Kahn (2000) claimed that on average one-third of all striped bass produced by the Delaware River from 1989 through 1998 had been killed by the Station.

The Service criticized PSEG's impact assessment on two principal grounds (June 30 comments), and rejected PSEG's conclusions. First, the Service questioned the quality of the data referenced, particularly the early preoperational data. The Service stated that it was especially concerned about changes in the PSEG bottom trawl survey programs, the only programs that provide finfish data for both pre-operational and operational years. The Service suggested that, because of the changes in sampling locations and gear deployment methods over the period spanned by the bottom trawl programs, the data were inadequate for determining the impact of Station operations on the finfish community of Delaware Bay. Second, the Service stated that a variety of abiotic and biotic factors influence fish populations, and that without data to separate the influence of these factors any conclusions concerning the effects of Station operations would be "tenuous at best."

(2) Quality of PSEG's Monitoring Program

The Service asserted that "irregularities" in long-term finfish monitoring programs conducted by PSEG "impose a bias in the resulting data, enough bias to warrant concern regarding the quality of the data, particularly the early pre-operational data. The Service noted that the goals of these programs have evolved over time, and that the PSEG's program scope and gear deployment methods have also evolved. The Service also cited "concerns" regarding sampling inconsistencies, interpretation of baywide sampling, and pelagic trawl vs. Cobb trawl sampling (see following subsections) and concluded that PSEG's ability to conduct an adequate finfish sampling program was questionable. The Service recommended that future finfish monitoring should be performed by NJDEP and DNREC, with funding provided by PSEG.

(3) PSEG's Compliance with Permit Conditions

The Service, in its June 30, 2000 comments, stated that PSEG had adequately complied with special conditions of the 1994 NJPDES permit regarding intake screen modifications, implementation of wetland restoration, construction of fish ladders, initiation of sound deterrent studies, and biological monitoring. However, the Service asserted that additional work was still needed to improve the quality of the monitoring program, further evaluate the effectiveness of the sound deterrent concept, and demonstrate the effectiveness of the fish ladders and wetland restoration at programs in offsetting losses at the Station.

(4) Success of the Estuary Enhancement Program

In its June 30 comments, the Service endorsed PSEG's conclusion that Estuary Enhancement Program has resulted in successful restoration of the former salt hay farms. The

Service also noted that PSEG had constructed fish ladders at eight sites, had documented the use of those ladders by immigrating adult river herring, and had also documented the emigration of juvenile river herring. The Service claimed, however, the PSEG had not been successful at restoring *Phragmites*-dominated sites.

The Service has contended in the past, and continues to contend, that PSEG should be required to fully offset entrainment and impingement losses at the Station by demonstrating that the Estuary Enhancement Program is providing increased fish production at least equal to the biomass lost at the Station. In its June 30 comments, the Service estimated the production of fish due to the restored marshes and fish ladders, and concluded that this production was still far smaller than the fish biomass lost at the Station.

(5) Comments on the Special Conditions

1. Condition 1: Flow limit

The Service recommended that the Draft Permit should be modified to require additional study of flow reduction alternatives, and to require implementation of alternatives "identified as effective and not cost-prohibitive."

2. Condition 2: Intake screen improvement

The Service supported the NJDEP's special conditions regarding reevaluation and improvement of the Ristroph traveling screens and the fish return sluice. Specific issues cited by the Service included modifications of flows, velocities and depth profiles to minimize mortality for "less robust" species such as bay anchovy and alewife.

3. Condition 3: Wetland restoration

The Service stated that it supports continued implementation of the Estuary Enhancement Program. The Service also stated its support for merging the Monitoring Advisory Committee and the Management Plan Advisory Committee into one oversight committee. However, the Service questioned whether the wetland restoration program has adequately compensated for entrainment and impingement losses. The Service recommended that PSEG should be required to increase and expand the wetland restoration program (including fish ladders) in order to adequately minimize entrainment and impingement effects.

4. Condition 4: Fish ladders

The Service supported continued monitoring of the existing fish ladders and, in addition, called for the installation of additional ladders to further minimize entrainment and impingement effects from the Station.

5. Condition 5: Diversion studies

The Service stated that it supports continuation of sound deterrents, and further supports ESSA's recommendation to evaluate multi-sensory hybrid deterrent systems and jetties. The

Service recommended that "an effective diversion system (e.g., extended jetties)" be installed at the Station.

6. Condition 6: Biological monitoring

The Service supported increased and improved entrainment and impingement monitoring, and also supported an improved biological monitoring program that "uses appropriate sampling gear and does not have the sampling inconsistencies identified in the Service's June 30, 2000 letter." The Service also supported inclusion of Atlantic silverside (*Menidia menidia*) and Atlantic menhaden (*Brevoortia tyrannus*) as RIS species. The Service expressed continued concern regarding PSEG's ability to "sample finfish and determine effects from the SNGS on finfish in the Delaware Estuary," and recommend that (1) future monitoring should be implemented by the States of New Jersey and Delaware, with funding provided by PSEG, and that (2) the sampling protocol should be reviewed by the Estuary Enhancement Program Oversight Committee.

7. Conditions 7-9: Improved monitoring

The Service supported permit conditions requiring PSEG to perform additional and improved analyses of entrainment and impingement losses, and additional hydrodynamic studies recommended by ESSA (2000). The Service also supported the comparison of Station losses to fish production associated with wetlands and fish ladders.

c. Summary of PSEG'S Response

(1) Impact of Entrainment and Impingement

The Service's review of PSEG's impact assessment was superficial and its conclusions were not supported by any technically valid analyses. PSEG was well aware of both the limitations of the available data and the potential influences of confounding environmental factors. The measures taken by PSEG to account for these limitations and confounding factors were thoroughly documented in Appendix F of the Application. PSEG's approach included (1) use of multiple indicators of adverse impact, (2) development of multiple lines of evidence for each indicator (3) thorough evaluation of data quality for every data set used in the Application, (4) elimination of data determined to be unsuitable for analysis, and (5) use of alternative "impact hypotheses" to evaluate the importance of potential confounding factors.

PSEG's approach was designed to use all of relevant information concerning the status of finfish populations and communities in the estuary. Three independent benchmarks of adverse environmental impact were developed. Determination of whether or not an adverse impact occurred or will occur was based on an evaluation of *all three benchmarks*.

The "large losses" cited by the Service as a rationale for concluding that the Station's impacts are "ecologically significant" are biologically meaningless, because the losses consist mainly of eggs, larvae, and early juvenile fish. These life stages suffer extremely high rates of natural mortality, so that only a small fraction of the entrained or impinged fish would have survived to adulthood, even if Salem did not exist. For example, less than one striped bass egg in 100,000 is likely to survive to become a one-year-old fish, and less than one in a million is likely to survive to reach six years of age, the median age at which female striped bass become sexually mature and enter the spawning stock. Mortality rates for early life stages of other species susceptible to entrainment and impingement at Salem are similar. For this reason, counts of total numbers of organisms killed, irrespective of the life stage affected, reveal very little about the impact of the Station on fish populations. A meaningful interpretation of the significance of these losses requires assessment of the impacts of the losses of individual organisms, principally early life stages, on the affected population.

Kahn's (2000) analysis of Station impacts on striped bass was reviewed by PSEG (Anthony et al. 2001) and found to contain numerous technical flaws, biases, and misinterpretations. Kahn's (2000) results and conclusions are derived from a flawed analytical method, are inconsistent with the observed distribution of striped bass larvae and juveniles in the Delaware River (Weisberg and Burton 1993; NJDEP Beach Seine Survey data documented in Application, Appendix J), and contradict his own previously published assessment of the status of the Delaware estuary striped bass population using the same data (Kahn et al. 1998).

d. Quality of PSEG's Monitoring Program

PSEG objects to the uses of the term "biases" by the Service in its comments on PSEG's monitoring program. Biases imply systematic overestimation or underestimation of the quantities being estimated from the data, resulting in an overestimation or underestimation of Station effects. In selecting data sets for use in the 1999 Application, PSEG carefully evaluated the gear, deployment, and sampling locations used by every program and selected data in a way that minimized any possible biases introduced by program changes or gear deployment methods (see discussions in Appendix F, §§ VII.A.1.b and VII.B.2.b of the 1999 Application). The specific concerns discussed by the Service did not compromise the analyses performed to support the 1999 Application or affect the validity of conclusions derived from those analyses. Moreover, PSEG is fully capable of conducting the biological monitoring program to be performed during the next permit period, as reviewed by the Estuary Enhancement Program Oversight Committee (EEPOC) and approved by the NJDEP.

e. PSEG's Compliance with Permit Conditions

PSEG agrees that it has complied with the conditions of the 1994 Permit with regard to intake screen modifications, implementation of wetland restoration, construction of fish ladders, initiation of sound deterrent studies, and biological monitoring. PSEG agrees that further studies regarding the benefits provided by the conservation measures undertaken by PSEG are appropriate, but PSEG disputes the Service's contention that an offset of Station losses by marsh and fish ladder production is required.

f. Success of the Estuary Enhancement Program

PSEG concurs with the Service's positive comments regarding this program. PSEG has performed the most comprehensive analysis of the faunal response to salt marsh restoration ever conducted. The analysis included extensive information on many aspects of the fauna (fishes, crabs, and invertebrates). For the fishes, it included a variety of life history stages and incorporates information on habitat use, food, growth, and movements of fishes at several trophic levels. As summarized in PSEG's Biological Monitoring Program 1999 Annual Report (PSEG 2000), PSEG continues to collect and analysis data on fish utilization of the restored wetland restoration sites.

PSEG agrees with the Service's comment regarding the success of the fish ladder program. Production of fish from the ponds to which access by river herring has been restored should greatly increase in the future.

PSEG believes, however, that the Service's comments inappropriately characterized PSEG's preliminary conclusions relative to the *Phragmites*-dominated wetland restoration sites. Based on PSEG's monitoring of fish abundance at the partially restored *Phragmites*-dominated sites, comparisons between treated *Phragmites* marshes and their reference marshes is difficult to interpret because of the inherent variability between sites relative to salinity, distances between restored and reference marshes, annual differences in the fish fauna, and the incomplete status of the restoration. Less dramatic early responses to the restorations were expected at these sites.

g. Comments on the Special Conditions

(1) Condition 1: Flow limit

The Service has provided no scientifically valid evidence that past or present Station operations are having an adverse environmental impact, therefore, there is no valid scientific or legal justification for evaluating or requiring flow reductions.

(2) Condition 2: Intake screen improvement

PSEG believes that the current intake screen design is consistent with generally recommended standards for fish return systems. PSEG agrees, however, that further improvements in survival of impinged fish may be possible and will comply with the terms and conditions in the permit to address these issues.

(3) Condition 3: Wetland restoration

The Service stated that it supports continued implementation of the Estuary Enhancement Program. The Service also stated its support for merging the Monitoring Advisory Committee and the Management Plan Advisory Committee into one oversight committee. However, the Service questioned whether the wetland restoration program has adequately compensated for entrainment and impingement losses. The Service recommended that PSEG should be required to increase and expand the wetland restoration program (including fish ladders) in order to adequately minimize entrainment and impingement effects.

PSEG concurs with the need to continue its wetland restoration program. However, PSEG disagrees with the Service's contention that the program must be expanded to provide greater compensation for Station losses. PSEG disputes the Service's statement that the enhanced fish production provided by the current program is substantially smaller than the biomass lost at the Station. Moreover, PSEG disagrees with the Service's contention that a one-for-one offset may or should be required in the revised renewal permit.

(4) Condition 4: Fish ladders

PSEG agrees that monitoring of the fish ladders should continue, but PSEG strongly disagrees with the Service's recommendation regarding the construction of additional ladders. The Service's recommendation is unnecessary and inconsistent with the NJDEP's basis for inclusion of the fish ladder requirement in the July 20, 1994. The NJDEP did not require the construction of fish passages as an intake technology under Section 316(b). PSEG voluntarily proposed the construction of fish ladders and the Department required them in the Permit on that basis. There is no justification or legal authority for requiring the construction of additional fish ladders to further compensate for Station losses.

(5) Condition 5: Diversion studies

PSEG does not believe that the type of system recommended by the Service is necessary or that such a system will be effective at reducing losses. However, PSEG is prepared to implement the feasibility studies specified in the Draft Permit.

(6) Condition 6: Biological monitoring

PSEG supports improved monitoring, and is prepared to implement the program specified in the Draft Permit. PSEG disagrees, however, with the Service's concerns regarding PSEG's ability to implement the proposed program. PSEG is fully capable of implementing an adequate monitoring program during the next permit period. PSEG is fully prepared to consult with an external advisory committee when developing this program. Delegating the implementation of the monitoring program to other entities would compromise PSEG's ability to full obligations imposed by the Draft Permit to provide information in support of renewal of its Permit.

PSEG believes that inclusion of additional species as RIS is unnecessary and unjustified. However, PSEG will address additional species, if required in the revised permit.

(7) Conditions 7-9: Improved monitoring

These proposed conditions were drawn from recommendations provided in ESSA's (2000) review of PSEG's 1999 Application. PSEG does not believe that any of these studies are necessary, and has provided responses to that effect in its own comments on the Draft Permit. However, PSEG is prepared to implement any such studies that are required in the revised permit.

2. USEPA Region III - Comments

USEPA Region III submitted comments on the Draft Permit in the form of a two-page letter, dated January 19, 2001, from Bradley W. Campbell, former USEPA Region III Regional Administrator, to USEPA Region II, which was transmitted to NJDEP along with a brief cover letter from Mr. Campbell of same date.

The letter from USEPA Region III to USEPA Region II expressed concern about the impacts of the Salem CWIS on "water quality and the living resources of the Estuary," stating that Delaware environmental officials share this concern. It stated that the Application documents the annual loss of 5.5 million "fish" from impingement and 3,328 million "fish" from entrainment, stating further that "[a]s [USFWS] pointed out in its June 2000 report to . . . NJDEP . . . these numbers undercount the annual loss of aquatic organisms."

The letter stated these are "serious questions" about the extent to which the "environmental restoration measures under the now-expired permit," 125/ "are minimizing adverse impacts. It further stated that: "The monitoring issues in the FWS June 2000 report must be resolved."

USEPA Region III's letter also stated that " renewed attention to technologies and measures for preventing aquatic damage is necessary in light of the level of impact to living resources." It expressed concern that the Draft Permit "may not meet the requirements of section 316(b)" of the CWA. It asserted that: "The reference point for best technology is closed cycle cooling. The letter further asserted that:

> . . . [I]t is essential that a rigorous review of available technologies and practices, including closed cycle cooling and seasonal outages, be conducted to determine if further reductions in the aquatic damage caused by the entrainment and impingement associated with Salem plant's once-through cooling system can be achieved. We understand that NJDEP provided a list of possible mitigation technologies in the permit fact sheet (pg. 66), but it is not clear that NJDEP has fully evaluated all available options.

The letter referenced certain supplements to the 1977 USEPA Section 316(b) Guidance that address intake technology options, 126/ and also asks USEPA Region II "to require" that NJDEP use information regarding intake technologies and methods generated in the pending USEPA Section 316(b) rulemaking for new sources. The letter concluded:

> In absence of a full technology review and documentation by NJDEP, EPA Region III will consult with our Delaware partners, the FWS and other Federal and State agencies to consider urging a formal objection to the permit.

The suggestion by USEPA Region III that relevant intake technology options were not considered or considered adequately in the Permit renewal proceeding is baseless, as its

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125/ USEPA's reference to the Salem Permit as "expired" is erroneous. By virtue of USEPA regulations and New Jersey law, the Permit continues in full force and effect by virtue of the timely filing by PSEG of a renewal application on March 4, 1999

126/ Preliminary Regulatory Development, Section 316(b) of the Clean Water Act, Background Paper Number 3: Cooling Water Intake Technologies (1994) and Draft Supplement to Background Paper Number 3: Cooling Water Intake Technologies (1996).

suggestion that there was an "absence of full technology review and documentation by NJDEP." Its claim that the "reference point for best technology is also fallacious. Its other contentions are likewise without merit. There are accordingly no grounds for "urging a formal objection to the permit."

USEPA Region III's suggestion that intake technology options were not adequately considered is baseless. Contrary to USEPA Region III's insinuation, the record provides "a full technology review and documentation." See § VI, B-G, supra; Application, Appendix F, Section VIII, ESSA Report Section 3.0. As shown in the Fact Sheet, NJDEP fully considered this evidence and analysis, including ESSA's recommendations. See FS pp. 66-70. The Section 316(b) Demonstration submitted by PSEG considered an extraordinarily wide array of options, 29 in all. Its analysis was carefully reviewed by ESSA. The ESSA Report provided extensive information and evaluation regarding intake technologies and other fish protection option, ESSA did not identify any additional new technology options not considered by PSEG other than potential modifications of the existing intake fish return system, ESSA also recommended consideration of the concept of a "multi-media hybrid" combination of technologies considered by PSEG. Based on this extensive documentation and analysis, NJDEP did not find that any of the numerous intake technologies considered were BTA. It required studies of certain intake technologies (all of which had been identified and extensively discussed by PSEG and/or ESSA) and combinations thereof, as well as a study and/or enhancement of the existing Salem fish return system, an option identified by ESSA. Further, NJDEP stated its commitment to require adoption at Salem of any cost-effective alternative intake technologies that would minimize impingement and/or entrainment effects at the intake.

NJDEP's determinations regarding intake technologies are amply supported by the record. USEPA Region III does not point to any evidence in the record or offer any evidence of its own that might cast doubt on NJDEP's determinations or on the completeness and the thoroughness of the consideration of CWIS technologies in the Permit renewal process. USEPA Region III does not identify any intake technology options potentially suitable for application at Salem that were not considered in the Section 316(b) Demonstration, the ESSA Report, or NJDEP's Fact Sheet but that should have been considered. It refers quite generally to supplements to USEPA's 1977 Section 316(b) guidance and pending EPA rulemaking, but does not point to any suitable options that were discussed therein that should have been considered in connection with Permit renewal and were neglected.

USEPA Region III's claim that closed cycle cooling is the "reference point" for BTA is erroneous and contrary to USEPA's 1977 Section 316(b) Guidance; the continued applicability of the Guidance to Section 316(b) determinations was reaffirmed in a Memorandum on Implementation of Section 316(b) in National Pollution Discharge Elimination System Permits from Michael B. Cook, USEPA Office of Wastewater Management Director, Washington, to the Water Division Directors of all USEPA Regions and State NPDES Directors dated December 28, 2000, three weeks before USEPA Region III issued its comments on the Draft Permit. Contrary to USEPA's claims regarding closed cooling, no single CWIS technology serves as the "reference point" for BTA determinations. As USEPA's Guidance makes clear, all such determinations are to be made case-by-case, taking into account the characteristics of the facility in question, the nature of the affected waters and their biota, the effects of the facility's intake, the availability of alternative technologies, and their benefits and costs. Thus, the Guidance states, p. 4, that "the environment-intake interactions in question" in Section 316(b) determinations "are highly site-specific and the decision as to best technology available for intake design, location, construction, and capacity must be made on a case-by-case basis." The Guidance does not provide any "reference point" technology for such determinations, and does not identify closed-cycle cooling as such. Under the "stepwise thought process" recommended in the Guidance, p. 13, for evaluating intake technology options and determining BTA, closed cycle cooling is the last option to be considered, not the first. NJDEP's BTA determinations and the Draft Permit provisions regarding intake technologies are fully supported by the extensive record and are eminently reasonable. USEPA's innuendoes to the contrary are frivolous.

USEPA's invocation of "fish" intake loss numbers in connection with its concern above the Salem intake's impacts on biota is misleading in several respects. As pointed out above in § V supra, and in PSEG's Response to USFWS, pp. 2-3, almost of all the organisms lost at the intake are early life forms, namely eggs and larvae, which are not commonly regarded as "fish." Furthermore, raw loss numbers are not a valid measure of the adverse impact on populations of losses of individuals, especially losses of early life forms, because most of the lost organisms would have died anyway due to natural causes before becoming adult fish, and because biological compensation operates to sustain populations in the face of individual losses.

Further, the claim by USEPA Region III that USFWS "pointed out in its June 2000 report" to NJDEP that the intake loss numbers presented in the Application and referenced in USEPA Region III's letter "undercount the annual loss of aquatic organisms" is erroneous. In its June 2000 report, USFWS did not claim that PSEG's intake loss numbers are erroneous or that they "undercount" true losses. USFWS did complain of "irregularities" and "bias" in certain abundance monitoring programs, data that was used in PSEG assessments. As shown in PSEG's Response to USFWS, p. 6, these complaints are unmerited.

USEPA's claims that there are "serious questions" about the extent to which the Permit conservation measures are "minimizing adverse impacts" provides no explanation of what these "serious questions" are and cites no evidence or other basis to support the suggestion that the wetlands restoration and fish ladder measures are not in fact providing benefits to the fish and other populations of the Estuary, thereby serving to minimize further any potential for adverse impact from the Salem intake. USEPA Region III's suggestion, moreover, is contradicted by the abundant evidence in the administrative record which shows that the conservation measures are generating significant fish production benefits. See § VII, supra. Accordingly, USEPA's "serious questions" about the conservation measures are simply empty words.

Finally, the "monitoring issues" raised in the USFWS June 30, 2000, comments to NJDEP are fully addressed in PSEG's U.S. Fish and Wildlife Service Response Document, Attachment VI, and summarized above, § IX C.1. As shown, USFWS charges of "bias" in the Estuary sampling data used by PSEG in its analyses of the Station's effects are unmerited. While USFWS is correct in pointing out some of the problems caused by evolutionary changes in sampling practices and other features of the various available sampling programs. PSEG properly recognized and addressed these problems, which did not compromise the analyses performed to support the 1999 Application or affect the validity of conclusions derived from these analyses.

Accordingly, none of the claims, concerns, or suggestions of deficiencies in the Application or in the renewal process asserted by USEPA Region III in its letter have any merit.

3. Other Third Party Comments

Pursuant to N.J.A.C. 7:14A *et seq.*, NJDEP sought and received comments to the Draft Permit from government agencies and the general public. Comments to the Draft Permit were received by the NJDEP both in writing and in Public Hearings held on January 23 and 25, 2001. PSEG has reviewed both the written comments and the stenographic transcripts of each of the public hearings. PSEG has prepared responses to comments received through the end of February and presents them in Attachment VI.

Attachment VI sets forth a detailed summary of the public issues recorded by these comments, identifies the commenter(s), and provides a summary of PSEG's response thereto, with appropriate reference to more detailed responses as set forth elsewhere in the submission. This summary of public comments is organized by major issues: general regulatory, impact assessment, wetlands, cost benefit analyses, fish ladders, fish protection alternatives, and miscellaneous issues. For each major issue area, issues raised through the public comments are compiled and the PSEG response presented. While they do not have to be addressed by this submission, selective positive comments received as part of this public comment process are presented at the end of Attachment VI.

The issues raised by the third party commenters are sufficiently addressed in Section VI and elsewhere in this submission. Accordingly, none of the claims, concerns, or suggestions of deficiencies in the Application or in the renewal process asserted by the various third party commenters have any merit.

X. CONCLUSION: THE DRAFT PERMIT REQUIREMENTS APPROPRIATELY MINIMIZE ANY POTENTIAL FOR ADVERSE IMPACT FROM SALEM'S INTAKE AND SHOULD BE ADOPTED WITH APPROPRIATE MODIFICATIONS

As shown in Section V of these Comments and in greater detail in the Application, the facts of record do not establish that the Salem intake has an adverse impact on the populations and community of the estuary. The studies presented in the application, using a number of different, independent benchmarks and indicators, and employing both retrospective and predictive methods of analysis drawing on a wide range of data services and the most recent scientific literature, all concluded that Salem was not having an adverse impact. Criticisms by ESSA and commenters of certain elements in the studies are, as has been shown, erroneous, misplaced, or unsubstantial, and do not disturb the conclusion of no adverse impact, which is supported by multiple independent lines of evidence and analysis. Moreover, ESSA and the commentators limit themselves to attempting (unsuccessfully) to poke holes in PSEG's studies. They present no valid affirmative evidence of adverse impact on the populations or community of the estuary as a result of Salems' operation.

Because NJDEP has not established AEI, additional BTA requirements may not be imposed on Salem pursuant to Section 316(a) & (b). PSEG, however, accepts the terms of the Draft Permit (with the modifications discussed above) because it acknowledges the concerns of the NJDEP, other environmental and resource management agencies, and the public regarding the potential for adverse environmental impact from the Salem intake. The suite of measures in the Draft Permit, consisting of ongoing intake technology studies, continuation of the wetlands restoration and fish ladder conservation programs, and an expanded biological monitoring program, are the appropriate means for addressing this concern. They represent a logical and well-justified continuation and extension of the three-pronged strategy adopted by NJDEP in the 1994 Permit for minimizing any potential for adverse environmental impact associated with the Salem intake.

As shown in Section VI of these Comments and in detail in the Application, Salem's existing CWIS, as modified in accordance with the 1994 Permit requirements, is BTA for Salem. As NJDEP has determined, there are no additional intake technologies or other measures available for implementation at Salem that would provide fish protection benefits at a cost that is reasonable in relation to the benefits afforded. USEPA's claims that the record fails to document this conclusion and that NJDEP failed to consider relevant options are baseless. In issuing the 1994 Permit, NJDEP properly rejected retrofit of closed cycle cooling and flow modifications at Salem on a determination that the environmental and economic costs of these measures would be wholly disproportionate to any benefit afforded. This determination was reviewed favorably by USEPA. The same parties who unsuccessfully urged that such measures be adopted in the 1994 Permit are again advocating their adoption in connection with renewal of that Permit. However, the facts of record show, and NJDEP has determined, that the costs of these measures remain wholly disproportionate to their benefits. Indeed, recent changes in electricity markets have resulted in increases in replacement power, making the costs of such measures even greater. Although, some commentators now urge that Salem be required to retrofit to dry cooling towers, which are significantly more costly than the wet cooling towers examined and rejected by NJDEP in 1994, those alternatives must accordingly be rejected. Therefore, the existing Salem intake is BTA and minimizes any adverse environmental impact, consistent with the requirements of Section 316(a) & (b)[127].

Based on investigations by PSEG and ESSA, NJDEP has identified a number of potential intake technologies and intake screen modifications for possible adoption at Salem. As NJDEP has recognized, however, further studies of these options are required before any decision can be

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[127] The reference to "minimizing" adverse environmental impacts in Section 316(b) does not compel the selection of whatever technology will reduce impacts to the greatest possible extent, regardless of cost or other considerations. As USEPA has recognized, the goal of minimization is qualified by the requirement that a technology be "available," a concept which incorporates considerations of cost; a technology is not BTA if its costs are wholly disproportionate to the environmental benefit derived from it, regardless of whether that technology might reduce, for example, fish losses to a greater extent than less costly options. See Application Appendix D, Section VI. Consistent with the requirement that BTA be determined on a flexible, case-by-case basis, taking costs into consideration in relation to environmental benefits, Section 316(b) does not force permitting authorities to adopt the intake technology which minimizes intake flows. Id.

made on their adoption. The Draft Permit requires such studies as an element of BTA. PSEG is committed to making appropriate searches for promising intake technology measures that might prove to be suitable for application at Salem intake and provide additional protection for fish at a cost that is reasonable in relation to the benefits obtained. It accordingly accepts the provisions of the Draft Permit providing for studies of hybrid intake technologies, and studies of whether the current intake fish return system can be modified to enhance survival of impinged fish.

PSEG is also committed to completing its implementation of the wetlands restoration and fish ladder measures incorporated as requirements in the 1994 Permit. The Draft Permit provides for continuation of these conservation measures, which will further minimize any potential for adverse environmental impact from the Salem intake. As shown in Section VII of these Comments and in the Application, a permitting agency may not unilaterally require a source to adopt such conservation measures pursuant to Section 316(b), but may include permits when they are proposed or accepted by permittees and are found by the agency to be environmentally appropriate. As also shown in Section VII of these Comments and the Application, and acknowledged by NJDEP, FS pages 75-77, PSEG's implementation of the wetlands and fish ladders provisions in the 1994 Permit is already providing substantial fish production benefits, which will only increase in the future as restoration proceeds and the productivity of the habitat made accessible by the fish ladders matures.

While additional work remains to be done on wetlands restoration, especially at the *Phragmites* sites, the restoration is progressing in full compliance with Permit requirements and the success benchmarks provided in the governing Management Plans. The record thus establishes that the conservation measures are proceeding in accordance with the expectations of PSEG in proposing them and of NJDEP in adopting them, following favorable review by USEPA. The record provides no legal or factual basis for modifying any of the conservation measure provisions in the current Permit, which are continued without material change in the Draft Permit.

Some commenters nonetheless claim that the conservation measures should be modified because restoration at the *Phragmites* sites will never succeed. This pessimism is unfounded. Similar skepticism was expressed in 1993 and 1994 regarding restoration at the salt hay farm sites yet the results there have confounded the skeptics. Other commentators claim that spraying glyphosate in connection with restoration poses an undue risk of harms, but this anxiety is baseless. USEPA has authorized use of glyphosate as safe and effective for the very purpose for which it is being used in the restoration effort. Glyphosate has been and is widely used by the State of Delaware for wetlands restoration without producing a scintilla of evidence of adverse effect. Baseless fears do not justify reversal of the Permit authorization for spraying and should not block restoration activities that will produce great environmental benefits.

Further, there is no basis in law or fact for the recommendations by USFWS and DNREC that NJDEP unilaterally modify the conservation measures in the current Permit and Draft Permit to impose requirements on PSEG to fund additional land acquisition and wetlands restoration unless PSEG is able to prove that the existing conservation measures will produce fish in numbers that equal or exceed the losses at the intake. No such requirements are imposed or authorized by applicable law. [128]/ Nor would any such requirements be justified as a matter of sound policy or basic fairness. PSEG in good faith proposed the conservation measures, including a wetlands restoration project of unprecedented magnitude, and in good faith has diligently and successfully implemented these ambitious and costly measures. When the conservation measures were adopted, all parties recognized that the work to implement them could not be completed within the five-year term of the Permit, as the Permit itself reflects. More work needs to be done by PSEG to complete restoration. To use the potential tactical leverage afforded by Permit renewal proceedings to heap fresh burdens on PSEG would deter similar initiatives in the future and be grossly inequitable and utterly unjustified.

The third component in the Draft Permit strategy for minimizing any potential for adverse environmental impact from the Salem intake in addition to technology studies and the wetlands restoration and fish ladder provisions is an ambitious and expanded biological monitoring program. This component also builds on the strategy adopted in the 1994 Permit, which required PSEG to carry out extensive monitoring and study going far beyond the usual requirements. As NJDEP has determined, PSEG fully complied with these requirements. The Draft Permit not only continues these requirements but also requires PSEG to gather additional data and conduct additional analyses of the effects of the intake and the fish production benefits provided by the wetlands restoration and fish ladder measures. These requirements include studies to estimate production from these measures in common units of biomass with intake losses. These measures will ensure that NJDEP, other environmental and resource management agencies, and the public have an even more extensive array of evidence available to assess the effects of Salem intake and the contributions of the Draft Permit measures for minimizing any potential for adverse impact.

Accordingly, for the reasons set forth above and in the Application, NJDEP should issue the Draft Permit with the modifications recommended herein.

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[128]/ NJDEP specifically determined that PSEG was not required to estimate fish production from its wetlands restoration sites under the 1994 Permit, and that in issuing the Permit the Department acknowledged the presence of "many factors, variables and limitations" to measuring the fish productivity of wetlands restoration sites and fish ladders. FS, page 77.

Specific Comments

Part Two

PSEG's Specific Comments on Proposed Terms and Conditions and Fact Sheet

Draft NJPDES Permit No. NJ0005622

Salem Generating Station

March 14, 2001

Introduction

This document provides PSEG Nuclear, LLC's ("PSEG") comments on the draft New Jersey Pollutant Discharge Elimination System ("NJPDES") permit terms and conditions and accompanying Fact Sheet issued by the New Jersey Department of Environmental Protection ("NJDEP") for the Salem Generating Station ("Salem" or the "Station"). See NJDEP, draft NJPDES Permit No. NJ0005622 (Dec. 8, 2000) ("Draft Permit"); NJDEP, Fact Sheet for a Draft NJPDES Permit including Section 316(a) Variance Determination and Section 316(b) Decision (hereafter "Fact Sheet"). This document tracks the order of the NJDEP Draft Permit, and is divided into the following four sections: (1) Draft Permit, Part III; (2) Draft Permit, Part IV; (3) Other Parts of the Fact Sheet; and (4) Other Parts of the Draft Permit, which addresses the cover page of the Draft Permit and the list of tables, figures and maps. This document only addresses those sections of the Draft Permit and Fact Sheet on which PSEG has specific comments or those sections that materially affect another section for which PSEG is seeking revision.

For each section of the Draft Permit or the Fact Sheet being discussed, the document first notes the particular section being addressed, under the heading "Permit Section, " "Fact Sheet Section," or "Permit/Fact Sheet Section," as appropriate, given the document(s) on which PSEG is commenting. PSEG's comment on the section is provided next, under the heading "Comment." Finally, where PSEG is proposing alternative permit language, that language is listed under the heading "PSEG Proposed Permit Language." If PSEG is seeking clarification of, corrections to, or otherwise challenging the language in the Fact Sheet, or is requesting NJDEP take action other than modifying the Draft Permit language, PSEG requests that NJDEP provide a response to PSEG's comment in its response to comments on the Draft Permit. The comment, which may take the form of a correction of the Fact Sheet language or new explanatory language, is included in this document under the heading "PSEG Proposed Clarification."

PSEG notes that many of its specific comments on proposed permit conditions are seeking to clarify its interpretation of the proposed term. Other of PSEG's comments address how a particular term should be implemented, consistent with sound science or engineering, site-specific factors, or information already available relative to the proposed term.

PSEG's Comments on the Draft Permit, Part III, and Related Portions of the Fact Sheet

Permit Section: Permit, Part III

Comment

The Header text on each page identifies the permittee as "Public Service Energy Group Nuclear LLC." The correct permittee name is " PSEG Nuclear LLC."

PSEG Proposed Permit Language

Change the header for each page to "PSEG Nuclear LLC."

Permit/Fact Sheet Section: Permit, Part III.B, C, E and F, (DSNs 481, 482, 484, and 485), Table III (Limits and Monitoring Requirements for the Parameter Entitled LC50 Statre 96hr Acu [sic] Cyprinodon (Acute Toxicity)); Fact sheet, Page 16.

Comment

Acute Toxicity testing requirements are included on each of DSNs 481, 482, 484, and 485. The Fact Sheet states that "... the permittee is required to perform acute toxicity testing on a minimum of one representative circulating water system outfall ..." (Fact Sheet, Page 16), which is consistent with the existing Permit requirement that testing need only be conducted on the outfall(s) through which DSN 48C is discharging during the sampling event. PSEG understands that the conditions expressed in the Fact Sheet clarify that only one circulating water outfall is required to be sampled during each sample event.

PSEG Proposed Clarification

PSEG requests that NJDEP confirm this understanding by adding a footnote to the appropriate permit page to clarify that the language in the Fact Sheet is controlling.

Permit Section: Permit, Part III.B through G, DSNs 481 through 486, Table III (Limits and Monitoring Requirements for the Parameter Entitled pH)

Comment

The Sampling Frequency for pH, Effluent Gross Value and Intake From Stream is stated as "1/Week" in Part III, consistent with the requirements in the current NJPDES Permit. The Fact Sheet at Part VIII, page 15 identifies that "(M)onitoring for pH is consistent with the existing permit ..." but specifies that "(M)onitoring for pH shall be performed three times per week ...." The conditions specified in Part III reflect the statement that "(M)onitoring for pH is consistent with the existing permit ..." The Fact Sheet should be modified to confirm that monitoring for pH is required to be performed only once per week.

PSEG Proposed Clarification

NJDEP should clarify in its response to comments document that the language in the Fact Sheet is incorrect and that the frequency for monitoring for pH set out in Part III.B through G (once per week) is controlling.

Permit/Fact Sheet Section: Permit, Part III.J and K, DSNs FAC A and FAC B, Table III (Limits and Monitoring Requirements for the Parameter and Sample Point Entitled Temperature °C Effluent Net Value)

Comment

PSEG believes that the Effluent Net Temperature (Differential Temperature) Sampling Frequency should be "Daily" instead of "Continuous." Part IV, Section G.13.b.iii, page 13 and the Fact Sheet, page 24 define the calculation of Differential Temperature as "... subtracting the daily intake temperature from the daily effluent temperature ... ," which reflects a sample frequency of "Daily." A Daily sampling frequency is consistent with the sampling frequency in the current NJPDES Permit.

PSEG Proposed Permit Language

The Sampling Frequency for Effluent Net Temperature (Differential Temperature) should be changed from "Continuous" to "Daily."

Permit/Fact Sheet Section: Permit, Part III.L, DSN FAC C, Table III (Limits and Monitoring Requirements for the Parameter and Sample Point Entitled Thermal Discharge, Million BTUs per Hr)

Comment

PSEG believes that the Thermal Discharge Sampling Frequency for heat expressed as MBTU/hr should be "Daily" instead of "Continuous." Part IV, Section G.13.c.ii, page 14 and the Fact Sheet, page 25 provide that the formula for the calculation of Thermal Discharge utilizes the Mass Flow Rate of Water and the Differential Temperature, parameters that are calculated Daily. A Daily sampling frequency is consistent with the sampling frequency in Salem's current NJPDES Permit.

PSEG Proposed Permit Language

The Sampling Frequency for heat in the Thermal Discharge should be changed from "Continuous" to "Daily."

Permit/Fact Sheet Section: Permit, Part III.L, DSN FAC C, Table III (Limits and Monitoring Requirements for the Parameter and Sample Point Entitled Thermal Discharge, Million BTUs per Hr)

Comment

The calculation parameter identified as "T_{int}" at Part IV, Section G.13.c.ii, page 14 and the Fact Sheet, page 25 is identified as "effluent temperature" and should be identified as "influent temperature."

PSEG Proposed Permit Language

The text of the calculation parameter identified as "T_{int}" should be modified to reflect "influent temperature."

PSEG Comments on the
Draft Permit, Part IV, and
Related Portions of the Fact Sheet

Permit Section: Permit, Part IV, E.1.e, Facility Management, Discharge Requirements

Comment

This section proposes to address the additives the Permittee is authorized to use. PSEG believes that the additives used in the steam plant and the non-radioactive liquid waste disposal system (DSN 48C) should be included in this section. PSEG recommends inclusion of a new paragraph that reflects the additives discussed in the Fact Sheet, pages 11 through 13 including ammonium hydroxide, hydrazine, and ethanolamine which are used for corrosion control in the plant steam systems, sodium hypochlorite, hydrogen peroxide, sodium hydroxide, and a coagulant aid which are used in the non-radioactive liquid waste disposal treatment system, and sodium hydroxide and sulfuric acid which are used to regenerate demineralizers.

PSEG also notes the discussion in the Fact Sheet, pages 11 through 13 does not include the treatment options presented in the correspondence dated May 30, 2000 addressed to D. Hammond of NJDEP from James Eggers of PSEG Nuclear LLC regarding the proposed installation of reverse osmosis units and/or state of the art makeup water options such as electro-deionization to supplement or replace the makeup water demineralizer system. A recommendation has been included elsewhere in these comments for incorporation of the relevant correspondence in the Administrative Record.

PSEG Proposed Permit Language

Add a new paragraph that states "Ammonium hydroxide, hydrazine, and ethanolamine are used for corrosion control in the plant steam systems. Sodium hypochlorite, hydrogen peroxide, sodium hydroxide, and a coagulant aid are used in the non radioactive liquid waste disposal treatment system. Sodium hydroxide and sulfuric acid are used to regenerate demineralizers." Alternatively, add a statement that "Additional treatment and process chemicals used are identified in the Fact Sheet."

Permit Section: Permit, Part IV, E.4.d., Facility Management, Toxicity Testing Requirements - Acute Whole Effluent Toxicity

Comment

This section proposes that Ammonia-N sampling and analysis is required on "the effluent on the day a sample is collected for WET testing." The ammonia testing required does not specify a sample type. PSEG recommends that an aliquot of the acute toxicity testing composite sample be analyzed for ammonia-N to provide a value representative of the WET sample period.

PSEG Proposed Permit Language

Add to the end of the section "The required ammonia-N analysis may be conducted on an aliquot of the acute toxicity testing composite sample."

Permit Section: Permit, Part IV, G.1.b., Custom Requirement, Intake Flow Limit and Dye Tracer Evaluation - Section 316 Special Condition.

NJDEP Draft Permit Language

As described later under item G.13. for FAC C, circulating water system intake flow is calculated as the sum of the twelve individual circulating water pump flows and reported as a monthly average in million gallons per day. The flow of each individual circulating water pump is calculated as the product of the number of operating hours for that pump for the reporting period and the flow rate for that pump. The flow rate for each individual circulating water pump shall be determined at least annually using a Rhodamine WT dye tracer evaluation ("the Tracer Evaluation"). The permittee shall continue Tracer Evaluation testing in accordance with the same schedule as in the July 20, 1994 permit. For example, if the dye tracer evaluation was performed in March 2000 under the July 20, 1994 permit, the dye tracer evaluation under this renewal permit shall be performed in March 2001. Prior to performing each annual test, the appropriate Enforcement Element must be notified regarding the use of any dye.

Comment

This section requires that the flow rate for each individual circulating water pump shall be determined at least annually using a Rhodamine WT dye tracer evaluation ("the Tracer Evaluation"). PSEG believes that NJDEP intends that the Tracer Evaluation testing required annually may be performed during any month of the calendar year, maintaining the schedule in the 1994 Permit. The example given uses dates, which could indicate that the annual tracer evaluation is required in the same month each year. Requiring the testing in a single month could create an impossibility of performance if outages, pump maintenance, or other operational conditions rendered a given pump non-operational during the month specified for testing.

PSEG Proposed Permit Language

As described later under item G.13. for FAC C, circulating water system intake flow is calculated as the sum of the twelve individual circulating water pump flows and reported as a monthly average in million gallons per day. The flow of each individual circulating water pump is calculated as the product of the number of operating hours for that pump for the reporting period and the flow rate for that pump. The flow rate for each individual circulating water pump shall be determined at least annually using a Rhodamine WT dye tracer evaluation ("the Tracer Evaluation"). The permittee shall continue Tracer Evaluation testing in accordance with the same schedule as in the July 20, 1994 permit. For example, if the dye tracer evaluation was performed in March 2000 under the July 20, 1994 permit, the dye tracer evaluation under this renewal permit shall be performed in 2001. Prior to performing each annual test, the appropriate Enforcement Element must be notified regarding the use of any dye.

PSEG Proposed Clarification

PSEG requests that NJDEP confirm that the annual Tracer Evaluation may be performed during any month of the calendar year, maintaining the schedule in the 1994 Permit. If NJDEP does not concur with PSEG's understanding and proposed permit language, a "force majeure" provision would be required to address those circumstances when compliance is impossible due to plant and equipment operational conditions.

PSEG Proposed Permit Language

G.1.c Force Majeure

i. In the event circumstances occur which PSEG reasonably believes will or may cause delay in the compliance with Specific Requirement G.1.b, PSEG shall notify the Department in writing within ten (10) calendar days of the delay or anticipated delay, as appropriate, referencing this paragraph and describing the anticipated length of the delay, the precise cause or causes of the delay, any measures taken or to be taken to minimize the delay, and the time required to take any such measures to prevent or minimize any such delay. PSEG shall take necessary actions to prevent or minimize any such delay.

ii. If the Department finds that: (a) PSEG has complied with the notice requirements of paragraph (i) above; and (b) that any delay or anticipated delay has been or will be caused by other circumstance(s) reasonably beyond the control of PSEG; and (c) that PSEG has taken necessary actions to prevent or minimize the delay, the Department shall extend the time for performance for a period no longer than the delay resulting from such circumstances. If the Department determines that PSEG has not complied with the notice requirements of the preceding paragraph, or the event causing the delay is not reasonably beyond the control of PSEG, or PSEG has not taken necessary actions to prevent or minimize the delay, this paragraph shall not be applicable and such failure to comply with Specific Requirement G.1.b shall constitute a violation of the terms and conditions of this permit.

Permit/Fact Sheet Section: Permit, Part IV, G.2.a; Fact Sheet, pages 8, 32-33 (Intake Screens and Fish Return System - Section 316 Special Condition).

NJDEP Draft Permit Language

a. The permittee shall ensure proper operation and maintenance of its Ristroph Traveling Screens at all times to minimize impingement effects on aquatic life. The permittee shall conduct semi-annual training of its employees operating the screens to ensure awareness of the function of the screens in reducing mortality of aquatic life. The permittee must provide upon the Department's request any material in this training at any time to ensure that it is appropriate and comprehensive.

Comment

PSEG requests that the Department make the training requirement "annual" instead of "semi-annual" to be consistent with the other training requirements for the individuals at the Station that will perform the work.

PSEG Proposed Permit Language

b. The permittee shall ensure proper operation and maintenance of its Ristroph Traveling Screens at all times to minimize impingement effects on aquatic life. The permittee shall conduct annual training of its employees operating the screens to ensure awareness of the function of the screens in reducing mortality of aquatic life. The permittee must provide upon the Department's request any material in this training at any time to ensure that it is appropriate and comprehensive.

Permit/Fact Sheet Section: Permit, Part IV, G.2.b; Fact Sheet, page 8, 32-33 (Intake Screens and Fish Return System - Section 316 Special Condition).

NJDEP Draft Permit Language

b. Further Study and Enhancements

i. Fish mortality of the fish return system shall be evaluated independently from the Ristroph screens to determine mortality rates as fish re-enter the estuary. In addition, impingement mortalities associated with the fish sampling pool shall be further investigated including a comparison of flow velocities for the fish return sluice versus the impingement sampling sluice. The permittee shall submit a ranking of best to worst (i.e., most vulnerable or frail) Representative Important Species (RIS) for which the Ristroph traveling screens are most effective at minimizing mortality.

ii. Based on the results of i., the permittee shall submit a proposed study and/or redesign of the fish return sluice and sampling pool where a biologist with expertise in the area of fish behavior shall specify flows, velocities, and depth profiles to minimize mortalities. Emphasis should be placed on reducing potential mortality of susceptible species.

iii. PSEG shall submit the findings and study to the Department regarding G.2.b.i. and G.2.b.ii. above. Submit the special report: within 180 days from the effective date of the permit (EDP).

iv. Based on these findings, the Department may impose new requirements and impose an installation schedule of a modified fish return sluice and/or sampling pool. Any such requirements will be incorporated as a minor modification to the NJPDES permit.

Comment

PSEG has concerns with some of the conditions detailed in Section G.2.b.i – iv. The observations in ESSA Technologies Ltd.'s "Review of Portions of New Jersey Pollutant Discharge Elimination System (NJPDES) Renewal Application for the Public Service Electric & Gas' (PSE&G) Salem Generating Station" (June 14, 2000) (hereafter, "ESSA Report") regarding possible enhancements to the fish return, are predicated on a misunderstanding of system operation and therefore, are erroneous. As explained in Section V.B.3 of PSEG's Response to the ESSA Report, the trauma and stress hypothesized by ESSA would not be experienced, and sampling fish at the point of discharge as ESSA suggests would be very difficult, if not impossible, given site-specific factors. Moreover, the results obtained would, in all likelihood, have the same uncertainties associated with the existing sampling system. It is premature to impose a requirement to redesign the fish return sluice prior to evaluating the study data.

PSEG also is concerned with the schedule required per Section 2.b.iii. PSEG can not propose a study design that is adequate to collect data on possible system enhancements for species and life stages of concern and conduct the studies within the schedule defined in the Draft Permit. PSEG is recommending an alternative that is predicated on its preparing a work plan that would include acceptance criteria to assure technically defensible and cost-effective actions.

PSEG Proposed Permit Language

b. Further Study and Enhancements.

i. The permittee shall submit a ranking of best to worst (i.e., most vulnerable or frail) Representative Important Species (RIS) for which the Ristroph traveling screens are most effective at minimizing mortality. In addition, impingement mortalities associated with the fish sampling pool shall be further investigated including an assessment of flow velocities and/or volume on fish survival for the fish return sluice.

ii. Based on the results of G.2.b.i, the permittee shall submit a proposed work plan for a study to determine ways to minimize the stresses associated with the fish return sluice and sampling pool. Emphasis should be placed on reducing potential mortality of susceptible species.

iii. PSEG shall submit the findings per G.2.b.i to the Department within 180 days of the effective date of the permit (EDP) and the proposed work plan required in G.2.b.ii within EDP + 270 days.

iv. Based on these findings, the Department may impose new requirements and impose an installation schedule of a modified fish return sluice and/or sampling pool. Any such requirements will be incorporated as a minor modification to the NJPDES permit.

v. It is important to note that the Department is committed to requiring implementation of any cost-effective alternate intake protection technologies that will minimize impingement and/or entrainment effects based on the results of these studies.

Permit Section: Permit, Part IV, G.3.c.i., Management Plans

NJDEP Draft Permit Language

i. restore an aggregate of no less than 10,000 acres of (1) diked wetlands (including salt hay farms, muskrat impoundments and/or agricultural impoundments) to normal daily tidal inundation so as to become functional salt marsh; and/or (2) wetlands dominated by common reed (Phragmites australis) to primarily Spartina species with other naturally occurring marsh grasses (i.e., Distichilis spicata, Juncus spp.); and/or (3) upland buffer. The permittee shall secure access to or control of such lands so as to have title ownership or deed restriction as may be necessary to assure the continued protection of said lands from development.

Comment

PSEG believes restricting the natural marsh grasses to be restored to just Distichilis spicata and Juncus spp. by the use of the abbreviation "i.e.," is not warranted, realistic, or do we believe intended by the Department. PSEG suggests using the abbreviation "e.g." to allow for the restoration of these species and other natural grasses.

PSEG Proposed Permit Language

i. restore an aggregate of no less than 10,000 acres of (1) diked wetlands (including salt hay farms, muskrat impoundments and/or agricultural impoundments) to normal daily tidal inundation so as to become functional salt marsh; and/or (2) wetlands dominated by common reed (Phragmites australis) to primarily Spartina species with other naturally occurring marsh grasses (e.g. Distichilis spicata, Juncus spp.); and/or (3) upland buffer. The permittee shall secure access to or control of such lands so as to have title ownership or deed restriction as may be necessary to assure the continued protection of said lands from development.

Permit Section: Permit, Part IV, G.3.c.ii., Management Plans

NJDEP Draft Permit Language

ii. Management Plans – The permittee shall design and file Management Plan(s) for any replacement acreage acquired under G.3.c. not later than 1 year after securing control of such lands. Contemporaneous with the submission of a Management Plan to the Department, the permittee shall provide copies of said Plan to the County library in the affected County. The permittee shall publicly notice the time and place that the Management Plan is available for review in a daily or weekly newspaper circulated in the affected County. Within 60 days of the Department's approval of the Management Plan(s), the permittee shall implement the Management Plan(s). Not later than EDP + 3 years, the permittee shall complete implementation of the Management Plan. The permittee must continue to implement the Management Plan(s) with respect to maintenance during any period of time the NJPDES permit is extended, including any lands that have met the success criteria.

Comment

PSEG contends that any requirement for completion of implementation of any Management Plan for replacement acreage, if any, cannot be tied to the effective date of the Permit. As the Department has indicated in the Fact Sheet, page 42), all restoration sites are presently in compliance with the success criteria. Moreover, any determination of failed acreage can only be made consistent with the NJDEP approved success criteria established in the Management Plans for the wetlands restoration sites and after appropriate implementation of Adaptive Management. Should a determination be made at some point in the future that "replacement acreage is necessary," PSEG would develop a schedule for implementation of the associated Management Plan for review by the EEPAC and approval of the NJDEP.

PSEG Proposed Permit Language

ii. Management Plans – The permittee shall design and file Management Plan(s) for any replacement acreage acquired under G.3.c. not later than 1 year after securing control of such lands. Contemporaneous with the submission of a Management Plan to the Department, the permittee shall provide copies of said Plan to the County library in the affected County. The permittee shall publicly notice the time and place that the Management Plan is available for review in a daily or weekly newspaper circulated in the affected County. Within 60 days of the Department's approval of the Management Plan(s), the permittee shall initiate implementation of the Management Plan(s). The permittee shall complete implementation of the Management Plan consistent with the schedule approved by the NJDEP and included in the Management Plan. The permittee must continue to implement the Management Plan(s) with respect to maintenance during any period of time the NJPDES permit is extended, including any lands that have met the success criteria.

Fact Sheet Section: Fact Sheet, Page 40, Compliance with Interim Vegetative Criteria and Final Success Criteria in Management Plans for Dennis, MRT, Commercial, Alloways, Cohansey and Delaware Sites.

Comment

The Interim Vegetative Criteria dates and the Final Success Criteria dates within the Fact Sheet are incorrect.

Proposed Clarification

To the extent the Department concurs with PSEG's comment, PSEG requests that the Department acknowledge the correct dates in the response to comment document issued with the final permit, as follows:

	Completion of Restoration Implementation Action	Interim Vegetative Criteria[1]	Final Success Criteria[1]
MRT	March 1998	October 2004	October 2009
Dennis	October 1996	October 2003	October 2008
Commercial	November 1997	October 2004	October 2009
Alloways	September 1999	October 2005	October 2011
Cohansey	September 1999	October 2005	October 2011
The Rocks	June 2000	October 2005	October 2011
Cedar Swamp	June 2000	October 2005	October 2011

[1]Criteria dates correspond with the end of the growing season of the appropriate year. The interim criteria at the salt hay farms are measured following a two-year lag period and five growing seasons. The interim criteria at the Phragmites-dominated sites are measured following a one-year lag and five growing seasons. The final success criteria at the salt hay farms are measured following a two-year lag period and twelve growing seasons. The final success criteria at the

Phragmites dominated sites are measured following a one-year lag period and twelve growing seasons. Data reports and evaluations are not required until June 30 of the year following the year in which data is collected. For example, at the MRT site, the results of the October 2004 interim criteria will not be submitted until June 30, 2005.

Fact Sheet Section: Fact Sheet, Page 40 (references Table 2, presented in the List of Tables, Figures, and Maps)

Comment

The vegetative criteria for the Alloway Creek Watershed Wetland Restoration Site in Table 2 are incorrect.

Proposed Clarification

To the extent that the Department concurs with PSEG's comment, PSEG respectfully requests that the Department acknowledge same in the response to comment document issued with the final permit, as follows:

Table 2 – Status of Vegetative Cover for Wetland Restoration Sites (as of 1999)

***Phragmites*-dominated Wetland Restoration Sites**

	The Rocks	Cedar Swamp	Cohansey	Alloways
Desirable Vegetation without *Phragmites*	74%	40%	57.8%	26.6%
Desirable Vegetation with *Phragmites*	6%	24%	3.8%	12.9%
Phragmites-dominated Vegetation	11.1%	11.3%	10.1%	37.4%
Non-Vegetated Marsh Plain	5.6%	17.2%	20.4%	11.5%
Internal Water Areas	3.5%	7.5%	6.6%	11.3%
Open Water	0%	0%	1.2%	0.3%

Fact Sheet Section: Fact Sheet, Page 40, Herbicide Use with Respect to *Phragmites*-Dominated Sites.

Comment

The characterization that the Department "...settled on an approach which uses glyphosate application followed by a prescribed burn of the sprayed area" is not entirely correct. Since 1997, the permittee in cooperation with the Department has restricted the use of herbicides while developing a test area program to determine whether other methods for treating *Phragmites* are effective. Herbicide use since 1997 at the *Phragmites*-dominated restoration sites was less than that which should have been applied to achieve initial control. PSEG in cooperation with the Department chose to reduce herbicide application while awaiting results of the test area program. In fact, the test area program has been an integral part of the *Phragmites* restoration program. It has been reviewed by both the Department and the Management Plan Advisory Committee ("MPAC") and is part of the Department-approved Management Plan for the Alloway Creek Watershed restoration site.

There have been no prescribed burns at any of the sites since 1997.

Proposed Clarification

PSEG requests that NJDEP include the following language in its response to comments on the Draft Permit:

Natural resource agencies with years of experience in attempting to eradicate *Phragmites* have come to regard the application of the herbicide, glyphosate (the active ingredient of Rodeo®), as one of the most effective means to eradicate *Phragmites*. Glyphosate is registered by the United States Environmental Protection Agency for use in an aquatic environment. After a careful and comprehensive review, the Department initially agreed on an approach, which uses glyphosate application followed by a prescribed burn of the sprayed area. While the Department approved a follow-up application of glyphosate, it is not intended to be a program of open-ended, perpetual herbicide application. The Department has supported PSEG's development of a test area program to evaluate alternative treatment methods for *Phragmites* control. The test area program is an integral part of PSEG's continuing efforts to restore *Phragmites*-dominated marshes. The Department continues to encourage minimization of the use of glyphosate on wetland restoration sites. The Department's goal is for native wetland vegetation such as *Spartina alterniflora* to outcompete *Phragmites*.

Permit/Fact Sheet Section: Fact Sheet, Page 42, Department's Determination Regarding Wetland Restoration Efforts and Oversight and Proposed Permit Conditions

Comment

The Total Acreage Creditable Towards Permit for the Commercial Upland Buffer should be "113" instead of the "123" listed in the Fact Sheet.

In addition, PSEG disagrees with the Department's decision to grant credit for the Cohansey River Watershed site at a 2:1 ratio. As demonstrated in G-2-17 of the March 1999, NJPDES Permit Application, *Phragmites* has expanded rapidly across many marsh areas in the less saline environments of the Delaware estuary. At the Cohansey River Watershed Site, *Phragmites* increased from 40.9 acres in 1962 to 420 acres in 1996 (see Table 1, G-2-17 of the Application). The expansion represents a ten-fold increase in *Phragmites* over approximately 30 years.

As detailed in G-2-6, *Phragmites* is an invasive plant that can adapt to a wide range of habitats. *Phragmites* has the ability to alter its own habitat to reduce stress and provide for its own expansion. Its dense culms and thick litter layer can act to slow water and enhance sediment deposition, increasing the elevations of the marsh plain and providing for a habitat conducive for its own growth and expansion. In addition, the ability of the plant to facilitate the movement of oxygen to rhizomes in anoxic environments further enhances its ability to rapidly expand within the marsh plain.

While *Phragmites* occupied 45% of the marsh plain in 1996, it is probable that it would have continued to expand rapidly throughout the marsh plain. Using the same rate of expansion occurring from 1962 to 1996 (7.3%/year), approximately 2/3 of the marsh plain would have been dominated by *Phragmites* vegetation in 2001 without treatment by PSEG. The rapid shift towards increased *Phragmites* coverage at the site was thwarted because of PSEG's restoration efforts. Had no restoration activities been undertaken, the progression towards an increased quantity of *Phragmites* would have continued. Subsequently, habitat losses would have mounted and the contribution of the site to the fishery resources of the Delaware Bay would have diminished. Given the documented biological and physiological ability of the plant to expand and the rapid expansion documented at the site, PSEG believes that full credit for the site is appropriate.

Proposed Clarification

To the extent that the Department concurs with PSEG's comment, PSEG requests that the Department acknowledge same in the response to comments document issued with the final permit, as follows:

The Department has determined that at the present time, the requirements pertaining to land acquisition and development have been met. The Department has determined that the following acreage is currently creditable towards the permit requirements:

Site	Total Acreage	Total Acreage Creditable Towards Permit
Alloways: Wetlands	2813	2813
Alloways: Upland Buffer	220	73.33
Cohansey: Wetlands	910	910
Cohansey: Upland Buffer	145	48.33
Dennis: Wetlands	369	369
Dennis: Upland Buffer	15	5
MRT: Wetlands	1135	1135
MRT: Upland Buffer	108	36
Commercial: Wetlands	2894	2894
Commercial: Upland Buffer	339	113
Bayside Tract: Wetlands	2585	0
Bayside Tract: Upland Buffer	1822	607.33
The Rocks and **Cedar Swamp**	2599	2000
Other Delaware Sites	1739	0
TOTAL	17693 acres	11,004 acres
Other Lands Within Site Boundaries	1374	
Other DNREC Lands	1452	
	20,520 acres	

The Department is hereby requiring the permittee to continue in its wetland restoration efforts as dictated in the Management Plans for each site.

Permit Section: Permit, Part IV, G.3.d, Establishment of the EEPOC-Section 316 Special Condition

NJDEP Draft Permit Language

d. Establishment of the EEPOC - The permittee shall establish an Estuary Enhancement Oversight Committee (EEPOC) to serve as a body to provide technical advice to the permittee concerning any continuing implementation of the existing Management Plans as well as the development and implementation of any future Management Plans for replacement acreage that may be needed. The EEPOC shall also provide technical advice concerning the design, implementation, modifications and interpretation of the Biological Monitoring Program (as described later under item

G.6). Any future Management Plans(s) as well as any changes to the Biological Monitoring Program must be submitted to the EEPOC for technical advice prior to submission to the Department for approval. All materials presented at any EEPOC meetings shall be distributed to EEPOC members at least one week in advance of any meeting.

i. The permittee shall request, subject to the Department's approval, members of the EEPOC to consist of representatives from at least three agencies having jurisdiction over wetland restoration activities and/or aquatic resources (a minimum of one representative from each agency); a minimum of two scientists with appropriate wetlands expertise; a minimum of three scientists with appropriate expertise in aquatic resources; and representatives from Cape May, Cumberland and Salem Counties (as appointed by the governments of Cape May, Cumberland and Salem Counties). The Department shall designate two representatives from its Division of Fish and Wildlife as well as a representative from its Mosquito Control Commission. The permittee shall designate a representative to serve on the EEPOC and to serve as the EEPOC's chair.

ii. A complete list of EEPOC members shall be submitted to the Department for approval. Comply with the requirement: within 90 days from the effective date of the permit (EDP).

iii. The EEPOC shall meet at least twice per year where at least one meeting shall include a tour of some or all of the wetland restoration sites. Upon finalization of this permit, all references to the "MPAC" and "MAC" in any documentation required under the July 20, 1994 permit, or incorporated therein by reference, shall be interpreted to mean "EEPOC."

Comment

Based on the language in the Fact Sheet, page 42, PSEG understands that the NJDEP is proposing by Specific Requirement G.3.d. to merge the existing advisory committees into a single committee. Since the proposed language states that the combined committee's purpose is ". . . to provide technical advice to the permittee . . . ," PSEG requests that the Department change the name of the Committee to the Estuary Enhancement Program Advisory Committee ("EEPAC") to be more reflective of the Committee's intended role as an advisory body.

PSEG Proposed Permit Language

d. Establishment of the EEPAC - The permittee shall establish an Estuary Enhancement Program Advisory Committee (EEPAC) to serve as a body to provide technical advice to the permittee concerning any continuing implementation of the existing Management Plans as well as the development and implementation of any future Management Plans for replacement acreage that may be needed. The EEPAC shall also provide technical advice concerning the design, implementation, modifications and interpretation of the Biological Monitoring Program (as described later under item G.6). Any future Management Plans(s) as well as any changes to the Biological Monitoring Program must be submitted to the EEPAC for technical advice prior to submission to the Department for approval. Materials to be presented at any EEPAC meetings shall be distributed to EEPAC members at least one week in advance of any meeting.

i. The permittee shall request, subject to the Department's approval, members of the EEPAC to consist of representatives from at least three agencies having jurisdiction over wetland restoration activities and/or aquatic resources (a minimum of one representative from each agency); a minimum of two scientists with appropriate wetlands expertise; a minimum of three scientists with appropriate expertise in aquatic resources; and representatives from Cape May, Cumberland and Salem Counties (as appointed by the governments of Cape May, Cumberland and Salem Counties). The Department shall designate two representatives from its Division of Fish and Wildlife as well as a representative from its Mosquito Control Commission. The permittee shall designate a representative to serve on the EEPAC and to serve as the EEPAC's chair.

ii. A complete list of EEPAC members shall be submitted to the Department for approval. The permittee shall comply with this requirement within 90 days from the effective date of the permit (EDP).

iii. The EEPAC shall meet at least twice per year; at least one meeting shall include a tour of some or all of the wetland restoration sites. Upon finalization of this permit, all references to the "MPAC" and "MAC" in any documentation required under the July 20, 1994 permit, or incorporated therein by reference, shall be interpreted to mean "EEPAC."

Fact Sheet Section: Fact Sheet, Page 37, Compliance with Special Condition 3: Wetlands Restoration and Enhancement Efforts

Comment

- Dr. Shisler's company affiliation is incorrectly stated and should be replaced with "...Environmental Consultants, Inc."

- The current MPAC includes a representative from USEPA Region II, Mario DelVeccario.

Proposed Clarification

PSEG requests that the NJDEP acknowledge Dr. Shissler's appropriate affiliation and USEPA Region II's participation in the MPAC in the response to comments issued with the final permit.

Fact Sheet Section: Fact Sheet, Page 51, Compliance with Special Condition 6: Biological Monitoring

Comment

This paragraph identifies certain of the agencies and independent scientists participating on the current MAC, in the context of their role in reviewing the BMWP. PSEG notes the following misstatements:

- the Delaware River Basin Commission ("DRBC") is a member of the MAC;

- the Biological Monitoring Work Plan should be abbreviated as "BMWP";

- the Biological Monitoring Work Plan is noted as having been "...approved..." by the MAC. The 1994 Permit established the MAC to provide technical advice to PSEG; only the NJDEP has authority to approve the BMWP.

Proposed Clarification

PSEG requests that the Department acknowledge these clarifications in the response to comment document issued with the final permit.

Fact Sheet Section: Fact Sheet, page 52, Department's Determination and Contractor Review Regarding Entrainment and Impingement Abundance Monitoring

Comment

The bottom paragraph states that the BMWP will be "approved" by the EEPOC. Since the EEPOC is a continuation of the existing MAC and since G.3.d proposes to establish the EEPOC to ". . . provide technical advice" to PSEG. PSEG contends that only the Department has the authority to approve the BMWP. This is also consistent with the Fact Sheet, page 54.

Proposed Clarification

PSEG requests that the NJDEP acknowledge in its response to comments that the language of G.3.d is controlling and that only the Department has authority to approve the BMWP.

Permit/Fact Sheet Section: Permit, Part IV, G.4.a., Fish Ladders - Section 316 Special Condition, Fact Sheet Pages 43-46

NJDEP Draft Permit Language

The permittee has installed eight fish ladders under terms of the July 20, 1994 permit. The locations for these fish ladders are as follows: Sunset Lake, NJ; McGinnis Pond, DE; McColley's Pond, DE; Silver Lake, DE; Coursey's Pond, DE; Cooper River, NJ; Garrisons Lake, DE and Moores Lake, DE. The permittee shall operate and maintain these fish ladders in accordance with the developed Operations and Maintenance Manuals. Routine maintenance and inspections shall be performed to ensure that the ladders are operating as designed. Inspection reports prepared as part of routine operations and maintenance shall be make available to the Department upon request.

Comment

The Permit Specific Requirement and the Fact Sheet are correct in stating that PSEG has installed eight fish ladders; however, only five of these fish ladders were installed as requirements of the July 20, 1994 Permit. The three fish ladders at Coursey's Pond, DE; Garrison's Lake, DE; and Moores Lake, DE were installed under the provisions of a settlement agreement with the Delaware

Department of Natural Resources and Environmental Control[1] and are not subject to the terms and conditions of the 1994 Permit.

In addition, the July 20, 1994 Permit required PSEG to conduct operational and maintenance activities of the five installed fish ladders during the term of the Permit and during any period of the time the Permit is extended pursuant to N.J.A.C. 7:14A-2.3. PSEG has complied and continues to comply with this Permit condition. PSEG has developed Operational and Maintenance Manuals for the installed fish ladders and has arranged for long-term operation and maintenance of these ladders to be conducted by the respective owner of each facility, with the exception of Sunset Lake. As the NJDEP has noted in the Fact Sheet, page 49, "As part of PSE&G's settlement with DNREC, it was agreed that after completion of the construction of the ladders in Delaware, DNREC would manage and maintain the ladders." The settlement agreement also provided DNREC with necessary funding for this maintenance responsibility.[2]

In New Jersey, a signed agreement between PSEG and the Camden County Department of Parks (CCDP) transfers the responsibility of maintenance of the Cooper River Lake fish ladder to the CCDP. This agreement appears as Section 3 of the site specific Operation and Maintenance Manual.

For the Sunset Lake fish ladder, no long-term maintenance agreement exists with the City of Bridgeton. PSEG acknowledges its responsibility for the maintenance of this fish ladder, and intends to continue to perform this activity.

The permit condition requiring PSEG to conduct routine maintenance and inspection of each facility is unnecessary and should be deleted from the Draft Permit. Furthermore, PSEG does not have the necessary legal authority to conduct long-term maintenance activities on property owned by others.

<u>PSEG Proposed Permit Language</u>

a. The permittee has installed eight fish ladders (five under the terms of the July 20, 1994 permit). The locations for these fish ladders are as follows: Sunset Lake, NJ; McGinnis Pond, DE; McColley's Pond, DE; Silver Lake, DE; Coursey's Pond, DE; Garrison's Lake, DE; Moore's Lake, DE; and Cooper River, NJ. The permittee shall provide formal notification to the ladder owner of any maintenance

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1 Settlement Agreement between PSEG and DNREC (March 23, 1995) (hereinafter, "DNREC Settlement").

2 Per Memorandum of Agreement dated July 1, 1999, based upon DNREC Spend-Down Plan dated January 29, 1999, approximately $145,000 of the escrow fund was placed in a sub-account of the Delaware Marsh Management Trust to aid DNREC in "long term management and maintenance costs for these structures."

issues identified during the routine inspections. Routine inspections during the upstream adult migration period shall be performed to ensure that the ladders are operating as designed. Documentation concerning inspections and any maintenance issues shall be made available to the Department upon request.

Permit/Fact Sheet Section: Permit, Part IV, G.4.b., Fish Ladders - Section 316 Special Condition, Fact Sheet, page 45-46

NJDEP Draft Permit Language

The permittee shall continue to perform juvenile and adult passage of river herring in connection with the fish ladder sites where the monitoring results shall be included in the annual Biological Monitoring Program Report as required under G.6.a.iv.

Comment

Draft Permit Specific Requirement G.4.b, as presently worded, appears to be an incomplete statement. If the proposed permit condition is intended to require the permittee to perform monitoring of juvenile passage, this is not a continuance of present activities; it would be a significant expansion to the present fish ladder monitoring program. Furthermore, as discussed during the June 2000 MAC meeting, monitoring for emigrating juvenile river herring at the fish ladder installations prior to successful establishment of an adult spawning run is premature and may result in additional mortality to the emigrating juveniles.

The permit condition should also be clarified to state that continued monitoring of upstream migrating adults will be required and that monitoring of emigrating juveniles may be required in the future in accordance with the provisions of Special Condition G.6.a and an approved BMWP.

For the record, PSEG would also like to correct one number provided in Table 3B to the Fact Sheet. The summary data contained within this table was provided by PSEG on June 13, 2000 (Letter from J. H. Balletto to S. T. Rosenwinkel). As indicated in PSEG's summary table, the number of river herring adults counted as passing up the McGinnis Pond fish ladder during 1999 should be 48 instead of 45. The NJDEP has properly noted that the 2000 data contained with Table 3B is preliminary and may be subject to minor revisions; however, the 1999 data is final and is contained with the Biological Monitoring Program 1999 Annual Report.

PSEG Proposed Permit Language

b. The permittee shall continue to perform monitoring of adult passage of river herring at the five fish ladder sites installed under the terms of the July 20, 1994 permit and the three additional fish ladder sites in Delaware where the monitoring results shall be included in the annual Biological Monitoring Program Report as required under G.6.a.iv.

Permit/Fact Sheet Section: **Permit, Part IV, G.4.c., Fish Ladders - Section 316 Special Condition, Fact Sheet, page 46**

NJDEP Draft Permit Language

The permittee shall continue to stock any impoundments until such time as the number of adults using the ladder meets the minimum number of adults calculated per acre for the minimum production of juveniles (1005/acre).

Comment

Draft Permit Specific Requirement G.4.c. incorrectly implies that the number of juvenile herring to be produced in an impoundment can be predicted based on the number of upstream migrating adults entering each impoundment. This permit condition should be changed to reflect the available scientific data concerning the re-establishment of river herring spawning runs.

As stated in the PSEG Application (Application Appendix G, Attachment G-5, p. 53-54), the relationship between juvenile abundance and the number of spawning females is highly variable and unpredictable. Various relationships between juvenile abundance and spawning stock size and between juvenile abundance and adult returns have been reported (Havey 1973; Walton 1987; Jessop 1990a, b). Parent-progeny relationships have been demonstrated (Havey 1973), but they vary widely at different spawning escapement levels (Jessop 1990a). Juvenile production is density-dependent above certain escapement levels. For example, Walton (1987) presents data for Damariscotta Lake in Maine, where he calculated that the alewife run is supported by the escapement of 0.53 females per acre. Also, Jessop (1990b) found no significant relationship between an index of juvenile abundance and spawning stock size for alewife and blueback that migrated upstream past the Mactaquac. The wide range of juvenile recruits per spawner reported in the literature demonstrates the influence of other factors in determining juvenile production.

Juvenile abundance and impoundment size is a better representation of production because it is less variable than the relationship between juvenile abundance and the number of spawning females (Application Appendix G, Attachment G-5, Table 19). The permit condition should be re-written to require stocking only until such time as a minimum of five adult herring per acre of impoundment successfully complete upstream migration into each impoundment[3].

PSEG Proposed Permit Language

c. The permittee shall continue to stock the eight fish ladders installed until at least five adult herring per acre of impoundment successfully complete upstream migration into each impoundment.

Permit/Fact Sheet Section: Permit, Part IV, G.5.a., Further Study of Intake Protection Technologies - Section 316 Special Condition; Fact Sheet, pages 46-50, 67-70

NJDEP Draft Permit Language

a. Multi-Sensory Hybrid Intake Protection Technology: PSEG shall study the feasibility of: 1) strobe light technology; 2) air bubble technology; 3) sound deterrent; 4) light attraction technologies such as mercury vapor light coupled with enhancements to the fish return system (e.g. fish pumps) to allow the fish to be returned to the estuary. These technologies shall be studied individually as well as in various combinations as a hybrid system. The objective of this study is to minimize impacts to those species that do not survive well off the intake traveling screens as well as those species that are most affected by Salem's operations (as indicated by Conditional Mortality Rates). The concerns and limitations documented by ESSA in its report for the 1994 Cage Tests; 1998 Cage Tests; and the in-situ tests shall be considered in the development of any Plan of Study with regard to any sound deterrent technologies. Also related to sound deterrents, far field attraction behavior or potential acclimation shall also be studied. Given these requirements, the permittee shall:

   i. Present a Plan of Study regarding the above technologies to the Department. Submit a description of planned activities: within 180 days from the effective date of the permit (EDP).

   ii. Not later than sixty days after receipt of the Department's approval of the Plan of Study, PSEG shall implement the

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3 As NJDEP has noted in the Fact Sheet, page 45, "The goal of the program was to achieve a total movement of at least five adult river herring per acre into each impoundment. "

Plan of Study in accordance with the schedule approved by the Department, subject to species availability.

iii. Not later than EDP + 36 months, PSEG shall complete the Study and file a report of the results to the Department in accordance with a schedule approved by the Department.

Comment

PSEG has concerns with some of the conditions detailed in Section G.5.a.i – iii of the Permit and the related sections of the Fact Sheet. Specifically, PSEG's concerns relate to the sound deterrent study, light attraction technologies, and the schedule for completion of the work. PSEG has provided extensive comment on the sound deterrent studies and the light attraction technologies in Section V. C and V. E. of the PSEG Response to the ESSA Report. PSEG contends that the light attraction technology should not be the subject of further study at Salem at the present time because there have been no studies conducted with full-scale light/pump systems for the RIS at Salem and the few studies cited by ESSA have limited application to Salem. Furthermore, it is unlikely that the light/pumping system would be biologically effective, reduce losses, or be feasible at Salem, particularly from a cost-benefit perspective (see PSEG's Response to ESSA Report, Section V.E.1.a.).

PSEG concurs that the technologies should be assessed collectively as a "system" that includes the existing Ristroph screens. However, PSEG is concerned with the schedule required per Section 5.a.iii. It may be impossible to implement a valid study within the time frame proposed in the draft permit, given the interannual variations in species presence and abundance in the vicinity of the Salem CWIS.

In summary, PSEG believes there is merit to assessing additional fish deterrent technologies presented in the Draft Permit. However, for the reasons stated, PSEG believes this condition should be modified as per PSEG's proposed permit language in order to meet the study objectives (i.e., meaningful results within a practicable timeframe).

PSEG Proposed Permit Language

5. Further Study of Intake Protection Technologies – Section 316 Special Condition.

   a. Multi-Sensory Hybrid Intake Protection Technology: PSEG shall study the feasibility of: 1) strobe light technology; 2) air bubble technology; and, 3) sound deterrent. These technologies shall be studied individually as well as in various combinations as a hybrid system. The objective of this study is to minimize impacts to those species that do not survive well off the intake traveling screens as well as those species that are most affected by Salem's operations (as indicated by Conditional Mortality Rates). The concerns and limitations documented by ESSA in its report for the 1994 Cage Tests; 1998 Cage Tests; and the in-situ tests shall be considered in the development of any Plan of Study with regard to any sound deterrent technologies. Given these requirements, the permittee shall:

i. Present a Plan of Study regarding the above technologies to the Department. Submit a description of planned activities: within 180 days from the effective date of the permit (EDP).

ii. Not later than sixty days after receipt of the Department's approval of the Plan of Study, PSEG shall implement the Plan of Study in accordance with the schedule approved by the Department, subject to species availability.

iii. PSEG shall complete the Study identified in 5.a.ii and file a report of the results to the Department in accordance with a schedule approved by the Department in the Plan of Study.

<u>Permit Section</u>: Permit, Part IV, G.5.b., Intake Screens and Fish Return System – Section 316 Special Condition

<u>NJDEP Draft Permit Language</u>

b. It is important to note that the Department is committed to requiring implementation of any cost-effective alternate intake protection technologies that will minimize impingement and/or entrainment effects based on the results of these studies.

<u>Comment</u>

PSEG supports NJDEP's position and would subject any promising multi-sensory hybrid technology determined to be available for application at Salem to the same detailed evaluation and cost-benefit analysis applied to the other technology alternatives presented in Appendix F (Application Appendix F).

<u>Permit/Fact Sheet Section</u>: Permit, Part IV, G.6.a., Biological Monitoring Program – Section 316 Special Condition; Fact Sheet, pages 50-57

<u>NJDEP Draft Permit Language</u>

a. The permittee shall develop and implement an improved biological monitoring program under this renewal permit. This biological monitoring program shall include, at a minimum: continued abundance monitoring for adult and juvenile passage of river herring as well as stocking in connection with fish ladder sites; improved impingement and entrainment monitoring; review and discussion as to the appropriateness of the representative important species; improved bay-wide abundance monitoring; continued detrital production monitoring (including vegetative cover mapping, quantitative field sampling and geomorphology); continued study of the fish utilization of restored wetlands; and other special monitoring studies as may be required by the Department and/or recommended by the EEPOC. Additional special studies could include residual pesticide release monitoring for any replacement acreage deemed necessary under item G.3.c where details of this monitoring is described in Part IV of the July 20, 1994 permit. Until such time as an improved Biological Monitoring Program is developed and approved, the permittee shall continue in its monitoring efforts as specified in the existing (at the time of this renewal permit issuance) Biological Monitoring Program.

<u>Comment</u>

PSEG presented an improved Biological Monitoring Program ("BMP") at the Monitoring Advisory Committee ("MAC") meeting held on June 22, 2000. The proposed improvements to the program included increased impingement, entrainment, and bay-wide abundance monitoring. With the establishment of the EEPAC, PSEG anticipates submitting an improved BMP for review. Clarification as to the precise role of the EEPAC is provided in PSEG's comments to Special Condition G.3.d.

In addition, the requirement within Special Condition G.6.a for monitoring juvenile herring abundance as a component of fish ladder monitoring is addressed in PSEG's comments to Special Condition G.4.c. PSEG disagrees that monitoring of juvenile river herring passage should be specified in the permit as a requirement for an improved BMP.

PSEG Proposed Permit Language

a. The permittee shall develop and implement an improved biological monitoring program under this renewal permit. This biological monitoring program shall include, at a minimum: continued abundance monitoring for adult passage of river herring as well as stocking in connection with the eight fish ladder sites; improved impingement and entrainment monitoring; review and discussion as to the appropriateness of the representative important species; improved bay-wide abundance monitoring; continued detrital production monitoring (including vegetative cover mapping, quantitative field sampling and geomorphology); continued study of the fish utilization of restored wetlands; and other special monitoring studies as may be recommended by the EEPAC and/or the Department and subsequently required by the Department. Additional special studies could include residual pesticide release monitoring for any replacement acreage deemed necessary under item G.3.c where details of this monitoring is described in Part IV of the July 20, 1994 permit. Until such time as an improved Biological Monitoring Program is developed and approved, the permittee shall continue in its monitoring efforts as specified in the existing (at the time of this renewal permit issuance) Biological Monitoring Program.

Permit/Fact Sheet Section: Permit, Part IV, G.6.a.i., Biological Monitoring Program – Section 316 Special Condition; Fact Sheet, pages 50-57

NJDEP Draft Permit Language

i. As described previously under G.3.d, the EEPOC shall provide oversight and advice regarding any improved Biological Monitoring Program. An improved Biological Monitoring Program Work Plan, shall be submitted to the EEPOC for technical advice prior to submission of the Work Plan to the Department for approval (which shall include a reporting schedule).

Comment

As discussed above, and in PSEG's comments on Special Condition G.3.d, PSEG understands that the EEPAC's role with respect to the BMP is a continuation of the MAC's role. Therefore, the words "oversight and" should be eliminated.

PSEG Proposed Permit Language

i. As described previously under G.3.d, the EEPAC shall provide technical advice regarding any improved Biological Monitoring Program. An improved Biological Monitoring Program Work Plan, shall be submitted to the EEPAC for technical advice prior to submission of the Work Plan to the Department for approval (which shall include a reporting schedule).

Permit/Fact Sheet Section: Permit, Part IV, G.6.a.ii., Biological Monitoring Program – Section 316 Special Condition; Fact Sheet, pages 50-57

NJDEP Draft Permit Language

ii. The permittee shall submit to the Department for approval an improved Biological Monitoring Program Work Plan which addresses the components described in item G.6.a. Submit an Instream Biological Study Workplan: within 90 days from the effective date of the permit (EDP).

Comment

PSEG believes the work "Instream" as included in this Special Condition is a typographical error and was intended to read: "improved."

In addition, PSEG contends that the specified schedule for submitting an improved Biological Monitoring Program Work Plan (BMWP) is inappropriate, given the requirement to obtain the advice of EEPAC prior to submitting the BMWP to the Department. PSEG proposes modifying the specified due date from 90 days to 270 days of the effective date of the permit (EDP). A submittal at EDP +270 days allows sufficient time for the establishment of the EEPAC and receiving the EEPAC's technical advice on the improved Biological Monitoring Work Plan.

Special Condition G.3.d.ii specifies the submittal of a complete list of EEPAC members to the Department by EDP +90 days for the NJDEP's approval. The time frame PSEG proposes allows an appropriate amount of time for NJDEP to review and act upon PSEG's submission of proposed EEPAC members, convene the Committee and consider and incorporate, as appropriate, EEPAC's comments.

PSEG Proposed Permit Language

ii. The permittee shall submit to the Department for approval an improved Biological Monitoring Program Work Plan

which addresses the components described in item G.6.a
Submit an improved Biological Monitoring Work Plan
within 270 days from the effective date of the permit (EDP)

Permit/Fact Sheet Section: Permit, Part IV, G.6.a.iii., Biological Monitoring Program – Section 316 Special Condition; Fact Sheet, pages 50-57

NJDEP Draft Permit Language

ii. Not later than sixty days after receipt of the Department's approval of the Work Plan, the permittee shall implement the Work Plan. The improved Biological Monitoring Work Plan is automatically incorporated as a condition of this permit upon final approval by the Department. Contemporaneous with submission of said results to the Department, the permittee shall forward the results to each member of the EEPOC for technical review.

Comments

PSEG believes that the inclusion of the sentence "Contemporaneous with submission of said results to the Department, the permittee shall forward the results to each member of the EEPOC for technical review" in this item is a typographical error. This requirement would be more appropriate as a component of Special Condition G.6.a.iv.

PSEG Proposed Permit Language

iii. Not later than sixty days after receipt of the Department's approval of the Work Plan, the permittee shall implement the Work Plan. The improved Biological Monitoring Work Plan is automatically incorporated as a condition of this permit upon final approval by the Department.

Permit/Fact Sheet Section: Permit, Part IV, G.6.a.iv., Biological Monitoring Program – Section 316 Special Condition; Fact Sheet, pages 50-57

NJDEP Draft Permit Language

iv. The results of any monitoring performed as part of the existing (at the time of the NJPDES renewal issuance) biological monitoring program and the improved biological monitoring program shall be submitted annually by June 30 of that following year in an annual report.

Comment

As discussed above, PSEG believes the incorporation of the sentence "Contemporaneous with submission of said results to the Department, the permittee shall forward the results to each member of the EEPAC for technical review" as a component of Special Condition G.6.a.iii is a typographical error. The sentence would be more appropriate as a component of this item.

PSEG Proposed Permit Language

iv. The results of any monitoring performed as part of the existing (at the time of the NJPDES renewal issuance) biological monitoring program and the improved biological monitoring program shall be submitted annually by June 30 of the following year in an annual report. Contemporaneous with submission of said results to the Department, the permittee shall forward the results to each member of the EEPAC for technical review.

Fact Sheet Section: Compliance with Special Condition 6: Biological Monitoring, Fact Sheet, page 54, Department's Determination Regarding the need for Review and Discussion as to the Appropriateness of the Representative Important Species (RIS)

Comment

The Department is asking PSEG to consider the inclusion of Atlantic silverside and Atlantic menhaden as RIS for the purposes of Section 316(a) and 316(b) of the Clean Water Act. PSEG believes the inclusion of additional species to Salem's RIS list is unwarranted for the following reasons:

USEPA's "Guidance for Evaluating the Adverse Impact of Cooling Water Intake Structures on the Aquatic Environment: Section 316(b) P.L. 92-500" (hereafter "USEPA 1977," page 17), states that: "... since all species which are critical, representative, etc. cannot be studied in detail, some smaller number ... may have to be selected." The USEPA also states that in selection of critical aquatic organisms for intake studies the following should be considered: commercially or recreationally important; threatened or endangered; critical to the structure and function of the ecological system; potentially capable of becoming a nuisance species; necessary in the food chain; and high potential susceptibility to impingement or entrainment. (USEPA 1977, page 16) Furthermore, the statement is made "...Often, but not always, the most useful list would include mostly sensitive, fish, shellfish, or other species of direct use to man..."

The Application (Appendix F, III.D., Appendix C, Attachments C-1 through C-14, Species Specific Reports, Appendix E, VI.D.2 and Table VI-4) provides details on the criteria and rationale for the selection of the 12 RIS for Salem. The selected RIS definitely meet the criteria listed by USEPA (1977).

To the extent the Department chooses to reconsider adding to the RIS list, PSEG believes it would also be appropriate to consider deleting those species that have minimal involvement with the Station.

Fact Sheet Section: Fact Sheet, Page 57, Proposed Permit Condition Regarding Biological Monitoring Plan

Comment

In the last bullet the wording implies that PSEG would be required to implement special monitoring studies "recommended" by EEPAC. It is suggested that this sentence be reworded to: "-other special monitoring studies as may be recommended by the EEPAC and/or required by the NJDEP and subsequently required by the Department."

The last paragraph is inconsistent with the Permit Condition IV.G.6.a.i and G.6.a.ii. Specifically, it calls for a distribution of a proposed BMWP to the NJDEP and EEPAC by EDP + 3 months. The Part IV term is EDP + 90 days.

Permit Section: Permit, Part IV, G.7.a-b, Entrainment and Impingement Abundance Monitoring - Section 316 Special Condition

NJDEP Draft Permit Language

a. Until such time as an improved entrainment sampling plan is developed as required under G.6.a. above, the permittee shall continue to conduct entrainment sampling during normal Station operations at a minimum frequency three days per week, from April - September and once per week from October through March, weather conditions permitting. During normal Station operations, nighttime sampling shall be included and a minimum of six abundance samples shall be collected per sampling day, weather conditions permitting.

b. Until such time as an improved impingement sampling plan is developed as required under G.6.a. above, the permittee shall continue to conduct impingement sampling during normal Station operations at a minimum frequency of three times per week, conditions permitting. During normal Station operations, nighttime sampling shall be included and a minimum of ten samples shall be collected per sampling day, weather conditions permitting.

c. The results of all entrainment and impingement abundance monitoring shall be reported in the Biological Monitoring Program Annual Report which is due by June 30 of each following year, as referenced above in G.6.a.iv.

Comment

PSEG proposes the use of the phrase "conditions permitting" which is contained in the current Biological Monitoring Work Plan. This is more appropriate for in-plant sampling and appropriately takes equipment availability into account. Therefore, the wording should be changed in both G.7.a and G.7.b.

PSEG also proposes that the reference in proposed Specific Requirement G.7.b to a minimal sampling frequency of three times per week be changed to "three days per week."

Finally, PSEG proposes that proposed Specific Requirement G.7.c be modified to include the phrase "or as established in the Biological Monitoring Program Work Plan, approved by the Department." PSEG believes this flexibility is necessary since the specific requirements of the BMWP are not defined presently and their scope may dictate an alternative date for submission of monitoring reports.

PSEG Proposed Permit Language

a. Until such time as an improved entrainment sampling plan is developed as required under G.6.a. above, the permittee shall continue to conduct entrainment sampling during normal Station operations at a minimum frequency of three days per week, from April through September and once per week from October through March, conditions permitting. During normal Station operations, nighttime sampling shall be included and a minimum of six abundance samples shall be collected per sampling day, conditions permitting.

b. Until such time as an improved impingement sampling plan is developed as required under G.6.a. above, the permittee shall continue to conduct impingement sampling during normal Station operations at a minimum frequency of three days per week, conditions permitting. During normal Station operations, nighttime sampling shall be included and a minimum of ten samples shall be collected per sampling day, conditions permitting.

c. The results of all entrainment and impingement abundance monitoring shall be reported in the Biological Monitoring Program Annual Report which is due by June 30 of each following year, as referenced above in G.6.a.iv, or as established in the Biological Monitoring Program Work Plan, approved by the Department.

Permit Section: Permit, Part IV, G.8.a, Expansion of Analyses - Section 316 Special Condition, Analysis of Losses at the Station; Fact Sheet, page 72-73

NJDEP Draft Permit Language

G.8.a. Analysis of Losses at the Station - The analysis of losses at the Station shall be supplemented with additional information as recommended in the June 14, 2000 ESSA Report. The objectives of this analysis shall be as follows: 1) The biomass lost to the ecosystem should be calculated either using a slightly modified version of the production foregone model for all RIS or the spreadsheet approach; 2) The contribution of RIS other than Bay Anchovy to the forage available for commercial and recreationally important species should be examined; 3) A more detailed analysis of the levels of uncertainty in the production and catch foregone estimate needs to be considered; 4) The estimates used for the survival rates of Age 0 - Blueback Herring used in the Appendix F, analysis (Application Appendix F, Attachment F-4) should be reviewed given the different values used in Appendix G-6; 5) The base case entrainment and impingement mortality estimates should be compared against the historical averages to ensure consistency; 6) Projected increases in RIS abundance should be included in the estimates of catch and production foregone; and 7) The potential to customize intake protection strategies to minimize the impact of the plant on catch foregone and the biomass lost to the ecosystem should be further investigated.

Comment

Specific Requirement G.8.a. proposes to require PSEG to supplement the analysis of losses provided in the March 4, 1999 NJPDES Permit Renewal Application with additional information as recommended in the ESSA Report (Fact Sheet, page 72). As discussed in PSEG's Response to the ESSA Report and summarized below, PSEG maintains that the results and conclusions it presented in the

Application are valid and that the large majority of ESSA's recommendations would not produce information that would materially affect NJDEP's review of PSEG's Application. Once the NJDEP has had an opportunity to review and evaluate PSEG's Response to the ESSA Report, the Department may determine that an alternative list of additional analyses and evaluations from that proposed in Part IV G.8.a is more appropriate. Notwithstanding PSEG's Response to the ESSA Report, PSEG recognizes the Department's need to address recommendations of its consultant that may produce information relevant to its review of PSEG's Section 316(b) Demonstration. Following the Department's review of PSEG's Response to the ESSA Report, PSEG requests the opportunity to work cooperatively with the NJDEP to address those recommendations deemed by the Department to warrant further analyses or evaluation.

The complex and highly technical nature of these analyses suggest that the Department's objectives can best be addressed through cooperative development of a work plan prior to initiation of additional work. PSEG, therefore, requests that the additional analyses be conducted in accordance with a work plan that PSEG will develop in conjunction with the Department and submit to the Department for review and final approval.

Because any required expansion of analysis with regard to entrainment sampling (Specific Requirement G.8.b) is integral to the types of additional analyses proposed in Specific Requirement G.8.a, PSEG proposes to address the two Specific Requirements in a single work plan.

PSEG's specific comments on each supplemental analysis listed in Specific Requirement G.8.a. (and reproduced below) are as follows:

1. The biomass lost to the ecosystem should be calculated either using a slightly modified version of the production foregone model for all RIS or the spreadsheet approach;

As discussed in PSEG's Response to the ESSA Report (Sections VII.B and VII.C), ESSA's method for estimating biomass lost to the ecosystem produces results that are biologically meaningless. Therefore, PSEG believes that computing estimates using the methods described in Section 5.2.3 of the ESSA Report (using either a modified version of the production foregone model or ESSA's spreadsheet) would not serve any useful purpose.

Notwithstanding PSEG's Response to the ESSA Report, PSEG recognizes the Department's need to address recommendations of its consultant that may produce information relevant to the NJDEP's review of PSEG's Section 316(b) Demonstration. PSEG, however, requests that any additional analyses regarding biomass lost to the ecosystem be conducted in accordance with a Work Plan that PSEG will develop in conjunction with the Department and submit to the Department for review and approval.

2. The contribution of RIS other than Bay Anchovy to the forage available for commercial and recreationally important species should be examined;

ESSA's contention that "including the contribution of RIS other than bay anchovy to the forage available for commercially and recreationally important species ... has the potential to significantly increase the estimates of lost revenue in the fishery" is incorrect. As described in PSEG's Response to the ESSA Report (Section VII.C.), inclusion of this component from ESSA's method of estimating biomass lost to the ecosystem would not materially affect the results of the benefits assessment. The reason that inclusion of this component would not "significantly increase" estimates of pounds lost to the fishery (and hence revenue) is because the forage biomass must be converted into predator biomass before it is available to the commercial or recreational fishery. That transfer from forage to predator biomass results in a loss of roughly 90% of the biomass (i.e., assuming a 10% trophic transfer efficiency). Also, the forage biomass must be allocated among a range of predator species, some of which are not recreationally or commercially important. Therefore, only a small fraction of the contribution of RIS to forage actually would become biomass of the recreationally and commercially important species.

Notwithstanding PSEG's Response to the ESSA Report, PSEG recognizes the Department's need to address recommendations of its consultant that may produce information relevant to the NJDEP's review of PSEG's Section 316(b) Demonstration. PSEG, however, requests that any additional analyses on the contribution of RIS other than bay anchovy to the forage available be conducted in accordance with a Work Plan that PSEG will develop in conjunction with the Department and submit to the Department for review and approval.

3. A more detailed analysis of the levels of uncertainty in the production and catch foregone estimate needs to be considered;

As discussed in PSEG's Response to the ESSA Report (Section VII.C.5), ESSA commented that because there is some uncertainty in estimates, the estimates should be presented with confidence intervals and ranges derived from sensitivity analyses. However, ESSA does not explain the purpose of the recommended uncertainty analyses, how the uncertainty analyses should be conducted, what the output of the analyses should produce, or how the output would be useful to NJDEP in its permit decision-making.

PSEG acknowledges that uncertainties exist, as they generally do in estimates based on environmental monitoring data. However, PSEG's position is, and has been, that the permit decision-making process is best served by consideration of the *best* estimates reasonably attainable, derived through the application of scientifically defensible analytical methods using the best available data. The findings presented in the Application were developed accordingly, and PSEG continues to advocate this approach.

Furthermore, in recognition of underlying uncertainties, PSEG deliberately chose methods for estimating pounds lost to the fishery (referred to by ESSA as "catch foregone") that would err on the side of producing overestimates so that estimated benefits associated with technology alternatives would tend to be overstated, and not understated. Because PSEG's methods for estimating pounds lost to the fishery do not account for the effects of compensatory mortality and growth, and the effects of alternative energy pathways within the estuarine food web, the estimates are likely biased high. For these reasons, PSEG does not believe implementing ESSA's recommendation is necessary, and does not believe implementing it would produce meaningful information.

Notwithstanding PSEG's Response to the ESSA Report, PSEG recognizes the Department's need to address recommendations of its consultant that may produce information relevant to the NJDEP's review of PSEG's Section 316(b) Demonstration. PSEG, however, requests that any additional analyses of the levels of uncertainty in the production and catch foregone estimates be conducted in accordance with a Work Plan that PSEG will develop in conjunction with the Department and submit to the Department for review and approval.

4. The estimates used for the survival rates of Age 0 - Blueback Herring used in the Appendix F-4 analysis (Application Appendix F, Attachment F-4) should be reviewed given the different values used in Appendix G-6;

PSEG has reviewed the survival rate estimates for age 0 - blueback herring used in the Appendix F-4 analysis and present in Appendix G-6 and found no inconsistencies. As discussed in PSEG's Response to the ESSA Report (Section VII.C.4.c), ESSA mistakenly assumed that the annual survival rates for blueback herring presented in Attachment G-6, Table 6 reflected natural mortality only. In fact, they included both natural mortality and fishing mortality. Moreover, ESSA erred in its calculation of a daily mortality rate for age 0 blueback herring (presented in Table 5.14 of the ESSA Report) from the value presented in Attachment G-6. ESSA's conclusion, "For blueback herring the different values chosen for age 0 survival are critical. This difference has a large effect, increasing both catch and production foregone of blueback herring by 14 times," was clearly erroneous and resulted from a misinterpretation of PSEG's analyses.

PSEG believes it has fully addressed this recommendation by ESSA and consequently the Department's proposed Specific Requirement in its Response to the ESSA Report. PSEG requests that this proposed component be deleted from Specific Requirement G.8.a.

5. The base case entrainment and impingement mortality estimates should be compared against the historical averages to ensure consistency;

As recommended by ESSA, PSEG has compared the Base Case (see Application Appendix F, Attachment F-4) and historical entrainment and impingement loss estimates and found no inconsistencies.

As discussed in PSEG's Response to the ESSA Report (Section VII.C.3.b), ESSA's review did not consider the effects of inter-annual variability in the vulnerability of weakfish and white perch eggs to entrainment. Because white perch spawn up-river of the Station, and weakfish generally spawn down-river of the Station, entrainment losses of eggs are not observed in all years. The greatest annual loss estimates during the Base Case years (1991-1998) for weakfish and white perch eggs were for 1998. Since the Base Case scenario includes scheduled spring outages, and no spring outages occurred in 1998, the Base Case water withdrawals were less than the historical water withdrawals during some periods in the spring (when weakfish and white perch eggs are subject to entrainment). Therefore, the Base Case loss estimates for weakfish and white perch eggs were lower than the estimates for historical conditions.

Likewise, ESSA's Report did not consider the effects of improved impingement survival for white perch on the modified intake screens. The reason the ratio is less than one for white perch adults is that the losses of white perch adults are due to impingement. The historical loss estimates for impingement were based on the impingement mortality rates for the old intake screens for all years prior to 1996, and on the impingement mortality rates for the new intake screens for 1996 through 1998. For the Base Case scenario impingement mortality rates for the new intake screens were used. The estimated impingement mortality rate for adult white perch is much lower for the new intake screens than for the old intake screens (Application Appendix L, Tab 10 and Application Appendix F, Attachment F-4, Table 3). Therefore, the Base Case scenario losses for 1991-1995 are substantially lower than the corresponding historical losses, and the Base Case scenario losses for 1996-1998 are higher than the corresponding historical losses.

The Base Case scenario is intended to represent future operating conditions and are the appropriate losses for use in any Cost-Benefit analyses of alternate intake technologies.

PSEG believes it has completed the analyses required by this component of the Specific Requirement and is submitting the results to the Department as part of its Response to the ESSA Report (Section III). Accordingly, PSEG requests that this component be deleted from Specific Requirement G.8.a.

6. Projected increases in RIS abundance should be included in the estimates of catch and production foregone;

As discussed in PSEG's Response to the ESSA Report (Section VII.A.2.b.), ESSA's recommendation to include projected increases in RIS abundance in estimates of catch and production foregone is without merit and contrary to other ESSA recommendations to reduce uncertainty in these analyses. This recommendation is apparently based on ESSA's belief that stocks have exhibited increases in abundance in recent years and will continue to increase in abundance in the future. It is surprising that ESSA (so concerned about uncertainties in

PSEG's analyses) would recommend alternative analyses that require predicting the future, which surely must involve more uncertainty than simply characterizing the past.

PSEG did not present any quantitative projections of future RIS abundance in the Application, and ESSA provided neither estimates of projected increases in RIS abundance, nor any suggestions on how projected increases should be computed. In the absence of scientifically valid estimates of "projected increases in RIS abundance," PSEG views this recommendation as a theoretical exercise that would serve no useful purpose in the context of the Application.

Notwithstanding PSEG's Response to the ESSA Report, PSEG recognizes the Department's need to address recommendations of its consultant that may produce information relevant to the NJDEP's review of PSEG's Section 316(b) Demonstration. PSEG, however, requests that any additional analyses of increases in RIS abundance in the estimates of catch and production foregone be conducted in accordance with a Work Plan that PSEG will develop in conjunction with the Department and submit to the Department for review and approval.

7. The potential to customize intake protection strategies to minimize the impact of the plant on catch foregone and the biomass lost to the ecosystem should be further investigated.

As discussed in PSEG's Response to the ESSA Report (Section VII.A.2.b.), ESSA's recommendation and this component of Specific Requirement G.8.a to "customize intake protection strategies to minimize the impact of the plant on catch foregone and the biomass lost to the ecosystem" with no reference to costs or to benefits associated with the biomass lost is inconsistent with requirements regarding decisions under Section 316(b) stated by the Department in the Fact Sheet. As stated by the Department on page 69 of the Fact Sheet:

> Under Section 316(b), a permitting agency has the ultimate burden of persuasion that any BTA measure that it requires is "available" for a given facility, and that its *costs are not "wholly disproportionate"* to environmental benefits. (emphasis added).

Furthermore, as discussed in PSEG's Response to the ESSA Report (Sections VII.A and VII.B), ESSA's method for calculating total biomass loss is severely biased because it does not account for the effects of density-dependent compensation, or the effects of alternative energy pathways within the ecosystem. Total biomass lost to the ecosystem (even if correctly calculated) does not translate directly into dollars for use in a Cost-Benefit analysis, and should not be a basis for decision making.

PSEG has used a pounds lost to the fishery approach to evaluate alternative intake technologies and to support the Cost-Benefit analysis. In addition, PSEG provided supplemental information and analyses to the Department, based on pounds lost to the fishery estimates of pounds lost to the fishery or catch, to further evaluate potential biases in benefit estimates associated with the Week 21 refueling outage schedule (Attachment II.B.1). This relevant supplemental information was not submitted to the Department at the time ESSA completed its review of PSEG's Section 316(b) Demonstration. Specific Requirement G.5 of the proposed Draft Permit also requires further study of intake protection technologies and an evaluation of their cost-effectiveness. Consistent with PSEG's Application, this required evaluation of cost-effectiveness in Specific Requirement G.5 will use a pounds lost to the fishery approach.

For these reasons, PSEG believes that it has already addressed one component of ESSA's recommendation and will address the remaining component via compliance with Specific Requirements G.5., assuming it is included in the draft permit. Accordingly, PSEG requests that this component be deleted from Specific Requirement G.8.a.

PSEG Proposed Permit Language

G.8.a. Analysis of Losses at the Station - The analysis of losses at the Station shall be supplemented with additional information recommended in the June 14, 2000 ESSA Report. PSEG shall prepare a work plan for NJDEP approval that shall address the following: 1) The biomass lost to the ecosystem for all RIS; 2) The contribution of RIS other than Bay Anchovy to the forage available for commercial and recreationally important species; 3) A more detailed analysis of the levels of uncertainty in the production and catch foregone estimate; and 4) Projected increases in RIS abundance in the estimates of catch and production foregone. PSEG shall consider ESSA recommendations relative to these issues in the development of the Work Plan:

Permit Section: Permit, Part IV, G.8.b.i, Expansion of Analyses - Section 316 Special Condition, Expansion of Analysis with Regard to Entrainment Sampling; Fact Sheet, page 72-73

NJDEP Draft Permit Language

G.8.b. Expansion of Analysis with regard to Entrainment Sampling - The analysis of losses at the Station shall be supplemented with the following additional information as recommended in the June 14, 2000 ESSA Report:

i. The uncertainty of the estimated historic annual entrainment losses should be characterized and presented as ranges with maximum and minimum levels.

Comment

As discussed in PSEG's Response to the ESSA Report (Section IV.B.), PSEG is aware of the limitations of the historical entrainment data and developed methods to account for the limitations when those data were analyzed in the Application. The ESSA Report acknowledges that PSEG has "done a good job of trying to account for them," but despite this acknowledgement, argues that a quantitative uncertainty analysis of the loss estimates is needed . . ." (ESSA Report, page 8.)

PSEG's position, which is consistent with applicable USEPA Guidance, is, and has been, that the permit decision-making process is best served by consideration of the *best* estimates reasonably attainable, based on the best available data and on scientifically defensible analytical methods. The findings presented in the Application were developed accordingly, and PSEG continues to advocate this approach.

Notwithstanding PSEG's Response to the ESSA Report, PSEG recognizes the Department's need to address recommendations of its consultant that may produce information relevant to the NJDEP's review of PSEG's Section 316(b) Demonstration. PSEG, however, requests that any additional analyses regarding the uncertainty of the estimated historical annual entrainment losses be conducted in accordance with a Work Plan that PSEG will develop in conjunction with the Department and submit to the Department for review and approval.

PSEG Proposed Permit Language

No modification proposed, provided NJDEP accepts PSEG's proposal for development of a Work Plan and conduct of the analyses in accordance with the schedule to be included in the Work Plan.

Permit Section: Permit, Part IV, G.8.b.ii., Expansion of Analyses - Section 316 Special Condition; Fact Sheet, page 72-73

NJDEP Draft Permit Language

ii. An error in the estimation of natural mortality rate and the effect on CMR estimates with the Extended Empirical Impingement Model (EEIM) (which was used to derive estimates of CMR for alewife, blueback herring, American shad, white perch and spot) shall be investigated. The uncertainty with the CMR estimates shall also be characterized and presented.

Comment

PSEG employed a number of steps to ensure minimization of errors and biases in natural mortality rate estimates, including: (1) a complete review of the available literature on natural mortality rates for each life stage of each RIS; (2) a review of preliminary estimates by recognized scientists from academia; and (3) use of the life-cycle balancing procedure. ESSA's claim that natural mortality rates used by PSEG systematically overestimated the true values of these parameters is false as demonstrated in Section IV.D.3 of PSEG's Response to the ESSA Report.

PSEG questions ESSA's request for uncertainty analyses. PSEG acknowledges that uncertainties exist; however, PSEG's position, which is supported by applicable USEPA guidance, is, and has been, that the permit decision-making process is best served by consideration of the *best* estimates reasonably attainable, based on the best available data and on scientifically defensible analytical methods. The findings presented in the Application were developed accordingly, and PSEG continues to advocate this approach. PSEG's scientific response to the underlying recommendation is set forth in Section IV.D of the PSEG Response to the ESSA Report.

Notwithstanding PSEG's Response to the ESSA Report, PSEG recognizes the Department's need to address recommendations of its consultant that may produce information relevant to the NJDEP's review of PSEG's Section 316(b) Demonstration. PSEG, however, respectfully requests that any additional analyses of uncertainty with the CMR estimates be conducted in accordance with a Work Plan that PSEG will develop in conjunction with the Department and submit to the Department for review and approval.

PSEG Proposed Permit Language

No modification proposed, provided NJDEP accepts PSEG's proposal for development of a Work Plan and conduct of the analyses in accordance with the schedule to be included in the Work Plan.

Permit Section: Permit, Part IV, G.8.c, Expansion of Analyses - Section 316 Special Condition; Fact Sheet, pages 72-73

NJDEP Draft Permit Language

G.8.c. The analyses specified in items G.8.a. and G.8.b. shall be provided to the Department by EDP + 6 months. Based on the fact that

ESSA did not recommend wedgewire screens, dual-flow fine mesh screens, modular inclined screens, and a retrofit with a new closed-cycle cooling system, a revised fisheries analysis will not have a bearing on the inclusion of the above referenced alternate intake protection technologies at this time.

Comment

Providing a quality product that addresses the issues and recommendations identified by ESSA will require a substantial effort and, therefore, considerable time.

PSEG proposes to develop for submission a Work Plan for these additional analyses. PSEG proposes to conduct the additional analyses in accordance with the schedule provided in the Work Plan. PSEG requests that any final Specific Requirement provide for submission of the supplemental analyses in accordance with the schedule defined in the Department approved Work Plan.

PSEG Proposed Permit Language

G.8.c. The analyses specified in items G.8.a. and G.8.b. shall be provided to the Department in accordance with the schedule defined in the Department approved Work Plan. Based on the fact that ESSA did not recommend wedgewire screens, dual-flow fine mesh screens, modular inclined screens, and a retrofit with a new closed-cycle cooling system, a revised fisheries analysis will not have a bearing on the inclusion of the above referenced alternate intake protection technologies at this time.

i. The permittee shall submit to the Department for approval a Work Plan including those supplemental analyses and additional information listed in G.8.a and G.8.b. above. The Work Plan shall be submitted to the Department within EDP + 9 months and shall include a schedule for completion of the analyses.

ii. Not later than sixty days after receipt of the Department's approval of the Work Plan, the permittee shall implement the Work Plan. The Work Plan is automatically incorporated as a condition of this permit upon final approval by the Department.

Permit/Fact Sheet Section: Permit, Part IV, G.9.a.i., Special Studies - Section 316 Special Condition, Study of the Hydrodynamics at the Intakes of the Station; Fact Sheet, page 74

NJDEP Draft Permit Language

i. The flow field in front of the intake and the existence of vortices at the intake shall be observed and photographed during: (1) an extreme low tide (2) when the current is at the strongest, namely at mid tide on the flood and mid tide on the ebb.

Comment

Consistent with the language in the specific permit requirement, PSEG requests that in the heading for Specific Requirement G.9.a. that the term "Intakes" be replaced with the term "Intake." PSEG understands that this special study is requested primarily based on ESSA's comment related to the possible significance of small scale eddies in the vicinity of the cooling water intake structure with regard to concentrated entrainment of organisms. PSEG responded to ESSA's concerns in its Response to the ESSA Report at Section IV.B.3. However, PSEG will submit a report to the Department on this condition within EDP + 180 days.

PSEG Proposed Permit Language

No modification proposed, provided NJDEP accepts the schedule proposed by PSEG in G.9.c.

Permit/Fact Sheet Section: Permit, Part IV, G.9.a.ii., Special Studies - Section 316 Special Condition, Study of the Hydrodynamics at the Intakes of the Station; Fact Sheet, page 74

NJDEP Draft Permit Language

ii. The pumping records of each pump should be examined to determine if the flow distribution is asymmetrical among the intake bays, particularly the most northern bay and the most southern bay (i.e., two outer bays).

Comment

The proposed Special Conditions of G.9.a.ii of the Draft Permit are based on recommendations in Section 2.1.3 of the ESSA Report. See PSEG's Response to the ESSA Report at Section IV.B.3. However, PSEG will submit a report to the department on this condition within EDP + 180 days.

PSEG Proposed Permit Language

No modification proposed, provided NJDEP accepts the schedule proposed by PSEG in G.9.c.

Permit/Fact Sheet Section: Permit, Part IV, G.9.a.iii., Special Studies - Section 316 Special Condition, Study of the Hydrodynamics at the Intakes of the Station; Fact Sheet, pages 74-75

NJDEP Draft Permit Language

iii. The bathymetric chart of the area should be examined to determine the potential for a strong back eddy during the ebb in Ship Wreck Bay [sic] immediately to the south of the intake. If such an eddy exists it will be observable from shore and from the air when ebb current is at a maximum. The chart may also provide insight in to the flow field entering the dredged channel from the side.

Comment

Bathymetric charts (e.g. National Oceanic and Atmospheric Administration) provide low spatial resolution in Sunken Ship Cove while more detailed bathymetric information near the CWIS, discharge, and Sunken Ships Cove was collected and examined in previous studies conducted for PSEG. However, PSEG will submit a report to the Department on this condition within EDP + 180 days.

PSEG Proposed Permit Language

iii. The bathymetric chart of the area and other relevant hydrodynamic data should be examined to determine the potential for a strong back eddy during the ebb in Ship Wreck Bay [sic] immediately to the south of the intake. If such an eddy exists, it will be observable from shore and from the air when the ebb current is at maximum. The chart and other relevant hydrodynamic data may also provide insight into the flow field entering the dredged channel from the side.

Permit/Fact Sheet Section: Permit, Part IV, G.9.b.i., Special Studies - Section 316 Special Condition, Study of Enhancements to Entrainment and Impingement Sampling; Fact Sheet, page 75

NJDEP Draft Permit Language

An analysis of the optimum sampling frequency for entrainment and impingement shall be conducted considering any episodic nature of the entrainment process. This needs to take explicit account of the shape of the zone of entrainment as well as the hydrodynamic study discussed above in G.9.a.

Comment

The present impingement and entrainment sampling programs, as conducted in accordance with the NJDEP-approved BMWP, are designed to account for potential variability in organism abundance associated with diel and tidal stage effects. The improved biological monitoring program developed in accordance with the proposed Special Condition G.6.a. will include components that address future impingement and entrainment sampling. As PSEG discussed with the NJDEP and the MAC on June 22, 2000, it is PSEG's intent to increase the number and frequency of samples for both programs to improve the precision of the estimates based on the sampling results.

Issues relating to the zone of entrainment and the flow hydrodynamics in the region of the intake have been addressed in the above response to proposed Special Condition G.9.a. The entrainment sampling program is designed to estimate the density of organisms that actually pass through the cooling water system, regardless of the entrainment zone, tidal stage, wind patterns or other factors. By sampling during all diel and tidal stages at an increased frequency, the proposed future program will provide estimates of impingement and entrainment density that account for variability relating to these and other potential factors. PSEG, therefore, requests that the second sentence of this proposed Special Condition be deleted.

PSEG Proposed Permit Language

i. An analysis of the optimum sampling frequency for entrainment and impingement shall be conducted considering any episodic nature of the entrainment process.

<u>Permit/Fact Sheet Section</u>: Permit, Part IV, G.9.b.ii., Special Studies - Section 316 Special Condition, Study of Enhancements to Entrainment and Impingement Sampling; Fact Sheet, page 75

<u>NJDEP Draft Permit Language</u>

ii. Alternative entrainment sampling methods with less process error shall be investigated.

<u>Comment</u>

The proposed Specific Requirement G.9.b.ii of the Draft Permit is based on the recommendations of ESSA. As discussed in PSEG's Response to the ESSA Report, PSEG is aware of the potential "process errors" associated with entrainment sampling and applied correction factors to account for these effects. The ESSA Report, in fact, states, "...the authors of the Application are aware of these difficulties and have done a good job of trying to account for them...." <u>See</u> PSEG Response to the ESSA Report at Section IV.B.

The potential process errors addressed by the proposed Specific Requirement are not unique to PSEG's entrainment sampling program and highlight issues faced by all scientists involved in estimating the abundance of small, fragile, life stages of aquatic organisms. The improved Biological Monitoring Program developed in accordance with the proposed Specific Requirement G.6.a. will include components that address future entrainment sampling. As PSEG discussed with the NJDEP and the MAC on June 22, 2000, it is PSEG's intent to increase the number and frequency of entrainment samples to reduce variability in the sampling results.

Further efforts to address potential "process errors" associated with estimating entrainment abundance would require the conduct of an elaborate and lengthy study program. Such a study would be constrained by the availability of the appropriate species and life stages. This study would also require the development and testing of new sampling equipment. Proper conduct of such a study on potential methods to further address potential "process errors" would, therefore, require two seasons of ichthyoplankton abundance sampling.

PSEG requests that this proposed Specific Requirement be modified to allow sufficient time for development of a detailed study plan and to allow two spring-summer seasons for completion of such a study.

<u>PSEG Proposed Permit Language</u>

ii. Alternative entrainment sampling methods with less process error shall be investigated. PSEG shall submit a

Plan of Study for evaluating alternative entrainment sampling methods within EDP + 6 months.

Permit/Fact Sheet Section: Permit, Part IV, G.9.c., Special Studies - Section 316 Special Condition, Findings regarding Study of Hydrodynamics and Enhancements to Entrainment and Impingement; Fact Sheet, page 75

NJDEP Draft Permit Language

G.9.c. PSEG shall present its findings regarding the Study of the Hydrodynamics at the Intakes of the Plant and the Study of Enhancements to Entrainment and Impingement Sampling to the Department within EDP + 6 months.

Comment

As addressed in PSEG's comments on proposed Specific Requirement G.9.ai and G.9.b., PSEG proposes that the Study of the Hydrodynamics and the Study of Enhancements to Entrainment and Impingement Sampling be two different programs with the latter program conducted in accordance with a Plan of Study approved by the Department. PSEG, therefore, requests that the Department separate the reporting requirements for these two studies to reflect the different schedules.

With respect to the proposed Study of Hydrodynamics, PSEG suggests that this Specific Requirement be modified to require presentation of the findings within EDP +180 days.

Proper conduct of the Study of Enhancements to Entrainment and Impingement Sampling cannot be completed until approximately 30 months following Department approval of a Plan of Study. PSEG therefore requests that this Specific Requirement be modified to allow sufficient time to conduct of a meaningful study.

PSEG Proposed Permit Language

G.9.c.i. PSEG shall present its findings regarding the Study of the Hydrodynamics at the Intakes of the Plant to the Department within EDP + 180 days.

G.9.c.ii. PSEG shall present its findings regarding the Study of Enhancements to Entrainment and Impingement Sampling to the Department within 30 months following receipt of the Departments' approval of the Plan of Study.

Permit/Fact Sheet Section: Permit, Part IV, G.9.d., Special Studies - Section 316 Special Condition, Reopener; Fact Sheet, page 75

NJDEP Draft Permit Language

Reopener - Upon completion of 9.c., the Department may reassess and adjust the entrainment and/or impingement sampling frequencies and/ sampling locations as included in the Biological Monitoring Program. The Department may also define alternative entrainment sampling methods to reduce process error, which is also included in the Biological Monitoring Program.

Comment

Provided the Department modifies the schedule for completing the two required studies as discussed in the above comments, PSEG accepts this proposed Special Condition as written.

Permit/Fact Sheet Section: Permit, Part IV, G.10.a., Submission of Documents – Section 316 Special Condition

NJDEP Draft Permit Language

a. The permittee shall submit all documents specified in items G.1-G.12, including, without limitation, workplan feasibility studies, further analyses, and reports, to the following person:

Director, Division of Fish and Wildlife
501 East State Street, P.O. Box 400
Trenton, NJ 08625-0400

Comment

Only the special conditions (i.e., G.2 through G.9 and G12b) that address biological studies related to impact assessment should be sent to the Director, Division of Fish and Wildlife.

PSEG Proposed Permit Language

b. The permittee shall submit all documents specified in items G.2 through G.9 and G.12b, including, without limitation, workplans, Plans of Study, feasibility studies, further analyses, and reports, to the following person:

Director, Division of Fish and Wildlife
501 East State Street, P.O. Box 400
Trenton, NJ 08625-0400

Permit/Fact Sheet Section: Permit, Part IV, G.12.b., Submissions as part of any NJPDES Renewal Application - Section 316 Special Condition; Fact Sheet, pages 75-77

NJDEP Draft Permit Language

b. Production Measurement of the Wetland Restoration Sites

i. As part of any renewal application, the permittee shall include estimates of overall fish production from all PSEG wetland restoration sites as well as the fish ladders. The permittee shall utilize appropriate methods, which may include bioenergetics. The Department acknowledges that these "estimates" are subject to many environmental variables. Measures of productivity shall be expressed in the same units as the analysis of losses at the intake structure.

Comment

PSEG agrees with the Department that, although an "acceptable common metric" for quantifying all of the increased production from marsh restoration and the re-establishment of river herring runs is not presently available, it is important to consider the available evidence relevant to assessing the fish production benefits of these measures. PSEG's Permit Renewal Application contains considerable data and information that demonstrate the marsh restoration and fish ladder installations have and will continue to provide substantial contributions to production in the estuary.

Inclusion of any Specific Requirement in the Final Permit that would require PSEG to estimate overall fish production from the wetland restoration sites and the fish ladders; however, must be framed and implemented in accordance with the Department's consistent regulatory approach relative to the incorporation of the conservation measures in the 1994 Permit and its subsequent interpretation of that condition.

As stated by the Department in the Fact Sheet accompanying this Draft Permit, "PSEG was not required to estimate fish production at its wetland restoration sites as part of the July 20, 1994 permit" (Fact Sheet, page 77). As quoted in the Fact Sheet, page 77, the Department's 1994 Response to Comments document issued with the Permit stated that "The Permittee would not be required to demonstrate how many fish of each species have been generated from the restored wetlands . . . . [and that] such a demonstration would not be practicable given the many environmental variables that influence fish populations in the Delaware estuary" (page 45). PSEG concurs with the Department's previously stated position that demonstration of how many fish of each species have been or will be generated from the restored marshes is not practical.

Although it is not a requirement of the 1994 Permit and the technical tools to quantify increased production and to compare that production to biomass lost at the Station have not been fully developed by the scientific community, comments on this Draft Permit submitted by the USFWS and others continue to urge the Department to require PSEG to quantify the overall fish production from the restored wetlands and compare the production to the estimated biomass lost at the Station. Given the many environmental variables that influence fish production and populations in the Delaware estuary, and the limited scientific ability to accurately quantify all of the increased production resulting from the restored wetlands and the fish ladder installations, there is considerable uncertainty as to whether or not a scientifically credible methodology can be developed to provide "estimates" of the increased production that are in the same units as an analysis of losses at the intake structure.

Nonetheless, PSEG recognizes the Department's need to address recommendations of other interested parties and PSEG will apply the best and most current scientific approaches available to implement this proposed Permit Specific Requirement, consistent with the Department's regulatory approach relative to the incorporation of the conservation measures in the 1994 Permit.

Comments on
Other Parts of the Fact Sheet

Fact Sheet Section: Fact Sheet, page 13, Part VII.B, Station Outfalls and Discharge Components

Comment

The identification of B Figure 25 at the top of page 13 of the Fact Sheet ("schematic of the non-radioactive cooling water system") is inconsistent with the heading on page 11.

PSEG Proposed Clarification

PSEG recommends that the identification of B Figure 25 be replaced with "schematic of the non-radioactive liquid waste disposal system" consistent with the heading on page 11 of the fact sheet. Also, PSEG recommends that the statement in the third paragraph on page 13 "enter the system and concentration in the residual" be changed to "enter the system and concentrate in the residual."

Fact Sheet Section: Fact Sheet, page 79-83, Part XII, Contents of the Administrative Record

Comment

Under the subheading "Components of the March 4, 1999 NJPDES/DSW Permit Application," add the following component:

"Application Forms"

Add the following documents to the Administrative Record for completeness:

31. Correspondence dated August 21, 2000 addressed to W. Boehle of NJDEP from Meredith M. Silvestri of PSEG submitting the affidavit informing of the transfer of the NJPDES Permit from PSEG to PSEG Nuclear LLC.

32. Correspondence dated August 25, 2000 addressed to D. Hammond of NJDEP from James Eggers of PSEG Nuclear LLC providing the final report of the chronic toxicity characterization study.

33. Correspondence dated May 30, 2000 addressed to D. Hammond of NJDEP from James Eggers of PSEG Nuclear LLC providing information regarding pre-treatment of well water.

34. Correspondence dated July 6, 2000 from N. Horiates of NJDEP to G. Salamon of PSEG Nuclear LLC indicating that a treatment works approval is not required for the well water pre-treatment system.

35. March 28, 2000. Plan of Action for Experimental Test Areas at Alloway Creek Watershed Wetland Restoration Site and supporting correspondence from G. Bickle (PSEG) to A. Wendolowski (NJDEP) and J. Boyer (USACE)

36. April 26, 2000. Correspondence from G. Bickle (PSEG) to A. Wendolowski (NJDEP) and J. Boyer (USACE) providing revised test area maps to support Experimental Test Area Plan of Action.

37. June 12, 2000. Plan of Action – 2 for Alloway Creek Watershed Restoration Site and supporting correspondence from G. Bickle (PSEG) to K. Broderick (NJDEP) and J. Boyer (USACE).

38. June 30, 2000. Plan of Action for Cohansey River Watershed Restoration Site and supporting correspondence from G. Bickle (PSEG) to K. Broderick (NJDEP) and J. Boyer (USACE).

39. October 4, 2000. Correspondence from G. Bickle (PSEG) to K. Broderick (NJDEP) and J. Boyer (USACE) revising Test Area Plan of Action (3/28/00) to include additional microtopography.

40. October 12, 2000. Plan of Action for Microtopography at the Alloway Creek Watershed Restoration Site and supporting correspondence from G. Bickle (PSEG) to K. Broderick (NJDEP) and J. Boyer (USACE).

41. Correspondence dated December 28, 2000 addressed to D. Hammond of NJDEP from M.F. Vaskis of PSEG providing information regarding increase in reactor power.

42. Correspondence dated January 30, 2001 addressed to S.T. Rosenwinkel of NJDEP from M.F. Vaskis of PSEG providing new information on the RMA-10 model.

PSEG Proposed Clarification

Include the above documents in the Administrative Record.

Comments on
Other Parts of the Draft Permit

Permit Section: Permit Cover Page

Comment

The Property Owner is identified as "PSEG Power LLC" on the Cover Page. As a result of the New Jersey Electric Discount and Energy Competition Act of 1999 and an order issued by the New Jersey Board of Public Utilities, Public Service Electric and Gas Company transferred all of its nuclear electric generation assets to PSEG Nuclear LLC.

PSEG Proposed Permit Language

Change the Property Owner from "PSEG Power LLC" to "PSEG Nuclear LLC."

Permit/Fact Sheet Section: List of Tables, Figures, and Maps, B Figure 31 - Station Schematic of Water Flow

Comment

PSEG recommends that figure numbered "B Figure 31" have the explanation of notes page entitled "B Figure 31 Schematic Of Station Water Flow Notes" in the Application included to clarify the schematic.

PSEG Proposed Permit Language

Incorporate the page entitled "B Figure 31 Schematic Of Station Water Flow Notes" from the Application or acknowledge that it is incorporated by reference.

Response to ESSA

I. INTRODUCTION, SCOPE AND OVERVIEW OF PSEG'S RESPONSE TO ESSA REPORT

A. Introduction

This document provides PSEG Nuclear LLC's ("PSEG") response to the report prepared for the New Jersey Department of Environmental Protection ("NJDEP" or the "Department") by ESSA Technologies Ltd. ("ESSA"), entitled "Review of Portions of New Jersey Pollutant Discharge Elimination System (NJPDES) Renewal Application for the Public Service Electric & Gas' (PSE&G) Salem Generating Station" (June 14, 2000) ("Report" or "ESSA Report"). PSEG's Response to the ESSA Report ("Response" or "PSEG's Response") has seven sections. This first section provides an overview of the themes of PSEG's Response, details the organization of the full Response, and identifies the experts who sponsored the technical portions of the Response.

1. Summary of PSEG's General Response

The ESSA Report provides a highly detailed review of selected portions of PSEG's Application. (See PSE&G Renewal Application, Salem Generating Station, Permit no. NJ0005622 (Mar. 4, 1999) (the "Application" or "PSEG's Application")). Due to the level of detail ESSA addresses in its review, the ESSA Report includes many particularized comments and suggestions. Also, due to the somewhat compartmentalized nature of ESSA's review, some topics are addressed in more than one section of the ESSA Report. Furthermore, given the format of the Report, many of the comments and recommendations are repeated in multiple sections or subsections of the Report. Consequently, ESSA's Report may appear highly critical of the Application.

However, the vast majority of ESSA's comments address the breadth and depth of technical documentation associated with the Section 316(b) Demonstration. Accordingly, most of ESSA's suggestions are aimed at improving the quality of that documentation. PSEG agrees that the technical documentation could be improved, as is always the case, but believes the level of documentation provided is appropriate and exceeds the applicable requirements for Section 316(b) Demonstration. ESSA also offers certain valid and constructive suggestions for improving the analyses presented in the Application, which PSEG appreciates and will implement, as appropriate. ESSA also makes well-intentioned suggestions that, due to site-specific conditions, would not produce meaningful results if implemented. In addition, ESSA makes many comments that PSEG believes are irrelevant or even erroneous, reflecting confusion or misunderstanding regarding the Application, lack of knowledge of site-specific factors and inadequate consideration of applicable Section 316(b) standards. Thus, in spite of the highly detailed and apparently critical nature of the ESSA Report, PSEG believes that many of ESSA's recommendations are unwarranted.

It is important to note that ESSA - notwithstanding its technical comments and suggestions regarding PSEG's analyses and documentation - after conducting its thorough and detailed technical review, does not, in essence, take issue with PSEG Application's fundamental conclusions and results regarding Section 316(b) compliance. Nor does ESSA provide arguments or new data or information that refute PSEG's basic findings. In fact, as detailed below, in some cases ESSA confirms or compliments PSEG's Application. PSEG therefore remains firmly convinced that its approach and conclusions - based on multiple lines of evidence and the judgment of recognized experts evaluating that evidence in a comprehensive, integrated manner - are sensible, defensible, and supported by solid scientific, engineering and economic analytical principles. In addition, the nature and scope of the information presented in the Application are fully consistent with relevant regulatory guidelines. Thus, NJDEP's determination that PSEG's Application successfully demonstrates Section 316(b) compliance is valid, and nothing in the ESSA Report effectively undermines this conclusion.

2. Organization of PSEG's Response

This Response consists of seven sections. Section I provides an Overview of PSEG's Response while Sections II through VII provide PSEG's Detailed Technical Response to the ESSA Report. The Overview provides important background information: Section I.B. outlines the procedural history of the Salem NJPDES Permit relevant to ESSA's review of the Application. It also provides a summary of the draft NJPDES Permit, including NJDEP's proposed renewal of PSEG's Section 316(a) variance and proposed determination that the Station's existing cooling water intake system, in conjunction with a variety of proposed permit conditions, would constitute the best technology available ("BTA") under Section 316(b). (See NJDEP, draft NJPDES permit No. NJ0005622 (Dec. 8, 2000) (the "Draft Permit")). Section I.C. provides background information regarding PSEG's Section 316(b) Demonstration, including the regulatory requirements for Section 316 demonstrations and the Application's approach to evaluating technology alternatives and determining whether the Station has any adverse environmental impact. Finally, Section I.D. summarizes PSEG's general response to the ESSA Report and its appropriate consideration by NJDEP in the permit renewal process.

The Detailed Technical Response provides a section-by-section response to ESSA's specific comments on the Application. Section II addresses ESSA's Executive Summary; Section III addresses ESSA's Introduction (ESSA Report § 1); Section IV addresses ESSA's comments on the entrainment and impingement analyses (ESSA Report § 2); Section V addresses ESSA's comments on PSEG's compliance with the 1994 permit, including intake screen improvements, sound studies and technology alternatives (ESSA Report § 3); Section VI addresses ESSA's comments on the cost-benefit analysis (ESSA Report § 4); Section VI I addresses ESSA's comments on the impact assessment of the Station, including indicators of adverse environmental impact, production and catch foregone, the balanced indigenous community analysis, the trends analyses and the retrospective assessment, the stock jeopardy analysis, and the data and use of the data (ESSA Report § 5).

Each of Sections II through VII follows, to the maximum extent practicable, the structure of the ESSA Report. Issues are addressed in the order in which they appear in the ESSA Report, and the section of the ESSA Report that is being addressed is provided.

3. Experts Sponsoring PSEG's Response

A number of distinguished experts are sponsoring PSEG's Response to the ESSA Report. Vaughn C. Anthony, Ph.D., who sponsored the cumulative effects assessment conducted for the Application, is sponsoring the retrospective analysis portion of the Response to ESSA's Section 5: Impact Assessment. In addition, the following experts are sponsoring the indicated sections of the Response:

- David G. Aubrey, Ph.D. (the hydrodynamics at the cooling water system intake portions of the Response to ESSA's Section 2: Entrainment and Impingement);
- Lawrence W. Barnthouse, Ph.D. (portions of the Response to ESSA's Section 2: Entrainment and Impingement, and the Response to ESSA's Section 5: Impact Assessment);
- David Harrison, Jr., Ph.D. (Response to ESSA's Section 4: Cost-Benefit Analysis);
- Douglas G. Heimbuch, Ph.D. (portions of the Response to ESSA's Section 2: Entrainment and Impingement, and the Response to ESSA's Section 5: Impact Assessment);
- Ray Hilborn, Ph.D. (portions of the Response to ESSA's Section 5: Impact Assessment);
- Ransom A. Myers, Ph.D. (portions of the Response to ESSA's Section 5: Impact Assessment);
- Arthur N. Popper, Ph.D. (the sound deterrent study portions of the Response to ESSA's Section 3: Compliance with 1994 Permit); and
- Edward P. Taft (the remaining portions of the Response to ESSA's Section 3: Compliance with 1994 Permit).1/

1/ A summary of qualifications for each of these experts is included as Appendix A to the ESSA Response. In addition, curriculum vitae for David Aubrey, Ransom A. Myers and Edward P. Taft are included in Appendix B. Curriculum vitae for the rest of these experts can be found in volume 1 of the Application.

B. Procedural History of PSEG's 1999 Permit Application

1. 1994 Permit and Obligation on Renewal

The environmental effects of Salem Generating Station ("Salem" or the "Station") have been carefully evaluated in numerous proceedings over three decades by several regulatory agencies. Most recently, NJDEP issued a NJPDES Permit (the "1994 Permit" or the "Permit") for the Station in 1994. The 1994 Permit found, with regard to thermal effects, that the continued operation of the Station in accordance with the permit terms "would ensure the continued protection and propagation of a balanced indigenous population" of aquatic life in the Estuary. (NJDEP, Response to Comments Document: PSEG Salem Generating Station, NJPDES/DSW Draft Permit NJ0005622, July 20, 1994, page 3 ("NJDEP Response to Comments")). The 1994 Permit thus included a 316(a) variance. With regard to the Station's cooling water intake structure, the 1994 Permit found that the existing intake, with the addition of several technology-related measures – including intake screen modifications, a feasibility study for a sound deterrent system, and a limitation on intake flow - was the best technology available for minimizing adverse environmental impacts, given the feasibility and appropriateness of the intake technologies available, and the evaluation of economic considerations. (NJDEP Response to Comments, page 5; 1993 Fact Sheet for Draft NJPDES Permit Renewal Including Section 316(a) Variance Determination and Section 316(b) "BTA" Decision, page 140.) The 1994 Permit also required PSEG to undertake a wetlands restoration program, install fish ladders, and conduct a comprehensive biological monitoring program. The purpose of the measures required by the 1994 Permit was to reduce losses at the Station and to provide ecological benefits to the Estuary. The 1994 Permit by its terms would have expired August 31, 1999, unless a permit renewal application was received by March 4, 1999. PSEG timely filed such an application by the deadline, and therefore the 1994 Permit continues in full force and effect pursuant to New Jersey law. (N.J.A.C. 7:14A-2.8(a)).

2. 1999 Permit Renewal Application

Consistent with the requirements of the Clean Water Act and the 1994 Permit, PSEG's March 4, 1999 Application for renewal of the Salem NJPDES Permit included several components. First, the Application presented a comprehensive demonstration that PSEG had implemented all of the Special Conditions required by the 1994 Permit. Second, the Application provided a thorough analysis of the effects of Salem's cooling water system on the Delaware Estuary and its aquatic biota pursuant to Section 316(a) and 316(b), consistent with applicable regulations and guidance. Third, the Application included a comprehensive evaluation of the biological efficacy of the technological and conservation measures established in the 1994 Permit. In addition to these individual components, the Application contained a cumulative effects assessment, sponsored by Vaughn C. Anthony, Ph.D.2/, that evaluated the combined

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2/ Dr. Anthony's qualifications are noted in Section I.A.3, and summarized in Appendix A. His full curriculum vitae can be found in volume 1 of the Application.

effects on the twelve Representative Important Species ("RIS") of impingement, entrainment and thermal exposure, as well as the fish production resulting from the wetlands restoration and fish ladder installations undertaken by PSEG. The cumulative effects assessment concluded that:

- the thermal discharge is and will be protective of the balanced indigenous population, taking into account the effects of the intake and other sources of stress on the relevant populations;
- the intake is not having and will not have an adverse environmental impact ("AEI");
- the Station's operations as a whole have not and will not have an AEI; and
- the validity of the above conclusions is reinforced when the benefits provided by the wetlands restoration and fish ladder programs are taken into account, as well as the improvements in the water quality of the Estuary and the improvements in fisheries management.

3. NJDEP Review of 1999 Application

A wide variety of NJDEP divisions has been involved in evaluating the PSEG Application and inspecting the PSEG wetland restoration sites as part of the Application review process. For example, representatives from the Division of Fish and Wildlife, Land Use Regulation Program, Division of Water Quality, as well as members of the Attorney General's office and the Southern Bureau of Water Compliance and Enforcement all were involved in the review process. In addition, a number of other groups and agencies – such as the U.S. Fish and Wildlife Service ("USFWS"), National Marine Fisheries Service ("NMFS"), United States Environmental Protection Agency ("USEPA"), the Delaware Department of Natural Resources and Environmental Control ("DNREC"), the Delaware River Basin Commission ("DRBC"), and numerous environmental organizations – provided comments on the PSEG Application and/or met with NJDEP representatives during the review process.

PSEG provided copies of relevant portions of the Application to members of the Management Plan Advisory Committee ("MPAC") and a full copy to the members of the Monitoring Advisory Committee ("MAC") required by the 1994 Permit. These Advisory Committees, which include nationally and internationally recognized scientists from academia and federal and state regulatory agencies, met with PSEG's expert witness team, who provided an overview of the Section 316(a) and 316(b) Demonstrations, the cumulative effects assessments, the wetlands restoration, and the faunal response to the restorations. These meetings provided an opportunity for a full discussion of PSEG's data, analyses and conclusions. Company representatives and expert scientists also met with interested parties, such as NJDEP, DRBC and DNREC, on several occasions to discuss the Application and respond to questions.

4. ESSA Review

NJDEP determined that it would be beneficial to its review process to hire an outside contractor to assist in reviewing certain portions of the Application. NJDEP therefore contracted the services of ESSA Technologies, Ltd. of Richmond Hill, Ontario, Canada for those issues associated with Section 316(b) of the Clean Water Act, including impingement and entrainment impacts, available intake protection technologies, cost-benefit analysis and the status of fish populations in the Delaware Estuary. ESSA essentially was charged with evaluating the accuracy, completeness and appropriateness of the conclusions reached in the Application, given the methodologies and data used. PSEG and its expert scientists met with ESSA personnel, along with NJDEP staff, on several occasions, including a Station visit, and provided considerable follow-up information in response to ESSA's questions. ESSA's findings are contained in the ESSA Report, which is Attachment A to the Draft Permit.

5. Overview of the Draft Permit

In the Draft Permit issued for the Station on December 8, 2000, NJDEP proposed a number of findings and a series of conditions. NJDEP noted in the Fact Sheet for the Draft Permit that it had "determined that a variance under Section 316(a) is warranted," and therefore it proposed to renew PSEG's 316(a) variance. (NJDEP, Fact Sheet for a Draft NJPDES Permit Including Section 316(a) Variance Determination and Section 316(b) Decision, Permit No. NJ0005622 (the "Fact Sheet"), page 64.) NJDEP also determined that the Station's existing cooling water intake system, in conjunction with a wide variety of proposed permit conditions, would constitute best technology available under Section 316(b). (Fact Sheet, page 77.) The proposed permit requirements relating to Section 316 include:

- an intake flow limit;
- continuation of wetland restoration and enhancement efforts, as well as operation and maintenance of fish ladders;
- an improved biological monitoring program, including monitoring of passage of river herring in connection with fish ladder sites, improved impingement and entrainment abundance monitoring, improved baywide abundance monitoring, continued detrital production monitoring, and continued study of fish utilization of restored wetlands;
- further analysis of losses at the Station, including such information as biomass lost to the ecosystem and the contribution of RIS (other than bay anchovy) to the forage available for commercial and recreationally important species;
- study of the hydrodynamics at the Station's intake;
- study of enhancements to entrainment and impingement sampling and, based on the study, possibly adjust the entrainment and/or impingement sampling frequencies, locations or methods;

- study of a multi-sensory hybrid intake protection technology system - including strobe light/air bubble combination technology, sound deterrent, and light attraction technologies coupled with enhancements to the fish return system - both individually and in various combinations as a hybrid system, with NJDEP's commitment to requiring implementation of any cost-effective alternate intake protection technologies;

- study of the fish mortality associated with the fish return system and fish sampling pool and, based on the study, consideration of the possible redesign of the fish return sluice and sampling pool; and

- on renewal of the permit, PSEG must provide, in addition to updated 316(a) and 316(b) Demonstrations, estimates of production from the wetland restoration sites and fish ladders, expressed in the same units used to characterized the losses at the intake structure.

(See Draft Permit, Part IV, section G.)

C. Overview of PSEG's Section 316(b) Demonstration

1. Requirements of Section 316(b) Demonstrations

Pursuant to Section 316 of the Clean Water Act, 33 U.S.C. § 1326, the location, design, construction, and capacity of a cooling water intake structure must reflect the best technology available ("BTA") for minimizing AEI. Although AEI is not defined by the statute, numerous Section 316(b) decisions, as well as USEPA guidance, have found that AEI occurs when the ecological function of the organisms of concern is impaired or reduced to a level that precludes maintenance of existing populations or communities, or the magnitude of the existing or proposed damage constitutes an unmitigatable loss to the aquatic ecosystem. (See Guidelines to Determine Best Technology Available for the Location, Design, Construction, and Capacity of Cooling Water Intake Structures for Minimizing Adverse Environmental Impact: Section 316(b), P.L. 92-500, pages 4, 52, 57 (draft Dec. 5, 1975) ("1975 USEPA Guidelines"); USEPA, Office of Water Enforcement, Permit Div., Guidance for Evaluating the Adverse Impact of Cooling Water Intake Structures on the Aquatic Environment: Section 316(b), P.L. 92-500 at 15 (draft May 1, 1977) ("1977 USEPA Guidance")3/; Seacoast Anti-Pollution League v. Costle, 597 F.2d 306, 309-310 (1st Cir. 1979)).

3/ The continuing applicability of the 1977 USEPA Guidance was recently affirmed. (See Memorandum addressing "Implementation of Section 316(b) in National Pollutant Discharge Elimination System Permits," from Michael B. Cook, Director, Office of Wastewater Management, to Water Division Directors, Regions I-X, and State NPDES Directors (Dec. 28, 2000) ("Cook 2000 Memorandum")).

In order to be considered BTA under Section 316(b), an intake technology must be feasible and appropriate for the individual source in question. (See, e.g., USEPA, Development Document for Best Technology Available for the Location, Design, Construction and Capacity of Cooling Water Intake Structures for Minimizing Adverse Environmental Impact, page 176 (April 1976) ("1976 USEPA Development Document") (noting the "highly site specific characteristics of available technology")). Regulatory guidance and legal precedent under Section 316 provide that the costs of any BTA imposed may not be wholly disproportionate to the environmental benefits to be gained. (Id., page 177; In the Matter of Public Service Co. of New Hampshire (Seabrook Station), Case No. 76-7 (June 10, 1977) ("Seabrook"); In the Matter of Carolina Power and Light Co. (Brunswick Steam Electric Plant), NPDES Permit No. NC0007064 (Nov. 7, 1977)). As NJDEP stated in the Fact Sheet, "[d]ecisions under Section 316(b) concerning BTA for cooling water intake structures require a case-by-case determination and should include an evaluation of economic considerations." (Fact Sheet, page 65.) Moreover, NJDEP stated, "a permitting agency has the ultimate burden of persuasion that any BTA measure that it requires is 'available' for a given facility, and that its costs are not 'wholly disproportionate' to environmental benefits." (Id., page 69 (citing Decision of the General Counsel, No. 63, July 29, 1977, page 382)).

2. Application Approach for Evaluating Technology Alternatives

The Application pursued a multi-step, functional approach to assessing the available technology alternatives for addressing the impacts of cooling water intakes on the aquatic environment. This approach is fully consistent with applicable USEPA guidance concerning technology evaluations under Section 316(b).

a. EPA Guidance and Legal Precedent Regarding Technology Evaluations

Longstanding USEPA guidance confirms that a site-specific, multi-step approach is appropriate for determining the best technology available for a particular cooling water intake structure. One of USEPA's original Section 316 guidance documents noted that case-by-case determinations were appropriate due to "the highly site-specific cost versus benefits characteristics of available technology" (USEPA, Office of Air and Water Programs, Effluent Guidelines Div., Development Document for Proposed Best Technology Available for Minimizing Adverse Environmental Impact of Cooling Water Intake Structures, page 145 (Dec. 1973)). Subsequent USEPA guidance confirmed this approach, stating that for Section 316(b) determinations, "the environment-intake interactions in question are highly site specific and the decision as to best technology available for intake design, location, construction, and capacity must be made on a case-by-case basis" (USEPA 1977, page 4). Similarly, USEPA stated that since "the optimal combination of measures effectively minimizing adverse impact on the biota is site and plant specific," the BTA determination "should be established on a case-by-case basis" (Id., page 14). As noted above, USEPA recently reaffirmed the validity of the 1977 Guidance document. (See 2000 Cook Memorandum.)

The 1976 USEPA Development Document recommends a "stepwise thought process" for choosing BTA, moving from least to most costly and time-consuming technology options

(USEPA 1976, pages 193-194). The first step is to consider modification of existing screening systems; USEPA notes that "the cost of in-place modifications of this type are not excessive and they can generally be made while the plant is operating" (Id., page 194). The second step, according to USEPA, is to consider increasing the size of the intake to reduce high approach velocities. (Id.) Next, USEPA recommends consideration of the "very costly" option of abandoning the existing intake and replacing it with a new intake at a different location. (Id.) Finally, the last option to be considered is installation of closed cycle cooling. (Id.) The stepwise approach to technology evaluations was reiterated in the 1977 USEPA Guidance, (USEPA 1977, page 13), which in turn was recently reaffirmed by the Agency. (See 2000 Cook Memorandum).

USEPA has issued additional guidance documents concerning technology evaluations. (See Preliminary Regulatory Development, Section 316(b) of the Clean Water Act, Background Paper Number 3: Cooling Water Intake Technologies (Apr. 4, 1994); Supplement to Background Paper 3: Cooling Water Intake Technologies (Sept. 30, 1996)). The continuing relevance and applicability of these guidance documents was specifically noted by USEPA in December 2000. (See 2000 Cook Memorandum.) The documents identify technologies used or being tested at cooling water intakes for the protection of aquatic life, and provide current (as of the time of their issuance) information regarding the use and effectiveness of the technologies.

EPA's 2000 proposed Section 316(b) rule for new sources identifies a number of potentially available technologies for minimizing adverse environmental impacts. (See 65 Fed. Reg. 49060, 49093 (Aug. 10, 2000)). The proposed rule classifies the technologies into four categories: intake screen systems, passive intake systems, diversion or avoidance systems, and fish handling systems. Although the proposed rule applies solely to new sources, rather than existing sources, it nonetheless provides an indication of the types of technologies USEPA considers appropriate for evaluation in Section 316(b) determinations.

As noted above, pursuant to regulatory guidance and legal precedent under the Clean Water Act, the cost of a technology must be considered in determining if it is BTA. (See USEPA 1976, page 177 ("[t]he term 'best technology available' infers the use of the best technology available commercially at an economically practicable cost")). The legislative history of Section 316(b) also indicates that the BTA analysis requires consideration of costs. According to one of the conference committee managers for the 1972 Clean Water Act amendments, BTA "is intended to be interpreted to mean the best technology available commercially at an economically practicable cost" (Senate Comm. on Public Works, 93rd Cong., 1st Sess., A Legislative History of the Water Pollution Control Act Amendments of 1972, vol. 1 at 264 (Comm. print 1973) (statement of Rep. Clausen)). In the preamble to the 1976 final rule issuing 316(b) regulations (which were subsequently withdrawn), USEPA agreed, stating that "the term 'available commercially at an economically practicable cost' reflects a Congressional concern that the application of 'best technology available' should not impose an impracticable and unbearable economic burden on the operation of any plant subject to Section 316(b)"

(41 Fed. Reg. 17387, 17388 (Apr. 26, 1976)). 4/ The USEPA General Counsel also concurred, finding that "under Section 316(b) [the regulator] has the ultimate burden of persuasion and economic considerations are appropriate" (Decision of the General Counsel on Matters of Law pursuant to 40 C.F.R. § 125.36(m), No. 63, at 26 (July 29, 1977)).

The degree to which costs must be taken into account has been repeatedly considered in USEPA permit decisions and in court rulings. The established standard is whether a technology's costs are "wholly disproportionate" to its environmental benefits. (See Seabrook at 13 (the USEPA Administrator "do[es] not believe that it is reasonable to interpret Section 316(b) as requiring use of technology whose cost is wholly disproportionate to the environmental benefit to be gained"). See also Seacoast Anti-Pollution League v. Costle, 597 F.2d at 311 (upholding the USEPA Administrator's determination that closed-cycle cooling, even though BTA for minimizing adverse environmental impacts, would not be imposed since its costs were wholly disproportionate to the environmental benefits to be gained)). Other cases and regulatory pronouncements have upheld the wholly disproportionate standard. For instance, in one decision, USEPA Region IV found that the $150 million cost of closed-cycle cooling would be wholly disproportionate to the environmental benefits to be derived. (In the Matter of Florida Power Corp., Crystal River Power Plant, NPDES Permit No. LF0000159, page 7 (Findings and Determination Pursuant to 33 U.S.C. § 1326, Sept. 1, 1988)). Thus the cost of the technology selected must not be wholly disproportionate to its benefits, even if the chosen technology does not minimize environmental harms.

b. PSEG's Approach Fully Comports with USEPA Guidance and Legal Precedent

Consistent with the approach to Section 316(b) technology evaluations outlined in the USEPA guidance materials, PSEG performed a detailed analysis of alternative fish protection technologies and flow reduction options in the process of determining BTA for Salem. Information on technologies is presented in depth in the Application (Application Appendix F, Section VIII and Attachment F-3). Review of this information clearly indicates that available technologies and other measures for minimizing potential adverse environmental impacts as a result of the Salem cooling water intake system were considered. The relevant USEPA guidance materials on technology evaluations, as well as information from other available journal articles and industry reports, were reviewed as inputs to the evaluation process.

The 316(b) Demonstration prepared by PSEG used a three-step, functional evaluation process for assessing potential intake-related technologies and other fish protection options. First, the range of potential fish protection options were identified. Second, based on whether

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4/ EPA's recently proposed rule for cooling water intake systems for new sources also cited the 1976 preamble and legislative history regarding cost considerations, and noted the "congressional concern" that application of BTA not impose "an impracticable and unbearable economic burden" (See 65 Fed. Reg. 49060, 49094 (Aug. 10, 2000)).

the option had a known effectiveness for reducing fish losses generally (and not necessarily in relation to the specific species involved at the Station), whether further engineering development would be required for the option to be considered "available," and the relative engineering and/or biological advantages of one option over another, the list of potential options was narrowed. Third, the remaining alternatives were subject to detailed evaluation of their potential applicability to Salem. The alternatives selected for detailed evaluation were:

- wedge-wire screens;
- fine mesh screens;
- modular inclined screens;
- hybrid strobe light/air bubble curtain barriers;
- seasonal flow reductions;
- revised refueling outage schedules; and
- closed cycle cooling.

The detailed evaluations considered a number of factors, such as relevant background knowledge derived from previous assessments of the feasibility of implementing the alternative at Salem, engineering and technical considerations affecting implementation, and potential biological effectiveness in reducing intake losses. PSEG also considered other potential environmental impacts that could result from implementation at Salem, and the costs and operational impacts of implementing the alternative. This approach is fully consistent with the "stepwise thought process" outlined by USEPA, in which technology options are considered ranging from least (screen system modifications) to most (closed cycle cooling) expensive (see USEPA 1976, pages 193-94).

For those options subject to detailed evaluation, a cost-benefit analysis was conducted. Costs considered included: costs associated with construction and installation necessary to implement an alternative; incremental and operating costs associated with the alternative; and the value of lost power at Salem as a result of construction and changes in continuing plant operations. The benefits consisted of commercial and recreational fishing benefits predicted to result due to additional fish protection alternatives. This evaluation of costs and benefits also is fully consistent with the Section 316 guidance materials and legal precedents that address consideration of economic practicability.

Each technology and flow reduction alternative that was carried forward for detailed analysis thus was subjected to an appropriate site-specific review to assess both the ability of that alternative to minimize the potential for AEI, and the costs and benefits associated with the alternative. (See Application Appendix F, Sections VIII and IX.) Therefore, NJDEP and ESSA were provided with all of the information needed to evaluate the range of possible alternatives for Salem.

3. Application Approach for Assessing AEI

a. The Application Uses a Population-Based Definition of AEI

The assessment of AEI in PSEG's Application is based on a definition of AEI that adverse environmental impact occurs under Section 316(b) only when harmful effects occur that have adverse, long-term impacts on aquatic populations and communities as a whole. Impacts to individual organisms do not constitute "adverse environmental impact" unless they affect the abundance, structure or function of the population, taking into account the type, intensity, and scale of the effect as well as the potential for recovery, given natural variability. Only in the case of threatened or endangered species, where impacts to individuals can have a population level effect, can harm to individuals constitute an adverse environmental impact. (See PSEG's Application Appendix F, Section V.A.2.) Thus, PSEG's Application is based on the view that, to determine whether entrainment and impingement losses at Salem have resulted in AEI, the consequences of the losses of individual organisms to fish populations and to the Delaware Estuary ecosystem as a whole must be analyzed. (See Anderson & Gotting, Taken in Over Intake Structures? Section 316(b) of the Clean Water Act, 26 Colum. J. Envtl. L. 1 (2001)).

As is detailed here, this population-based definition of AEI is consistent with an extensive body of legal and regulatory precedents, including statements made most recently by USEPA in the agency's proposed rule for cooling water intake systems for new sources. See 65 Fed. Reg. 49060 (Aug. 10, 2000). The population-based definition is also the most scientifically defensible one.

(1) Section 316(b) Legal Precedent Supports a Population-Based Definition of AEI

The leading judicial decision interpreting the definition of adverse environmental impact for cooling water intake structures concluded that in the context of Section 316(b) the term "adverse environmental impact" refers to harm to fish populations or communities, not individuals. (Seacoast Anti-Pollution League v. Costle, 597 F.2d 306 (1st Cir. 1979)). As the court put it, the central inquiry in assessing AEI was whether intake losses would "affect the ability [of fish species] to propagate and survive" (Id., page 310). (See generally Application Appendix D, Section V.B., pages 114-116.)

In the agency proceedings relating to the Seacoast decision, the Administrator emphasized that the loss of larvae through entrainment "cannot be expected to result in [the same degree of loss to] the adult population because it does not take into account compensatory mechanisms and density-dependent limiting factors. . . ." (Seabrook at 41). He also acknowledged the importance of recruitment to populations from other areas, and rejected as excessively conservative the use of population models that fail to account for compensation. (Id.) In a subsequent decision (following remand on procedural grounds), the Administrator reaffirmed these principles. (In re Public Service Co. of New Hampshire, Seabrook Station, NPDES Permit Application No. NH 0020338, Decision on Remand, Case No. 76-7, Region I (Aug. 14, 1978) ("Seabrook II")). He emphasized, for example, that entrainment mortality would not have an adverse impact on abundance and distribution of plankton "even though the total biomass . . . killed may amount to hundreds or thousands of tons per year" because "[t]here is great ability of planktonic species to reproduce themselves rapidly," and "the Gulf of Maine is rich in plankton" (Seabrook II at 18-19). The Administrator concluded that entrainment losses need not be quantified precisely because "the available sources of recruitment and replacement [were] so large" that populations were unlikely to be affected (id., pages 21-22 & n.5).

EPA and state agencies have applied the Agency's population-based concepts of AEI in numerous other permit decisions through the years. (In re Boston Edison Co., Pilgrim Power Plant Proposed NPDES Permit Nos. MA0003557 and MA0025135, USEPA Region 1 (Mar. 11, 1977) (large intake losses of individual blue mussel not causing adverse population impacts due to compensatory mechanisms); Potomac Electric Power Co., Chalk Point Generating Station, Modification of NPDES No. MD0002658B, Maryland Department of the Environment (Apr. 29, 1991) (existing intake structure represents BTA despite entrainment losses of 10-20 percent of population because no evidence of adverse impacts on fish populations); Indian River, USEPA Region IV, Determination re: NPDES No. 0000680 (July 11, 1983) (existing intake structure represented BTA despite reducible entrainment and impingement losses); Nebraska Public Power District, Gerald Gentleman II Power Plant, NPDES Permit No. NE0111546, Nebraska Department of Environmental Control, Case No. 201 (Nov. 1981) (intake structure modifications not required absent a showing of significant adverse impact on fish populations); Florida Power Corp., Crystal River Power Plant Units 1, 2 and 3, NPDES Permit No. FL0000159, USEPA Region IV (Dec. 2, 1986) (relevant impact is impact on macroinvertebrate communities, not individuals)). This consistent application of the AEI concept firmly establishes that Section 316(b) is designed to address adverse impacts at the population or community level.

(2) Section 316(b) Regulatory Guidance Supports a Population-Based Definition of AEI

In several guidance documents issued pursuant to Section 316(b), USEPA has articulated clearly the appropriate concepts for evaluating AEI, and has left no doubt that the inquiry must be undertaken with respect to populations, not just individuals. In the 1975 USEPA Guidelines, for example, USEPA said that "[a]dverse environmental impacts occur when the ecological function of the organism(s) of concern is impaired or reduced to a level which precludes maintenance of existing populations . . . ." (USEPA 1975, page 52 (emphasis added)). Similarly, in the 1976 USEPA Development Document, USEPA said that "[t]he major impacts related to cooling water use are those affecting the aquatic ecosystems. Serious concerns are with population effects that . . . may interfere with the maintenance or establishment of optimum yields to sport or commercial fish and shellfish, decrease populations of endangered organisms, and seriously disrupt sensitive ecosystems" (USEPA 1976, page 5).

In addition, the recently-reaffirmed 1977 USEPA Guidance states that "the exact point at which adverse aquatic impact occurs at any given plant site or water body segment is highly speculative and can only be estimated on a case-by-case basis by considering the species involved, magnitude of the losses, years of intake operation remaining, ability to reduce losses, etc." (USEPA 1977, page 11.) 5/ And the Guidance unequivocally states that "[r]egulatory agencies should clearly recognize that some level of intake damage can be acceptable if that damage represents a minimization of environmental impact." (Id., page 3.)

Moreover, USEPA's most recent publications on the subject confirm the view that, for existing cooling water intake systems, population level adverse impacts must be identified before AEI occurs. The August 10, 2000 proposed rule for cooling water intake structures for new sources (65 Fed. Reg. 49,060, 49074) includes a section describing EPA's current definition of AEI for purposes of implementing Section 316(b). USEPA indicates that, for existing sources, the definition is guided by the 1977 USEPA Guidance as follows:

> [T]he 1977 Section 316(b) draft guidance defined the term "adverse environmental impact." It states that "[a]dverse aquatic environmental impacts occur whenever there would be entrainment or impingement damage as a result of the operation of a specific cooling water intake structure." That definition also states, however, that "[t]he critical question is the magnitude of any adverse impact." The guidance lists specific factors relevant for determining the long- and short-term magnitude of any adverse impacts. The 1977 Draft Guidance established a process under which cooling water intake structures were evaluated on a case-by-case basis to determine the level of environmental impact occurring and the appropriate best technology available to minimize adverse environmental impact. The framework and definitions in the 1977 Draft Guidance recommend that facilities should initially determine the incremental environmental impact of each cooling water intake structure on the populations of affected species or organisms and that BTA be applied only where it is determined that such incremental impacts are deemed to constitute "adverse environmental impact." (Emphasis added; notes omitted.)

While the proposed rule goes on to acknowledge some of the difficulties in applying this case-by-case population level definition, and to encourage consideration of alternative

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5/ The 1977 USEPA Guidance specifies that the magnitude of any adverse impact should be estimated in terms of "both short-term and long-term impact" with reference to the following factors: (1) absolute damage; (2) percent damage; (3) absolute and percentage damage to any endangered species; (4) absolute and percentage damage to any critical aquatic organism; (5) absolute and percentage damage to commercially valuable and/or sport fisheries yield; and (6) whether the impact would endanger (jeopardize) the protection and propagation of a balanced population of shellfish and fish in and on the body of water from which the cooling water is withdrawn (long-term impact). (USEPA 1977, page 15.)

definitions for purposes of the new source rulemaking, USEPA states clearly in the proposed rule that the case-by-case population level analyses advocated in its 1975 and 1977 guidances remain the currently applicable standard for assessing AEI with regard to existing cooling water intake systems. Moreover, as noted above, in December 2000, USEPA circulated a Memorandum that reiterated that, for existing cooling water intake structures, NPDES permit writers should continue to rely on the 1977 USEPA Guidance. (See 2000 Cook Memorandum.)

In the "Scope of Work" for the ESSA Report (reprinted in the ESSA Report, pages 157-159), NJDEP indicates that it disagrees with a population-based definition of AEI, stating that "NJDEP and other states, such as New York, have considered the death of any fish at or through a cooling water intake to be an 'adverse impact' which must be minimized through available technologies under Section 316(b)." ESSA Report, page 158. Despite NJDEP's view, however, it is clear that defining AEI under Section 316(b) as harm to one individual fish is not consistent with existing case law or USEPA guidance on the subject. Thus, while PSEG acknowledges that impingement or entrainment of a fish constitutes a harm to that individual organism, PSEG does not agree with NJDEP's view that it constitutes "adverse environmental impact" under Section 316(b). Sound science as well as applicable regulatory and legal precedent support PSEG's view.

b. PSEG's Approach to Assessing AEI Relied on Ecologically Based, Multiple Independent Lines of Evidence Interpreted by Recognized Experts

PSEG's Application uses benchmarks of AEI that are ecologically based and that express the Station's effects in terms of their implications for population/ecosystem health. This approach is not only consistent with legal and regulatory precedents, as detailed above, but also with sound science. In biological terms, the reproducing population is the smallest ecological unit that is persistent in time (Suter 1993). Salem causes losses of small invertebrates and of early life stages of and/or small fish, which experience very high natural mortality rates even in the absence of entrainment and impingement. For this reason, the loss estimates in and of themselves are virtually meaningless as indicators of AEI, since many of the organisms lost due to the Station would otherwise have succumbed to concurrent risks of death from natural causes. To meaningfully determine whether entrainment and impingement losses at Salem have resulted in AEI, the consequences of the losses of individual organisms to populations and to the Delaware Estuary ecosystem as a whole must be assessed.

Applying these concepts, PSEG expended considerable effort and resources to document the extent to which Salem's operations affect aquatic organisms, and whether such effects are having an adverse environmental impact. That body of research uses multiple lines of evidence and multiple data sources, and applies the judgment of recognized experts to appropriately evaluate those lines of evidence in a comprehensive, integrated approach that is fully consistent with best practice in ecological risk assessment ("ERA") and is explicitly endorsed in USEPA's Guidelines for Ecological Risk Assessment ("USEPA 1998").

(1) In Recognition of Inherent Uncertainties, PSEG's Assessment of AEI relies on Multiple Lines of Evidence

PSEG developed an impact assessment approach (see Application, Appendix F, Section VI) that used multiple lines of evidence for assessing AEI as a means for addressing the recognized and inherent uncertainties in data and inputs to the assessment. Many of these uncertainties were identified by ESSA in its report. The USEPA ERA Guidelines explicitly endorse the use of multiple lines of evidence in characterizing ecological risks:

> Confidence in the conclusions of a risk assessment may be increased by using several lines of evidence to interpret and compare risk estimates. These lines of evidence may be derived from different sources or by different techniques relevant to adverse effects on the assessment endpoints, such as quotient estimates, modeling results, or field observational studies. (USEPA 1998.)

The three benchmarks of AEI in PSEG's impact assessment are:

1. Absence of a balanced indigenous community of aquatic biota;

2. Observation of a continuing decline in abundance of aquatic species vulnerable to the Station; and

3. Indication (from modeling) that the Station is jeopardizing the sustainability of important fish stocks.

In other words, the AEI benchmarks focus on fish community balance, population abundance, and fishery sustainability.

Two of the three benchmarks used by PSEG were addressed using field data rather than predictive methods. PSEG's assessment relied heavily on the observed condition of the Estuary for two reasons. First, Salem is an existing plant with a 20-year operational history, a period sufficiently long that several generations of even the longest-lived RIS have been exposed to the Station. Monitoring of the estuary's ecological resources has been nearly continuous over this period. Any adverse impacts caused by Salem should be reflected in this empirical record. Second, whereas model outputs provide predictions concerning *potential* effects of Station operations on estuarine biota, the empirical data provide measures of the *actual* condition of the biota. PSEG believes that despite difficulties that may exist in interpreting observational data, making full use of information concerning the actual conditions of the aquatic ecosystem is preferable to relying solely on loss estimates and models.

As is detailed in Section VII.B. of this Response, these benchmarks are consistent with the recommendations provided in USEPA's Guidelines for Ecological Risk Assessment (USEPA 1998). According to the ERA Guidelines, assessment endpoints are "[e]xplicit expressions of the actual environmental value that is to be protected, operationally defined by an ecological entity and its attributes." (USEPA 1998) Individual species (e.g., the Salem RIS) and communities of species (e.g., the Delaware Estuary fish community) are identified in the ERA Guidelines as examples of appropriate "ecological entities" for defining assessment endpoints. "Attributes," according to the ERA Guidelines, are specific characteristics of the entities of concern that are important to protect and are potentially at risk. Based on the regulatory precedents cited above, it is clear that fish community balance, population abundance, and fishery sustainability are "important to protect and are potentially at risk" due to Station operations and, therefore are valid "attributes."

Although appropriate from the perspective of legal and regulatory guidelines, the benchmarks would be useless from an assessment perspective without explicit definition of the kinds and degrees of change in the attribute that should be considered "adverse," and without specific methods for determining whether those definitions have been met. In the ERA Guidelines, the methods - combinations of data and models - used to measure or estimate changes in an attribute (e.g., abundance of an ecologically or economically important species) in response to a stressor (e.g., entrainment and impingement) are termed "measures of effect." (USEPA 1998) In the Salem Section 316(b) Demonstration (Application, Appendix F), the functional equivalents of USEPA's measures of effect are the various indicators developed for each benchmark.

For each benchmark of AEI, the Application documents one or more indicators of AEI. (See Application, Appendix F, Section VII.) For each indicator, the Application provides a specific method - a combination of data and models - for measuring the impact of the Station, and a quantitative criterion for determining whether an AEI has occurred or will occur. For example, in the stock jeopardy analysis, PSEG used reductions in spawning stock biomass ("SSB") and reductions in spawning stock biomass per recruit ("SSBPR") as indicators of AEI. These reductions were quantified using the Equilibrium Spawner Recruit Analysis ("ESRA") model and the Spawning Stock Biomass per Recruit ("SSBPR") model. Consistent with the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. § 1801 et seq.), AEI was assumed to occur if Station operations were to cause SSB to fall below a level equal to 20% of the unfished SSB, or to cause SSBPR to fall below 30% of the unfished SSBPR.

All three of the criteria discussed above, i.e., direct relationship to population or ecosystem health, existence of regulatory and scientific precedents, and feasibility of establishing criteria for interpreting significance of impacts, were deemed by PSEG to be essential for performing an adequate determination of AEI. As noted above and detailed in Appendix F of the Application, the benchmarks and indicators chosen by PSEG satisfy all of these criteria.

Further, PSEG did not assume that a few statistics for one component could be sufficient to detect all changes in a "highly variable" system. Rather, PSEG chose indicators that would be expected to respond to Station influences, and used multiple indicators to address the influence of environmental variability. By using multiple benchmarks, each with multiple indicators, PSEG followed EPA's recommendation for increasing confidence in assessment conclusions, and effectively reduced the risk of drawing an erroneous conclusion due to uncertainties in any one indicator.

(2) Multiple Data Sources

The Application thoroughly describes the multiple data sources used by PSEG in the Section 316(b) Demonstration (see Application, Appendix F, Section VI), and Appendix L presents the data used in the evaluations. A review of these documents illustrates that PSEG considered the voluminous data provided by the States of Delaware and New Jersey, federal agencies, academic institutions and private entities. The studies included entrainment and impingement monitoring, PSEG's nearfield and baywide surveys, the DNREC large trawl survey, the DNREC juvenile bottom trawl survey, the NJDEP beach seine survey, the American shad and white perch mark-recapture programs, pre-operational monitoring studies, and numerous special studies that are particularly relevant to the performance of a thorough, site-specific Section 316(b) assessment.

PSEG's use of the available data sources was focused on addressing the major Section 316(b) issues. For example, one of PSEG's objectives was to use the available relevant historical data to determine whether, taking account of changes in water quality, fishing pressure, and habitat over the relevant thirty-year period, the operation of Salem has upset or modified the balance of the Delaware Estuary fish community. The objective was not to detect or explain all possible changes that might have occurred over this period.

For example, PSEG's conclusion that Station operations have not upset or modified the fish community of the Delaware Estuary was derived from the concordance of three lines of evidence and was described as such in the Application. (Application, Appendix F, Section VII.A.4.) PSEG does not claim and has not ever claimed that its analyses could detect or explain all possible ecological changes in the Delaware Estuary. Given the size and complexity of this ecosystem, not even the most intensive monitoring studies could achieve such an ambitious objective. The objectives of PSEG's research were much more limited: to determine whether the past 20 years of Station operations had caused an AEI to the aquatic biota of the Estuary.

(3) Integrative Interpretation by Expert Judgment

PSEG recognized that a thorough assessment of the cumulative effects of the operation of Salem would require consideration of a vast amount of disparate data and information on the affected RIS populations. PSEG also recognized that considerable uncertainty would exist within this information and data (as is always the case with data and information on aquatic populations). It was also clear to PSEG that no single formula or procedure was available that could be used to analyze all relevant information and data in a holistic manner that would lead to unambiguous answers. Finally, the assessment of cumulative effects had to provide scientifically defensible conclusions regarding Station effects; it was not enough for the Assessment to be simply a descriptive discourse on the data and information.

For these reasons, PSEG engaged scientists with expertise in fishery stock assessments, ecology and biometrics to assemble and interpret the relevant information and data. The conclusions presented in Appendix H ("Cumulative Effects Assessment") are based on empirical data, modeling results and the expert opinion of five nationally recognized scientists with collective experience of over 100 years.

The approach used for the cumulative effects assessment includes a detailed evaluation of: the historic effects of entrainment and impingement on each of the RIS; the historic effects of Salem's operation on the aquatic community; and a predictive evaluation of the likely effects that the Station will have on the RIS and aquatic community based on full power Station operations in the future (a conservative assumption that overestimates likely future effects of Salem). Both the predictive and retrospective studies of the Station's effects show that the intake is not having and will not have an adverse environmental impact as assessed at the population and community level. The conclusions presented in Appendix H were based on the professional judgement of the scientists. The technical foundation for each conclusion was discussed as part of the Retrospective Assessment, or by reference to other parts of the Application. The interpretation of the technical foundation was also discussed as part of the Retrospective Assessment and was based on the professional judgement of the scientists.

D. General Comments on the ESSA Report

The ESSA Report is a lengthy, detailed review, which applies "academic" rather than regulatorily-driven standards, of selected, highly complex, technical portions of the documentation in PSEG's Application. It offers many comments and recommendations regarding the analyses in PSEG's Section 316(b) Demonstration, particularly regarding known and potential uncertainties in the data and analyses.

As PSEG's Response to the ESSA Report details, however, only relatively few of the many comments and recommendations in the ESSA Report are potentially worthy of further consideration by NJDEP and PSEG; the majority of the comments are either based on misinterpretations of PSEG's Application or irrelevant with respect to evaluating the merits of PSEG's Section 316(b) Demonstration. To ensure that NJDEP fully understands the scientific and technical bases for PSEG's position that most of ESSA's comments are erroneous or irrelevant, PSEG prepared the detailed section-by-section Detailed Technical Response to the ESSA Report that is presented in Sections II-VII. In addition to acknowledging the comments by ESSA that have merit, these sections provide in-depth analysis and documentation of why the overwhelming majority of ESSA's comments do not merit further consideration by either PSEG or NJDEP.

ESSA's approach to the task of reviewing PSEG's Application focuses on improving the degree of "scientific rigor" in each of the analyses. In general the comments and recommendations that result from this "academic" approach are irrelevant to the Section 316(b) permitting context. As is well established by relevant regulatory guidance and legal precedent, the goal of the Section 316(b) review process is to ensure that the data supporting a demonstration reasonably demonstrate compliance with Section 316(b), not to ensure that the highest level of theoretical perfection is achieved in every detail of the supporting technical analyses.

ESSA's review appears to lose sight of the important distinction between the legal requirement that compliance with Section 316(b) must be reasonably demonstrated, and the academic goal of achieving technical perfection in that demonstration. In particular, the ESSA Report's compartmentalized, highly academic approach to reviewing the analyses and data in PSEG's Application fails to focus on the fact that, as detailed above in Section I.C.3.b., the Application relies on the use of multiple lines of evidence, multiple data sources, and integrative interpretation by expert judgment as a scientifically appropriate and reasonable way to address uncertainties in the data and analyses. For the most part, the ESSA Report ignores the significance of these factors in reasonably addressing many of the concerns about uncertainty raised in the Report.

In addition, despite the qualifications and experience of the ESSA Report's authors, the majority of the comments in the ESSA Report are erroneous and/or irrelevant, for a number of reasons. Some comments simply reflect an inability to locate information in the Application; some reflect lack of understanding of certain aspects of the Application, and some reflect lack of detailed knowledge about site-specific factors. It is clear that, while the authors of the ESSA Report certainly possess relatively high levels of academic and professional expertise consistent with their responsibility to review PSEG's Application, in many instances they did not, and indeed could not be expected to, possess a great degree of familiarity with the highly fact- and site- specific details of PSEG's Application, Salem Station's structure or operations, and/or the local estuary conditions. That lack of familiarity, however, is responsible for a number of the ESSA Report's ill-founded comments.

In many cases, as detailed below in Section I.D.3.e., ESSA's errors might have been avoided had ESSA consulted more closely with the experts who prepared PSEG's Application during the review process regarding any issues of confusion. Throughout the Application review process, PSEG made its technical experts available to ESSA for whatever assistance ESSA deemed necessary in understanding details of the Application. For example, on May 17, 2000, PSEG provided a detailed, lengthy document to NJDEP and ESSA addressing preliminary findings that ESSA had presented to NJDEP and PSEG in April, 2000. (See Letter to S.T. Rosenwinkel from M.F. Vaskis, Response to ESSA's Presentation of Preliminary Findings From Its Review of PSE&G's March 1999 Permit Renewal Application for Salem Generating Station ("May 2000 Report"); Attachment II-C to these Comments.) However, there is no evidence in the ESSA Report, dated June 14, 2000, that ESSA reviewed or took any of this information into account for purposes of its Report.

For all of the foregoing reasons, the many specific comments and recommendations in the ESSA Report regarding how to improve the scientific "rigor" of the Application are primarily irrelevant and/or erroneous for purposes of ensuring that PSEG's Application meets the standards applicable to a Section 316(b) demonstration.

1. ESSA Provides a Detailed, Highly Critical Review of the Technical Documentation of PSEG's Application

As stated in the "Scope of Work" for the ESSA Report, NJDEP sought ESSA's assistance in reviewing "limited portions" of PSEG's Application (see "Scope of Work for ESSA

Technologies Ltd. to Assist New Jersey Department of Environmental Protection" October 1, 1999; reprinted in ESSA Report, pages 157-159). Further, the "primary focus" of the contractor's charge was "to review [PSEG]'s assessment as to whether technological measures can be implemented at Salem to reduce the number of organisms that are impinged and entrained at Salem each year where the economic costs are not wholly disproportionate to the benefits pursuant to Section 316(b) of the Clean Water Act, 33 U.S.C. Section 1326." (Id., page 157.)

The "Scope of Work" went on to delineate fairly specifically the technical portions of PSEG's Application that ESSA was to review:

> Specifically, the contractor shall review the accuracy of PSEG's entrainment and impingement mortality estimations; PSEG's evaluation and determination as to available technologies to reduce impingment and entrainment mortality; and PSEG's assessment of economic costs associated with various available technologies as well as the economic benefits to the fishery from such technologies. Lastly, the contractor will review those portions of the Application that pertain to models and analyses presented to demonstrate that the actual and potential effects of cooling water withdrawal operations at the [Salem Station] are fully understood and adequately documented for twelve representative important species [RIS] of the Delaware River." (ESSA Report, page 157.)

It is clear from both the general and specific charges of the Scope of Work that NJDEP did not ask ESSA to evaluate the merits of PSEG's assessments regarding AEI, but only to evaluate the BTA assessment and selected technical portions of the analyses supporting the AEI assessment.

ESSA apparently viewed its goal under this Scope of Work as evaluating the "scientific rigor" of PSEG's many sources of data and multiple lines of analysis. ESSA expressly represents its task as one of identifying ways to "increase the scientific rigor of the present Permit Application and future applications" (ESSA Report, page 152). Further, ESSA expressly states that determining "the relevance and application of the results of the ESSA review to the requirements of Section 316(b) ... is outside the scope of ESSA's Terms of Reference" (ESSA Report, page 5) and that assessing "the impact of our concerns on the results and conclusions of the Permit Application will require further analyses that are beyond the scope of this review" (ESSA Report, page 146).

Thus, the ESSA Report does not seek to provide an integrated evaluation of the substantive merits of PSEG's BTA assessment pursuant to Section 316(b), but instead offers a series of compartmentalized analyses of discrete portions of the Application. These academic, compartmentalized analyses do not generally reflect that ESSA's comments or recommendations are predicated upon or conditioned by the regulatory standards applicable in a Section 316(b) context for determining the level of scientific rigor that appropriately may be demanded of the analyses in the Application. That is, ESSA's many highly academic criticisms of particular methods and conclusions in the Application do not appear mindful of the reasonableness standard of review that, under applicable Section 316(b) regulatory guidance and precedent, is the appropriate standard for the analyses supporting a Section 316(b) demonstration.

2. ESSA's Approach is Inconsistent with Regulatory Precedent Regarding Section 316(b) Demonstrations

ESSA's approach to reviewing PSEG's Application is not consistent with applicable regulatory precedent. For existing plants, the goal of the supporting analyses for a Section 316(b) demonstration is not perfection or certainty but rather to provide data and information that are "reasonable" and "reliable" in the particular circumstances. As detailed in the extensive 1977 USEPA Guidance (USEPA 1977), which USEPA has recently affirmed as the guidance currently applicable for existing plants (Cook 2000 Memorandum), an agency reviewing a Section 316(b) determination must do so mindful of the limits of scientific research, the importance of site-specific factors in evaluating impacts, and the need for informed professional judgment to address uncertainty. See, e.g., (emphases added):

> The overall goal of [intake studies] ... will be accomplished by providing reliable quantitative estimates of damage that is or may be occurring and projecting the long-range effect of such damage to the extent reasonably possible. (USEPA 1977, page 4.)
>
> [M]odels are highly desirable ..[but] the time and costs involved will not be justifiable in many situations. (Id., page 32.)
>
> Each survey should be designed on a case-by-case basis recognizing the uniqueness of biota-site-structure interrelationships .... (Id., page 33.)
>
> The optimal [sampling] methodology is highly dependent on the individual species studied coupled with site and structure characteristics .... (Id., page 35.)
>
> For many if not most critical species, the natural mortality may be impossible to determine and the impact may have to be based on a reasonable judgment. (Id., page 37.)
>
> [When standard survey and analytical techniques cannot detect an adverse impact] it may be necessary to base a determination of adverse impact on professional judgment by experienced aquatic scientists. (Id., page 39.)
>
> [The assumptions on which diverse population and community models] are based are difficult to test and the parameters difficult to estimate ... [n]evertheless, models are a means of integrating the available information and the subjective underlying assumptions

> about a problem in order to produce the most rational answer based on the inputs. (Id., page 46.)

In addition to the 1977 USEPA Guidance clearly articulating the importance of reasonable standards regarding the degree of scientific rigor required in the analyses supporting a Section 316(b) demonstration, the Seabrook decision cited above supports a reasonableness standard as well, indicating that an agency must make Section 316 permitting decisions relying on the "best information reasonably attainable," so long as there are not critical deficiencies in the information. The Administrator quoted with approval a draft Section 316(a) Guidance Manual that stated:

> Mathematical certainty regarding a dynamic biological situation is impossible to achieve, particularly where desirable information is not obtainable. Accordingly, the Regional Administrator (or Director) must make decisions on the basis of the best information reasonably attainable. At the same time, if he finds that the deficiencies in information are so critical as to preclude reasonable assurance, then alternative effluent limitations should be denied. Seabrook at 22 (emphasis added).

There is no question that the data and analyses presented in PSEG's Application to support its assessments regarding best technology available and adverse environmental impact more than meet the level of scientific rigor articulated in the 1977 USEPA Guidance and in the Seabrook decision.6/

In contrast, ESSA's highly academic focus on evaluating the scientific rigor of the documentation in the PSEG Application clearly is not consistent with Section 316(b) precedent. Indeed, many of ESSA's comments ask for a level of supporting documentation that goes well beyond that typically provided in 316(b) demonstrations and other regulatory contexts such as fisheries management decision-making. ESSA's highly critical, academic review does not alter the fact that the Department's obligation is to determine whether PSEG's data and analyses provide reasonably sufficient support for its Section 316(b) determination.

6/ Of course, under Section 316(b), unlike Section 316(a), the burden of proof is on the regulatory agency when evaluating intake technologies. See In the Matter of Public Service Co. of New Hampshire (Seabrook Station, Units 1 and 2), Case No. 76-7 (Decision on Remand Aug. 4, 1978) at 22 ("precise quantification of affected organisms was not required" in order to make a Section 316(b) determination).

3. The Majority of ESSA's Comments Do Not Warrant Consideration by NJDEP or PSEG

The ESSA Report clearly provides assistance to NJDEP in evaluating the more technical portions of PSEG's Application. ESSA's Report provides detailed elaborations of complex issues that could potentially be of concern in analyses of the type provided in PSEG's Section 316(b) Demonstration, and the ESSA Report includes many comments addressing relationships between the analyses in PSEG's 316(b) Demonstration and broader ecological resource management issues.

In addition, the ESSA Report also provides certain valid, relevant comments or recommendations that offer reasonable suggestions for improving PSEG's Application. A concrete example is ESSA's correctly pointing out that PSEG should have but failed to include estimates of degrees of freedom in Application Appendix J (see Section VII.E.1.(e)(5) of PSEG Response).

However, as is detailed at length in the section-by-section response to the ESSA Report provided in Sections II-VII of this Response, many of ESSA's comments are either irrelevant or erroneous and thus do not warrant further consideration by NJDEP or PSEG.

a. Many of ESSA's Comments Reflect an Inability to Locate Information in PSEG's Application

PSEG acknowledges that its March 4, 1999 filing was a complex, lengthy, highly technical submission, consisting of many parts and subparts. Still, PSEG endeavored to present those materials in an organized fashion, with detailed tables of contents provided. Despite PSEG's efforts, however, it is evident from many of ESSA's comments that ESSA missed information that was contained in the Application. For example, many of ESSA's comments mistakenly identify what ESSA perceived to be incomplete discussions of issues or instances where PSEG's Application inadequately addressed data uncertainty. To a great extent these comments reflect simply a lack of knowledge about where certain information is found in the Application. For example, ESSA indicates that it is "unable" to determine at what level PSEG's costs-benefit analyses defined costs and benefits, even though the Application states clearly that both costs and benefits are measured from the standpoint of society (see PSEG Response Section VI.B.6a., VI.C.2.a.(3), VI.C.6.e.). Indeed, ESSA's many comments regarding PSEG's failure to address uncertainties in the data often ignore extensive evidence in the Application that PSEG was aware of such data uncertainties, and documented and addressed them in the Application.

ESSA also frequently states that the discussions of some topics in some sections of the Application are incomplete, implying that the incomplete discussions reflect scientific flaws, when in fact the topics are discussed fully elsewhere in the Application. For example, ESSA states that the "statistical populations" associated with indices of fish abundance are not provided, when the Application provides the relevant information in three different places (see PSEG Response VII.E.). Similarly, ESSA states that the selection criteria for recreational demand studies are unclear when they are clearly outlined in Application Appendix F (see PSEG Response VI.C.6.a.).

In concluding its Report, ESSA briefly notes the possibility that it could have failed to find information which it cited as missing in the Application:

> In some cases, our concerns may reflect the size and complexity of the Application - the appropriate explanation or caveat may exist, but we could not find it. (ESSA Report, page 152.)

This statement is somewhat surprising since PSEG made all reasonable efforts to assist ESSA in understanding the organization and content of the Application. At the November 8, 1999 initial meeting with NJDEP and ESSA, PSEG gave a presentation on its Application that exhaustively described the components of the Application, what each contained and their inter-relation with one another (see PSEG Presentation to NJDEP, November 8, 1999; Attachment III-A to these C omments). Moreover, PSEG made its experts available to meet in person or by conference call with ESSA on numerous occasions and provided responses to numerous requests for additional information. In other words, ESSA had NJDEP's authorization and PSEG's pledge of cooperation to obtain answers to any questions that might arise, including answers to such basic issues as where to locate information in the Application.

b. Many of ESSA's Comments Reflect Lack of Understanding of Certain Aspects of the Application

Some of ESSA's many comments about how uncertainty is documented or analyzed in the Application reflect a lack of understanding regarding the Application's fundamental approach. As detailed above in Section I.C.3., PSEG's Section 316(b) Demonstration includes a vast variety of analyses, based on multiple lines of evidence and multiple data sources, that cover a wide range of topics related to the health of fish stocks of the Delaware Estuary and the effects of Salem on those stocks. An important part of PSEG's Section 316(b) Demonstration is the holistic synthesis of this vast array of data and information in the cumulative impacts assessment.

In preparing this assessment, PSEG recognized that considerable uncertainty would be associated with this information and data (as is always the case with data and information on aquatic populations) in part because of the breadth and complexity of the information PSEG had compiled. It was also clear to PSEG that no single formula or procedure was available that could be used to analyze all relevant information and data in an integrated manner that would lead to unambiguous answers. Furthermore, since the Demonstration had to provide scientifically defensible conclusions regarding Station effects, it was not enough for the Application to be simply a descriptive discourse on the data and information. For these reasons, PSEG engaged stock assessment scientists with decades of experience conducting stock assessments for resource agencies to assemble and interpret the relevant information and data. The conclusions presented in PSEG's Application are based on the informed, professional judgement of these scientists.

The ESSA Report's approach to reviewing the analyses in the Application for the most part fails to consider the significance of the Application's integrative, holistic approach when evaluating the technical merit or the defensibility of conclusions in the analyses. This is especially true with respect to ESSA's many and repeated calls for additional extensive uncertainty analyses. ESSA's approach seems to entirely ignore regulatory precedents discussed above in Section I.D.2, especially the 1977 USEPA Guidance for Section 316(b) demonstrations, that recognize the uncertainties of scientific research and the need for reasonable ways to address them, including the use of expert judgment.

In addition to the many comments which do not reflect the significance of the integrative expert approach of the Application, the ESSA Report also contains many comments that simply reflect misunderstandings of particular assumptions or conclusions in the Application. ESSA frequently makes erroneous assumptions about the objectives of an analysis that result in comments that are irrelevant to PSEG's analysis. For example, in some instances ESSA posits hypothetical conditions that have no relevance to the topics being reviewed, and then implies that the Application is flawed due to some speculation of its hypothetical condition, as when ESSA implies that the Application interpreted each index of abundance for a species as a measure of the relative abundance of the overall stock (see PSEG Response Section VII.E.1.b.(2).). In other instances, ESSA offers comments that are based on misconstruing the objective of an analysis or that are irrelevant to the objective of an analysis, as when reviewing PSEG's indicators of fluctuations in abundance and presence/absence in the BIC analyses (see PSEG Response VII.D.1).

c. Many of ESSA's Criticisms Reflect Lack of Detailed Knowledge about Site-Specific Factors

Contrary to the 1977 USEPA Guidance, the ESSA Report ignores the importance of site-specific characteristics in evaluating research on technologies for effectiveness and engineering practicability (see PSEG Response V.E.1). ESSA's discussion of Salem Station's "fish escape routes" reveals a lack of understanding of the Salem CWIS and how fundamental hydraulic principles operate there (see PSEG Response V.E.1.a(2)). ESSA's recommendation that installation of a jetty could reduce organism entrainment and impingement similarly reflects a lack of familiarity with relevant site-specific conditions that render the recommendation ill-founded (see PSEG Response V.E.1.b.).

Further, the ESSA Report frequently suggests additional analyses that ESSA claims should be conducted that in fact are infeasible or irrelevant given site-specific conditions. Examples include the suggestion to sample fish for mortality after the fish have been returned to the Estuary (see PSEG Response V.B.3.); and the recommendation that PSEG evaluate other indicators of ecosystem function and structure when evaluation of such indicators is not warranted by the site or applicable guidance (see PSEG Response VII.B.2).

Similarly, many of ESSA's recommendations for additional analyses frequently appear to be made without awareness of how other site-specific factors make it infeasible to conduct the analyses. For example, ESSA recommends calculating the marginal value of additional fishing trips when there are no studies available to do so (see PSEG Response VI.C.4.a.). ESSA also recommends additional studies in the trends analyses to separate the effects of the Station from other anthropogenic effects when such is not a goal of the trends analyses and when the data necessary to conduct such an analysis validly are not available (see PSEG Response VII.E.1.f).

Generally, ESSA's suggested additional analyses would not produce meaningful answers, even if they could be successfully conducted.

d. Many of ESSA's Comments Are Irrelevant in the Section 316(b) Context

As previously discussed in Section I.D.2. above, ESSA's approach – which focuses on improving the "scientific rigor" of the documentation in the Application -- frequently results in comments and recommendations that are irrelevant to evaluating whether the analyses satisfy the standards associated with Section 316(b) demonstrations. The Detailed Technical Evaluation repeatedly identifies such irrelevant comments and recommendations. The most common type of such irrelevant criticisms in the ESSA Report are the many recommendations for the development of additional data or analyses where the purpose of the recommended analyses with respect to the Section 316(b) Demonstration is not clear. Examples include: ESSA's recommendations regarding additional cost-benefit analyses that would not add to the understanding or affect overall conclusions, discussed below in Section IV.; ESSA's vague recommendation of analyses of "additional indicators" for the balanced indigenous community ("BIC") analysis without indicating how or why the analysis would improve the basis for NJDEP's Section 316(b) permit decision, discussed below in Section VII.D.5; ESSA's recommendations of additional discussions of uncertainty regarding PSEG's production foregone calculations when PSEG's conclusions did not depend on an inability to detect changes due to low statistical power and therefore further discussions would not improve the analysis, discussed below in VII.C.5.b. Clearly, there can be no basis for NJDEP or PSEG considering such recommendations.

e. ESSA Could Have Resolved Many of its Concerns if ESSA had Consulted More Closely with PSEG Regarding Areas of Confusion

Many of ESSA's comments that are due to lack of detailed knowledge of the Application or of site-specific factors could have been resolved had ESSA posed additional questions or information requests to PSEG during the review process. To assist NJDEP and ESSA in ESSA's review of the Application, PSEG made its staff and experts available to ESSA, at ESSA's request, to answer questions and provide clarification. The ESSA Report, while acknowledging PSEG's cooperation and responsiveness during the review process, does not reflect that ESSA availed itself of PSEG's offers to address any questions or confusions that might arise in the course of the ESSA review or of the extensive supplemental information PSEG provided to ESSA either directly or through the review process.

For example, the ESSA Report apparently did not take into account any of the extensive information that PSEG developed expressly in response to issues that ESSA representatives had identified in a presentation of findings to NJDEP and to PSEG in April of 2000. Despite the fact that PSEG provided a written response to many of ESSA's issues in the May 2000 Report, there is no evidence from the ESSA Report that ESSA took any of this information into account, since many of the comments identified in the ESSA Report were fully addressed in PSEG's May 2000 Report.

The issues PSEG addressed included: ESSA's concern that costs are based on utility costs only and not consumer costs (May 2000 Report, pages 13-18); ESSA's recommendation that combinations of fish protection alternatives be considered (id., pages 23-24); ESSA's view that the benefits methodology was incompletely documented (id., pages 18-20); ESSA's view that the PSEG analysis omits consideration of non-fishing related environmental benefits (id., page 17); and ESSA's confusion regarding whether PSEG estimated costs and benefits from a societal level (id., pages 13-18).

4. ESSA's Recommendations Regarding "Biomass Lost to the Ecosystem" ("BLE") Lack Scientific Credibility and Do Not Warrant Consideration by NJDEP or PSEG

The ESSA Report introduces a concept ESSA refers to as "biomass lost to the ecosystem" ("BLE"). As represented in Figure VII.B-2 of this Response, which is derived from a figure in ESSA's Report and depicts the relationships between BLE and its component measures, BLE has two component measures: (1) production foregone (i.e., incremental growth lost to predators due to failure of impinged and entrained organisms to grow, also referred to as natural mortality foregone), and (2) the biomass of organisms entrained and impinged at the plant.

a. ESSA's Recommendation that BLE be Used as an Additional AEI Indicator Lacks Scientific Credibility and Is Inconsistent with Regulatory Guidance

ESSA recommends that PSEG include BLE as an additional AEI indicator in the cumulative impact assessment. The recommendation to include BLE as an AEI indicator lacks scientific credibility and reflects a misunderstanding of PSEG's AEI approach and of USEPA guidelines and relevant regulatory guidance. PSEG pointed out the flaws of ESSA's proposed BLE indicator in the May 2000 Report, but the ESSA Report does not respond to or address PSEG's criticisms. As detailed in that May 2000 Report and more fully in Section VII.B.2.a. of this Response, ESSA's proposed biomass lost indicator is inconsistent with the ERA Guidelines and with PSEG's benchmark selection criteria. Moreover, as detailed in VII.B.2.b. of this Response, the BLE indicator is based on a grossly over-simplified conceptual model of aquatic ecosystem processes and is biologically meaningless.

Despite ESSA's characterization of its proposed BLE indicator as a valid risk assessment endpoint consistent with the ERA Guidelines, BLE fits neither the definition nor the criteria for endpoint selection defined in those Guidelines. The proposed BLE indicator does not describe an actual ecological entity such as a species, population, community, ecosystem, or habitat (see ERA Guidelines, Section 3.3.2), and thus BLE is a useless measure of effects.

The BLE indicator also does not satisfy PSEG's three benchmark selection criteria, which are: (1) A benchmark must be directly related to population or ecosystem health; (2) Regulatory and scientific precedents for the use of the benchmark must exist; and (3) It must be possible to establish objective criteria for interpreting the significance of measured or predicted impacts. ESSA's proposed indicator does not satisfy the second and third criteria. Whether it satisfies the first is also highly questionable, because the BLE methodology reflects a grossly simplistic conceptual model of the Delaware ecosystem that neglects many important biomass and energy transfer processes.

ESSA's approach assumes that entrainment and impingement remove fish that otherwise could have been eaten by predators. However, a more realistic description of the biomass production process in the Estuary includes critical recycling processes that are neglected in the BLE approach. As discussed in Sections VII.B. and VII.C of this Response, fish production within the Estuary is ultimately determined by primary production. The Station does not remove biomass from the ecosystem, and does not alter the productive capacity of the ecosystem. Rather than being removed from the ecosystem, entrained and impinged fish are returned to the estuary where they are available for consumption by predators and scavengers. If not consumed, they decompose and the nutrients released become available for new primary production. Moreover, the prey organisms that would have been consumed by the entrained or impinged fish are available for consumption by the survivors. Because of reduced competition and increased prey availability, the survivors grow more rapidly and suffer lower rates of natural mortality. Ultimately, a large fraction of the prey biomass lost due to the deaths of entrained and impinged fish may be recovered due to a compensatory increase in the prey biomass provided by the survivors.

While the degree to which compensatory processes offset the direct effects of losses at the Station is unknown, the processes themselves are well documented in Appendix I of the Application. Thus, it is possible that the only biomass actually lost to the ecosystem is the biomass of the entrained and impinged organisms at the time of death ("biomass killed" in ESSA's terminology). Even this loss may simply be a transfer of biomass from the pelagic food web to the benthic food web, with no net loss in ecosystem productivity. ESSA's method of estimating "total biomass lost to the ecosystem" does not account for any of these fundamental ecosystem properties.

As a result of ignoring these biomass and energy transfer processes, ESSA's BLE indicator produces estimates of loss that are biased high and are not credible estimates of actual biomass lost. Thus, because ESSA's proposed BLE indicator is both scientifically invalid and inconsistent with both ERA Guidelines and PSEG's criteria for selecting benchmark indicators, ESSA's recommendation that PSEG include BLE as an indicator of AEI does not warrant further consideration.

b. ESSA's Recommendation that PSEG Expand Its Cost-Benefit Analyses to Address BLE Lacks Scientific Credibility and Would Not Materially Alter the Results of the Analyses

In evaluating the cost and benefits of alternative technology options, PSEG assessed the benefits of the technology alternatives in terms of the expected increases in fisheries catches that would be associated with their implementation. To do this PSEG used as an input of "pounds lost to the fishery." For commercially fished species, the input was based on estimates of catch foregone (i.e., pounds lost to the fishery due to failure of impinged and entrained organisms to grow). For non-commercially fished species, the input was based on estimates of production foregone (also referred to as natural mortality foregone, which is the incremental growth lost to predators due to failure of impinged and entrained organisms to grow).

ESSA argues that PSEG's cost-benefit analyses should instead, for all species, evaluate the economic value of the sum of (1) catch foregone, (2) production foregone, and (3) the biomass of the organisms actually entrained and impinged at the plant. ESSA refers to this tripartite measure as "total biomass lost." ESSA claims that, because PSEG's estimates of pounds lost to the fishery did not include all three of the components of total biomass lost for all species, the cost-benefit estimates presented in the Application are biased.

To demonstrate the alleged problem with PSEG's analyses, ESSA inappropriately compares PSEG's estimates of pounds lost to the fishery to ESSA's proposed total biomass lost estimates and claims that:

> [T]he actual total biomass of fish lost to the ecosystem (including fisheries, station losses, and losses of food to predators, summed over all species) is at least 2.2 times greater than that listed in the Permit Application. (ESSA Report, page 101.)

This is an illegitimate comparison. While it is true that PSEG's estimate of pounds lost to the fishery is less than half of ESSA's estimate of total biomass lost, this fact does not reflect any biases or problems with PSEG's calculations, but only that ESSA's measure inappropriately includes estimates of two additional components not included in PSEG's.

ESSA recommends that PSEG should add consideration of these additional components of loss to its cost-benefit analyses for the technology alternatives. Since PSEG's cost-benefit analysis already addresses the value of catch foregone, ESSA recommends that PSEG's analyses should include BLE to address the other two components of ESSA's total biomass lost measure. As detailed in Section VII.C.3. of this Response, ESSA's recommendation lacks scientific credibility. Further, if the expanded analyses were done correctly, the results would not differ materially from those of PSEG's method, and so there is no justification for ESSA's recommendation.

First, as PSEG has previously detailed, ESSA's methods for calculating total biomass lost are severely biased high because they fail to take into account density-dependent compensatory processes and other fundamental properties of ecosystems that act to offset the direct effect of losses due to Station operation (see discussion in Section I.D.4.a. above and Section VII.B.2. of this Response, and PSEG's May 2000 Report, Attachment II-C to these Comments).

While PSEG's estimates of pounds lost to the fishery are similarly biased high due to failure to address these compensatory and other properties, in selecting its methods for the cost-benefit analyses PSEG concluded that the overestimates of pounds lost to the fishery, and associated overestimates of benefits from the technology alternatives, would reasonably ensure that the resulting cost-benefit ratios were conservative. In contrast, the overestimation of losses in ESSA's total biomass lost approach would be unreasonably high due to the inclusion of the additional biased components. Thus, including the additional biased BLE estimates of loss in

PSEG's cost-benefit analyses would dramatically, and unreasonably, increase the estimates of benefits as well as severely skew, and unreasonably lower, the cost-benefit ratios.

Moreover, incorporating these biased estimates of BLE directly into the cost-benefit analyses of technology alternatives, as ESSA appears to recommend, would be scientifically invalid and even further skew the cost-benefit ratios unreasonably low. Directly incorporating ESSA's BLE estimates into the cost-benefit analyses would essentially double count the value of BLE by ignoring three factors that affect the economic valuation of the BLE components: (1) the fraction of natural mortality that is due to predation by economically valuable species, (2) the trophic transfer efficiency of biomass moving up through the food chain, and (3) the fishery exploitation rate.

These three factors must be considered in any valid cost-benefit analysis incorporating the BLE estimates because production lost to natural mortality due to disease, starvation, or predation by invertebrates like jellyfish does not generate economic value. In contrast, production lost to natural mortality due to predation by economically valuable species could result in an increase in the biomass and harvest of economically valuable species, thereby generating economic value. Therefore, the fraction of natural mortality that is due to predation by economically valuable species must be taken into account. Second, only a fraction of the prey biomass consumed by a predator is turned into additional predator biomass. Third, since the benefits estimates are based on pounds of fish harvested, the fishery exploitation rate, which is the fraction of fish in a population that is harvested by the fishery, must be considered.

The only way to appropriately address the BLE estimates in the cost-benefit analyses would be by taking the above three factors into account to translate the component measures of BLE – i.e., production foregone and biomass impinged and entrained at the Station – into "equivalent catch foregone" measures. (The methods for applying these factors to translate the various components of production foregone into units of equivalent catch foregone are different for losses of forage fish and predator fish, and are discussed in Section VII.C.5.a. of this Response.)

PSEG calculated estimates of equivalent catch foregone that include all three of the components of total biomass lost identified by ESSA for the predator RIS. The results show that the inclusion of omitted components would not materially affect the cost-benefit analyses. The inclusion of the BLE components identified by ESSA would increase the total catch foregone estimate for the Base Case scenario (for all predator RIS collectively) by less than 8%. This calculation, which does not even address the biasing effects of the failure to account for density-dependent compensation in the estimates, underscores why ESSA's implied claim that PSEG's estimates of catch foregone are less than half what they should be in the cost-benefit analyses has absolutely no merit. (And, as detailed in Section VII.C.5.a. of this Response, PSEG's calculations also show the same results for the nonpredator bay anchovy species: the equivalent catch foregone estimate for the base case scenario for bay anchovy is 41% lower than the catch foregone estimate presented in the Application.)

Thus, PSEG's analyses show that including ESSA's BLE components of biomass lost in the cost-benefit analyses, while it would still result in estimates biased high due to the failure to consider density-dependent compensation, would not materially affect PSEG's results if the calculation of the BLE components properly takes into account the relevant trophic transfer efficiencies. Therefore, even apart from the scientific invalidity of ESSA's BLE measures, there is no practical justification in the Section 316(b) context for ESSA's recommendation to expand PSEG's cost-benefit analysis to include them. (ESSA Report, page 101.)

5. NJDEP's Draft Permit Decision Appropriately Considers the ESSA Report

In PSEG's Application and related filings, PSEG has provided prodigious amounts of information on environmental conditions in the Delaware Estuary as well as on the technical and economic characteristics of available technologies for additional fish protection at Salem. This material was provided both in the original Application as well as in subsequent responses to concerns raised by ESSA and the NJDEP in the course of their review of the Application.

PSEG's approach and conclusions in all facets of the Application are sensible, defensible, represent solid scientific, engineering and economic analytical approaches, and meet or exceed what should be expected in Section 316(b) determinations. With regard to the determination of BTA for Salem, PSEG relied on established principles for technology evaluation and cost-benefit analysis, including a thorough multi-step approach consistent with applicable regulatory and legal precedent. Similarly, in the cumulative impact assessment, PSEG approached "uncertainty" in a realistic manner relying on multiple lines of evidence and the judgment of recognized experts to evaluate appropriately those lines of evidence in a comprehensive, integrated approach to Section 316(b) compliance consistent with USEPA guidance.

a. Despite its Critical Approach, the ESSA Report Does Not Refute the Fundamental Conclusions in PSEG's Application

As thoroughly documented in the Detailed Technical Response in Sections II-VII of PSEG's Response, the ESSA Report does not call into question any of the major conclusions and results of PSEG's Application regarding Section 316(b) compliance, and none of the concerns raised by ESSA provide any persuasive reason to change PSEG's conclusions and results in the Application.

Moreover, despite ESSA's many unfounded technical criticisms, the fact is that the ESSA Report confirms many essential findings in PSEG's assessment. For example, in order to address its concern regarding possible bias in the beach seine survey trend analysis presented in the PSEG Application, ESSA requested that PSEG redo certain analyses in a different manner to eliminate possible bias introduced by using duplicate hauls. PSEG conducted the analyses as requested, and, the ESSA Report states "the general results as reported in Appendix J did not change" (ESSA Report, page 115-116). In addition, in response to PSEG's evaluation of technology alternatives, ESSA states that "[i]f many species are involved, as is the case for Salem . . . the likelihood that a single behavioral system, such as sound or strobe lights, will be effective for all species is very, very low" (ESSA Report, page 47). ESSA 's statement is fully consistent with the conclusions reached by PSEG in its Application.

ESSA also compliments the PSEG studies of the use of sound to deter fish from the area in front of the intake, saying that the cage tests were "very thorough in data collection," (ESSA Report, page 38), and, with regard to the in situ tests, "the data collection in this study was impressive" (ESSA Report, page 40). Similarly, concerning the cost-benefit assessment, ESSA stated that "the documentation and methodology presented in the Application seem reasonable for the major design modifications that would be required" to implement new technologies at Salem (ESSA Report, page viii).

Finally, PSEG notes that, as is documented throughout Sections II-VII of this Response, PSEG's approach to assessing AEI is repeatedly shown to be consistent with relevant regulatory guidance such as the ERA Guidelines and 1977 USEPA Guidance, while ESSA's comments and recommendations are not. Further, PSEG's research and analytical methods are also consistently shown to align with expected norms and practices in the context of cooling water intake system permitting, and PSEG's findings are consistently shown to align with those of independent sources researching the same issues.

b. NJDEP's Draft Decision Appropriately Adopts Certain of ESSA's Recommendations

PSEG's Comments on the terms and conditions of the Draft Permit are presented as Part Two of these Comments. As those comments indicate, PSEG believes that, in issuing the Draft Permit, NJDEP appropriately respected the distinction between the ESSA Report's highly academic recommendations for technical rigor in documentation and the standards of reasonableness the Department must use in evaluating the merits of PSEG's data and analysis for purposes of supporting the Section 316(b) Demonstration. The NJDEP appropriately reviewed ESSA's Report and incorporated relevant recommendations in the Salem Draft Permit to address BTA compliance and the assessment of Station impacts. NJDEP's proposed terms and conditions mandate substantial additional requirements that impose significant added financial obligations on PSEG. Further, even though PSEG believes ESSA's recommendations are unwarranted, PSEG will work cooperatively with the NJDEP to address the ESSA recommendations adopted in the final permit and to explore any potential benefit that may be derived from them.

II. RESPONSE TO ESSA'S EXECUTIVE SUMMARY

In its Executive Summary, ESSA summarizes its comments and recommendations regarding the four aspects of the Application included in its Scope of Work:

1. Entrainment and impingement losses,

2. PSEG's compliance with certain conditions of the 1994 Permit;

3. The costs and benefits assessment of Best Technology Available (BTA) to reduce entrainment and impingement mortality caused by the Station; and

4. The impact assessment of the Station on fish populations and the Delaware River ecosystem. (ESSA Report, pages vii-x.)

This section of PSEG's Response addresses each component of ESSA's Executive Summary.

A. Entrainment and Impingement of Fishes by Salem Station

ESSA commends PSEG for its "great effort directed at extracting maximal information on entrainment losses of fish from limited data" and for its "thorough treatment of the comparatively rich impingement database from which impingement loss estimates were derived" (ESSA Report, page vii). ESSA then comments that "the analyses indicated that the annual loss of fish due to entrainment and impingement is high" (ESSA Report, page vii). PSEG acknowledges that the number of fish lost may appear to be numerically high. However, when interpreting the number lost several factors must be considered, in particular the species lost, the life stages at which the loss occurs, the estuary-wide abundance of those life stages, the natural mortality rates of those life stages, and the presence of density-dependent compensation must be taken into account.

The species with the largest losses due to entrainment and impingement at Salem is bay anchovy. In comparison to other representative important species ("RIS"), over 98% of all fish lost due to entrainment and impingement at Salem (1978-1998) were bay anchovy. Bay anchovy, a small pelagic prey species that lives inshore from Maine to Mexico, are not commercially fished but serve as an important food source for other fish species in the estuary.

The vast majority of the bay anchovy that are lost due to entrainment and impingement at Salem are eggs, larvae and juveniles. Although the number of bay anchovy eggs, larvae and juveniles lost at Salem may appear large, these losses are extremely small in comparison to the number of bay anchovy in the estuary. The average number of bay anchovy eggs, larvae and juveniles in Delaware Estuary is extremely high, generally 10's of trillions of fish. Thus, the losses of bay anchovy eggs, larvae and juveniles, which vary considerably among years, average much less than 1/10th of 1% of the number in the estuary.

Furthermore, fish species, of the types entrained or impinged at Salem, experience high rates of natural mortality. Generally, fewer than 1 in 10,000 eggs survive to become 1 year old fish. Fish counteract their extremely high natural mortality by producing very large numbers of eggs at a very early age. For example, bay anchovy begin to spawn at age 1 and lay batches of eggs every few days that total over 50,000 during the course of the year. Only 2 of the 50,000 eggs need to survive to age 1 in order for the population to remain stable. Because bay anchovy have such a high natural mortality rate, 97% of the bay anchovy lost at Salem would have died prior to age 1 even if Salem were not operating.

Density-dependent compensation refers to the natural ability of a fish population to change survival, egg production, and growth rates in response to its abundance. Compensation keeps fish populations from increasing in abundance without limit, and helps fish populations recover when their abundances are depressed.

Recent research by the Atlantic States Marine Fisheries Commission ("ASMFC") has confirmed the presence of strong density-dependent compensation in weakfish and striped bass stocks. That research documents changes in survival in response to changes in spawning stock size (number of eggs). It shows that as the number of eggs laid decreases, the number of weakfish recruits per unit of eggs greatly increases. The fish are compensating for low spawning stock by improving their survival rate from egg to age 1. Conversely, at high levels of spawning stock, as now exists for these species, the number of eggs laid is excessive and does not produce any more recruitment than if the number of eggs were greatly reduced. It should also be noted that when the spawning stock biomass exceeds the point of producing maximum recruitment, a reduction in the spawning stock (or in the number of eggs) could actually increase recruitment.

The losses of eggs and larvae due to Salem operations have the same compensation effect on recruitment as reductions in number of eggs laid. Therefore, the losses of eggs and larvae are, to some degree, compensated for by an increase in the survival rate of the remaining eggs and larvae. This results in a higher number of recruits than one would expect based solely on the number of eggs and larvae lost. However, to date, the calculation of abundance reductions at Salem have not considered the effects of compensation and therefore overstate the effects of Salem operations on the fish stocks.

For these reasons, simply looking at the number of fish lost due to entrainment and impingement provides no indication of the effects of Salem operation on the affected fish stocks. PSEG's impact assessment approach provides a scientific context within which Station losses can be interpreted in a meaningful way.

ESSA also commended PSEG for applying "notable skill" in its estimation of conditional mortality rates ("CMR") for entrainment and impingement (ESSA Report, page vii). However, ESSA incorrectly defined the term CMR:

> The CMRs describe the proportion of a fish population that is killed by the station. (ESSA Report, page vii.)

In fact, a CMR is the fractional reduction in the abundance at some age (e.g., age 1) due to Station effects that occurred prior to that age. This important distinction, that was described in some detail in Application, Appendix F (Section VII.C.1.a), apparently is not understood by the ESSA reviewers.

ESSA comments, however, that PSEG fails to characterize the uncertainty associated with the loss estimates. This uncertainty, according to ESSA, is important "because the entrainment and impingement loss estimates underpin other major analyses of the effects of the station, such as lost fish production and biomass to the Delaware fisheries and ecosystem." (ESSA Report, page vii.) ESSA also comments that PSEG fails to perform an uncertainty analysis of the variability around the CMR point estimates, and that the natural mortality rate estimates for some species are too high, leading to an underestimation of CMRs and to difficulties with forecasting the effects of the Station on fish populations. ESSA recommends that "the variability and potential bias associated with entrainment loss estimates be examined." (ESSA Report, page vii.)

PSEG does not dispute that the loss estimates and CMRs used in the Application reflect uncertainty in the underlying data. Such uncertainty is inevitable in all biological studies of a system as complex as the Delaware Estuary. However, PSEG believes that ESSA overstated the importance of this uncertainty with respect to the conclusions presented in the Application.. A more quantitative treatment of uncertainty concerning Station losses would not materially alter PSEG's conclusions and, therefore, would not provide additional useful information to support NJDEP's permitting decision. Section IV.B.1 of this Response addresses ESSA's main concerns, particularly those associated with the uncertainty of entrainment loss estimates due to changes in sampling protocols, and notes that PSEG identified the problems associated with changes in sampling that began in 1977 and developed and applied data analysis methods accordingly.

ESSA also expressed concern about the models and data used by PSEG to estimate CMRs. Section IV.B.2 of this Response addresses ESSA's critiques and specifically discusses example VII.C.1 from the Application, which ESSA mischaracterizes as "misleading," and addresses ESSA's incorrect assertions concerning the value of the W factor used in the Application. Section IV.B.2.b explains that the assumption that the W factor was 1, required by the Empirical Transport Model ("ETM"), was only used for two fish species. Section IV.B.3 addresses ESSA's faulty hypotheses concerning the hydrodynamics at the cooling water system intake and further dismisses ESSA's speculations concerning the effects of hydrodynamics on the W factor.

ESSA's comments concerning uncertainties contained in PSEG's methods for estimating impingement losses, specifically estimates of latent impingement mortality, which were used to estimate the number of impinged fish that were alive when collected but likely would die due to the effects of impingement, are addressed in Section IV.C.2.b of this Response. PSEG agrees that impingement mortality rate estimates may not be accurate for some of the reasons stated by ESSA. However, PSEG does not agree with ESSA's statement that the stresses experienced by fish re-entering the estuary exceed the stresses experienced by fish entering the fish sampling pools, and ESSA provides no support for this statement in its Report. Although PSEG does not concur entirely with ESSA's recommendation for a new proposed study design, PSEG agrees that a study to produce accurate estimates of impingement mortality rates as fish re-enter the estuary is warranted.

ESSA's preliminary evaluation of variability around CMR point estimates, discussed in Section IV.D.1 of this Response, was conducted using flawed scientific methods and produced meaningless results that have no bearing on the validity of PSEG's CMR estimates. As discussed in Section IV.D.2 of this Response, ESSA's claim that natural mortality rates for some species are biased high is also incorrect and indeed is inconsistent with the analysis of natural mortality rates presented in Section 2.3 of the ESSA Report.

Section IV.D.2 of this Response details the steps employed by PSEG to minimize errors and biases in natural mortality rate estimates, including: (1) a complete review of the available literature on natural mortality rates for each life stage of each RIS; (2) development of preliminary estimates; and (3) use of the life-cycle balancing procedure to ensure that the final parameter sets could reasonably represent the life histories of the actual populations. Section IV.D.3 addresses ESSA's comments on PSEG's life-cycle balancing approach, which misstate the purpose of the approach and reflect a misunderstanding on ESSA's part of the way in which the approach was applied. Finally, Section IV.E addresses the Base Case entrainment and impingement scenario that PSEG used in its assessment of future Station effects and in its Cost-Benefit analyses of technology alternatives and notes considerations that ESSA failed to consider, including the effects of inter-annual variability in the vulnerability of weakfish and white perch eggs to entrainment and the effects of improved impingement survival for white perch on the modified intake screens.

PSEG questions ESSA's request for uncertainty analyses. PSEG acknowledges that although some uncertainties do exist, PSEG's position, which is supported by applicable USEPA guidance, is, and has been, that the permit decision-making process is best served by consideration of the best estimates reasonably attainable, based on the best available data and obtained through scientifically defensible analytical methods.

B. Compliance with 1994 Permit Conditions

ESSA finds that the Station's Ristroph screen modifications "are innovative, and represent BTA at the screens for reducing fish mortalities" (ESSA Report, page viii). In addition, in the Executive Summary as well as later in its Report, ESSA endorses an integrated approach to fish protection measures, rather than separate consideration of individual technologies (ESSA Report page 33). Thus, in order to supplement the Station's existing screen technology, ESSA makes a number of additional recommendations, including:

1. further studies for a fish defense system employing multi-sensory or hybrid technologies that focus more on behavioral deterrents;

2. study of the feasibility of a jetty associated with the intake; and

3. redesign of the fish return flume. (ESSA Report, page viii.)

PSEG concurs with ESSA's conclusion that the Salem screen modifications are innovative and believes that these modifications, in conjunction with the other measures undertaken in accordance with the 1994 Permit, represent BTA for the Station. And, although PSEG disagrees with ESSA's statements regarding the need for additional fish protection measures, the Company believes that certain aspects of the multi-sensory approach proposed by ESSA may have merit. In fact, PSEG has consistently evaluated combinations of technologies in its previous Section 316(b) Applications. Of the technologies recommended by ESSA for further study as part of the multi-sensory approach, the strobe light/air bubble curtain, combined with the existing Ristroph screens, and possibly sound, could be promising. With regard to sound deterrents, ESSA notes later in the Report that the studies conducted by PSEG were thorough and comprehensive, and that the results show promise for deterring some species. (ESSA Report, page 33.) PSEG agrees, and therefore is proposing to submit a Plan of Study that will consider additional fish protection technologies, including sound deterrents.

However, PSEG does not believe that the light attraction or jetty modification alternatives suggested by ESSA warrant further consideration. The studies cited by ESSA in support of the use of light attraction technology are of limited application at the Station, since they involve different species and turbidity levels, or are based on laboratory results that do not necessarily reflect actual water clarity, current or debris conditions. In addition, it is highly questionable whether such a technology would be feasible in terms of engineering practicability. ESSA's jetty modification suggestion similarly raises many questions regarding biological effectiveness and engineering feasibility. First of all, the absence of a clearly-defined organism density gradient near the estuary shoreline makes it unlikely that jetties would substantially reduce entrainment. Moreover, due to the hydrodynamic processes of the estuary, jetties could merely direct near-shore waters further offshore, resulting in the Station intake drawing primarily the same water into the Station cooling system as it presently does, with the only difference that the water would first travel around the jetties to get to the intake. Also, jetties present serious operational issues with regard to the accumulation of sediment and the structural integrity of the discharge tunnel. Finally, it is possible that installation of jetties could attract, rather than repel, fish. For all of these reasons, PSEG does not believe that the light attraction and jetty alternatives proposed by ESSA deserve further consideration.

ESSA's concerns about the fish return flume appear to be based on an erroneous understanding of the Salem fish return system. ESSA's comments assume that fish suffer trauma when hitting the surface of the water abruptly, as opposed to entering below the surface. However, in actuality the discharge points are submerged, so that the trauma to fish that ESSA hypothesizes does not occur. In addition, the results of extensive biological testing using a full-scale model of another power plant's fish return system suggest that ESSA's statements regarding anticipated mortality due to the fish return would not be substantiated. PSEG thus believes that ESSA's recommendation regarding modification of the fish return is unwarranted.

C. Cost-Benefit Assessment of BTA

ESSA makes a number of comments and recommendations regarding the cost-benefit analysis in the Application. With regard to the cost estimates, ESSA finds that the "estimated construction costs of the various technologies are reasonable," and that the "documentation and methodology presented in the Application seem reasonable for the major design modifications that would be required for the cooling water intake system" (ESSA Report, page viii). PSEG agrees that the costs presented in the cost-benefit assessment are reasonable, and that the data and methods used are well-documented. ESSA also notes that the cost estimates "appear to focus on reductions in power generation and revenue to the station as opposed to the net costs to the end consumer" (ESSA Report, page viii).

The power cost estimates included in the Application reflect neither lost revenue to PSEG nor net costs to consumers, but rather total costs to society. The implication of ESSA's statement in the Executive Summary – that the power costs should reflect net costs to the end consumer – is incorrect and inconsistent with most of ESSA's comments in the remainder of its Report. Indeed, throughout the section of its Report concerning the cost-benefit assessment, ESSA repeatedly makes the point that the cost estimates should represent costs to society, rather than to an individual firm. As explained in detail in Section VI of this Response, the materials submitted in PSEG's Application, as well as information submitted subsequent to the Application (information which does not appear to have been considered by ESSA), clearly demonstrate that costs and benefits are measured from the standpoint of society, not an individual firm. Moreover, the cost methodology used and documented in the Application is fully consistent with widely-accepted social cost methodology.

ESSA also notes, with regard to the cost estimates, that "[e]ach alternative BTA was assessed as a discreet [sic], isolated action" (ESSA Report, page viii). ESSA suggests that:

> [a] more comprehensive approach would be to define alternative BTAs in terms of the specific objective it is designed to achieve, e.g., to reduce impingement of one or more species by 20% with no increase in entrainment. An optimized package of alternative actions could then be determined to minimize the costs of achieving the stated objective. (ESSA Report, page viii.)

As discussed in Section VI of this Response, combinations of alternatives likely would not be more beneficial from a cost-benefit perspective, since costs generally would be the sum of the individual costs, while benefits generally would be less than the sum of benefits. Thus, net benefits generally would be lower for combined alternatives than for any individual alternative. In any event, ESSA appears to agree that this is not a significant issue, because ESSA concludes that it is unlikely that the costs of an optimized package of the alternatives examined in the Application could be reduced by the factor of four to five necessary to achieve a cost/benefit ratio greater than one from the perspective of society (see, e.g., ESSA Report, page 52).

Regarding the benefits estimates, ESSA raises a number of concerns. As a general matter, ESSA states that "the documentation and written explanation of the benefits assessment was incomplete and generally did not provide a clear description of the justification of methodology, procedures and assumptions used in the assessment" (ESSA Report, page viii). As explained in detail in Section VI of this Response, the Application thoroughly documents the methods and assumptions used in the cost-benefit analysis. Furthermore, the cost-benefit assessment comports with applicable regulatory guidance regarding such assessments. ESSA's recommendations for additional documentation and analyses therefore are unwarranted, and would not add to understanding of the likely costs and benefits of fish protection alternatives at Salem.

ESSA also notes several specific concerns with regard to the Application's benefits assessment. First, ESSA objects to the Application's treatment of uncertainty, stating that the Application "suggests that the point estimates of net benefits and cost/benefit ratios are deterministic," and that it "does not describe the uncertainty introduced by biological and technical input data, and economic methods" (ESSA Report, page viii). On the contrary, the Application fully addresses uncertainty through sensitivity analyses of alternate discount rates and qualitative evaluation of factors and cost-benefit categories not considered in the analysis. ESSA's second specific concern regarding the benefits estimates is that non-fishing related environmental benefits are not adequately considered. The Application and supplemental materials provide a thorough discussion of the benefits categories considered in the analysis, and, as detailed in Section VI of this Response, explain that non-fishing benefits are not relevant at Salem since the health of the estuary ecosystem is not in jeopardy. ESSA's final specific concern with regard to the benefits analysis is that it does not attempt to predict changes over time in demand for recreational fishing. As discussed in Section VI below, the Application's assumption that recreational values remain constant after adjusting for inflation over the period of the analysis is reasonable, and further analysis is not justified.

ESSA concludes that its "primary recommendation" is that "the methods, assumptions and justification of assumptions used in the analysis be more fully explained and documented to improve comprehension of what was done" (ESSA Report, page viii). As noted above, the Application and supplemental materials thoroughly document the methods and assumptions used in the cost-benefit assessment, and the assessment is fully consistent with applicable regulatory guidance. Therefore, ESSA's suggestions for additional documentation are unwarranted. Moreover, it is important to note that ESSA's critique of the cost-benefit analysis does not fundamentally challenge, or take issue with, the data, methods and conclusions of PSEG's analysis. ESSA provides no evidence that any of its concerns would affect the conclusion that the costs of the additional fish protection measures at Salem considered in the Application far exceed their benefits.

D. Impact Assessment of Station

In this part of the Executive Summary, ESSA provides separate comments and recommendations regarding six topics:

1. Indicators of Adverse Environmental Impact,
2. Production Foregone,
3. Balanced Indigenous Community (BIC),
4. Trends and Retrospective Analysis,

5. Prospective Stock Jeopardy Analysis, and

6. Summary of Data Sets and Their Use in the Application. (ESSA Report, pages ix-x.)

As detailed below, and throughout this Response, many of ESSA's comments and recommendations reflect an overly academic approach to reviewing the technical documentation in PSEG's Application. In addition, ESSA's statements suggest inadequate consideration of both the relevant regulatory precedents governing Section 316 analysis, and the analytical and scientific bases underlying PSEG's results and conclusions. Responses to each of the above elements of ESSA's Executive Summary are provided below.

1. Indicators of Adverse Environmental Impact

ESSA states that the indicators of adverse impact as defined by PSEG in the Application also reflect the effects of past and ongoing changes in water quality and harvest, which may mask the full effect of the Station. ESSA further states that while PSEG's indicators were necessary for assessing Station impact, they are not sufficient for a complete assessment of Adverse Environmental Impact (AEI). ESSA recommends that "[m]ore direct" indicators of AEI should be used, including "total biomass lost to the ecosystem" and "effects on lower trophic levels" (ESSA Report, page ix).

ESSA's comments reflect a fundamental misperception of PSEG's overall approach to determining AEI, a misinterpretation of USEPA's ERA Guidelines, and insensitivity to relevant regulatory precedents. PSEG is fully aware of the confounding influences of past and ongoing changes in water quality and harvest, and for this reason PSEG based its impact assessment on three independent lines of evidence concerning AEI (i.e., the BIC analysis, the trends analysis, and the stock jeopardy analysis). The use of multiple lines of evidence to overcome confounding influences such as those identified above is a widely-used practice in environmental assessment, and is explicitly endorsed in USEPA guidance documents. In its review, ESSA identifies uncertainties and limitations associated with each individual analysis, but does not address the integration of the analyses.

As discussed in Section VII.B.2 of this Response, ESSA's recommendations regarding indicators of adverse environmental impact are inappropriate. ESSA's proposed "effects on lower trophic levels" indicator is inconsistent with regulatory guidance concerning 316(b) demonstrations, because it focuses on components of aquatic ecosystems that EPA has acknowledged are not susceptible to AEI due to entrainment or impingement (ESSA Report, page ix). Similarly, ESSA's proposed biomass lost to the ecosystem ("BLE") indicator is inconsistent with USEPA's ERA Guidelines and with PSEG's benchmark selection criteria, and is based on a grossly over-simplified conceptual model of aquatic ecosystem processes and is biologically meaningless.

Despite ESSA's characterization of its proposed BLE indicator as a valid risk assessment endpoint consistent with the ERA Guidelines, BLE fits neither the definition nor the criteria for endpoint selection defined in those Guidelines. The proposed BLE indicator does not describe an actual ecological entity such as a species, population, community, ecosystem, or habitat (see ERA Guidelines, Section 3.3.2), and thus BLE is a useless measure of effects. The BLE indicator also does not satisfy PSEG's three benchmark selection criteria, which are: (1) A benchmark must be directly related to population or ecosystem health; (2) Regulatory and scientific precedents for the use of the benchmark must exist; and (3) It must be possible to establish objective criteria for interpreting the significance of measured or predicted impacts. ESSA's proposed indicator does not satisfy the second and third criteria. Whether it satisfies the first is also highly questionable, because the BLE methodology reflects a grossly simplistic conceptual model of the Delaware ecosystem that neglects many important biomass and energy transfer processes.

ESSA's approach assumes that entrainment and impingement remove fish that otherwise could have been eaten by predators. However, a more realistic description of the biomass production process in the estuary, as discussed in Sections VII.B and VII.C of this Response, recognizes that the prey organisms that would have been consumed by the entrained or impinged fish are available for consumption by the survivors. Because of reduced competition and increased prey availability, the survivors grow more rapidly and suffer lower rates of natural mortality. Ultimately, a large fraction of the prey biomass lost due to the deaths of entrained and impinged fish may be recovered due to a compensatory increase in the prey biomass provided by the survivors. Moreover, fish production within the estuary is ultimately determined by primary production. The Station does not remove biomass from the ecosystem, and does not alter the productive capacity of the ecosystem. Rather than being removed from the ecosystem, entrained and impinged fish are returned to the estuary where they are available for consumption by predators and scavengers. If not consumed, they decompose and the nutrients released become available for new primary production.

While the degree to which compensatory processes offset the direct effects of losses at the Station is unknown, the processes themselves are well documented in Appendix I of the Application. Thus, it is possible that the only biomass actually lost to the ecosystem is the biomass of the entrained and impinged organisms at the time of death ("biomass killed" in ESSA's terminology). Even this loss may simply be a transfer of biomass from the pelagic food web to the benthic food web, with no net loss in ecosystem productivity. ESSA's method of estimating "total biomass lost to the ecosystem" does not account for any of these fundamental ecosystem properties.

As a result of ignoring these biomass and energy transfer processes, ESSA's BLE indicator produces estimates of loss that are biased high and are not credible estimates of actual biomass lost. Because ESSA's proposed BLE indicator is both scientifically invalid and inconsistent with both ERA Guidelines and PSEG's criteria for selecting benchmark indicators, ESSA's recommendation that PSEG include BLE as an indicator of AEI does not warrant further consideration.

2. Production Foregone

PSEG used estimates of pounds lost to the fishery (referred to as catch foregone by ESSA) as inputs to PSEG's assessment of benefits associated with technology alternatives.

ESSA implies, by defining a metric it refers to as "total biomass lost" and showing that estimates of pounds lost to the fishery are not equivalent to ESSA's estimates of "total biomass lost," that PSEG's estimate of pounds lost to the fishery are somehow biased:

> The total biomass of fish lost to the ecosystem can be divided into two components: 1) biomass lost to commercial fisheries (catch foregone); and 2) biomass lost to other parts of ecosystem. The Application underestimates biomass lost from the ecosystem by perhaps greater than 2-fold. (ESSA Report, page ix.)

ESSA's claim that the Application underestimates biomass lost from the ecosystem seriously misrepresents information presented in the Application. PSEG did not present estimates of "biomass of lost from the ecosystem" in the Application, and did not imply that its estimates of pounds lost to the fishery could be construed as being anything but pounds lost to the fishery. Nevertheless, ESSA equated the two, and alleged that PSEG's estimates of pounds lost to the fishery were flawed because PSEG's estimates omitted some components:

> Estimates of lost biomass exclude, for example: a) actual biomass of fish lost at the station for all species including bay anchovy; b) lost prey production other than bay anchovy thereby underestimating catch foregone; and c) the projected increases in RIS abundance in the Application that should be included in estimates of catch and production foregone. (ESSA Report, page ix.)

Even if one were to accept ESSA's metric of "total biomass lost" as having some utility, the methods ESSA used to compute estimates of its metric are so scientifically flawed that its estimates are biologically meaningless. ESSA's method of estimation is not scientifically valid because it ignores fundamental properties of ecosystems in favor of algebraically tractable but biased oversimplifications.

In evaluating the cost-benefits of alternative technology options, PSEG assessed the benefits of the technology alternatives in terms of the expected increases in fisheries catches that would be associated with their implementation. For commercially fished species, the pounds lost to the fishery input was based on estimates of catch foregone (i.e., pounds lost to the fishery due to failure of impinged and entrained organisms to grow). For non-commercially fished species, the pounds lost to the fishery input was based on estimates of production foregone (also referred to as natural mortality foregone, which is the incremental growth lost to predators due to failure of impinged and entrained organisms to grow).

ESSA argues that PSEG's cost-benefit analyses should instead, for all species, evaluate the economic value of the <u>sum</u> of (1) catch foregone, (2) production foregone, and (3) the biomass of the organisms actually entrained and impinged at the plant. ESSA refers to this tripartite measure as "total biomass lost." ESSA claims that, because PSEG's estimates of pounds lost to the fishery did not include all three of the components of total biomass lost for all species, the cost-benefit estimates presented in the Application are biased.

ESSA recommends that PSEG should add consideration of these additional components of loss to its cost-benefits analyses for the technology alternatives. Since PSEG's cost-benefit analysis already addresses the value of catch foregone, ESSA recommends that PSEG's analyses should include BLE to address the other two components of ESSA's total biomass lost measure. As detailed in Section VII.C.3. of this Response, ESSA's recommendation lacks scientific credibility. Further, if the expanded analyses were done correctly, the results would not differ materially from those of PSEG's method, and so there is no justification for ESSA's recommendation.

First, as PSEG has previously detailed, ESSA's methods for calculating total biomass lost are severely biased high because they fail to take into account density-dependent compensatory processes and other fundamental properties of ecosystems that act to offset the direct effect of losses due to Station operation (see discussion in Section VII.B.2 of this Response, and PSEG's May 17, 2000 Report, included as Attachment II-C to these Comments).

While PSEG's estimates of pounds lost to the fishery are similarly biased high due to failure to address these compensatory and other properties, in selecting its methods for the cost-benefit analyses PSEG concluded that the overestimates of pounds lost to the fishery, and associated overestimates of benefits from the technology alternatives, would reasonably ensure that the resulting cost-benefit ratios were conservative. In contrast, the overestimation of losses in ESSA's total biomass lost approach would be unreasonably high due to the inclusion of the additional biased components. Thus, including the additional biased BLE estimates of loss in PSEG's cost-benefit analyses would dramatically, and unreasonably, increase the estimates of benefits as well as severely skew, and unreasonably lower, the cost-benefit ratios.

Moreover, incorporating these biased estimates of BLE directly into the cost-benefit analyses of technology alternatives, as ESSA appears to recommend, would be scientifically invalid and even further skew the cost-benefit ratios unreasonably low. Directly incorporating ESSA's BLE estimates into the cost-benefit analyses would essentially double count the value of BLE by ignoring three factors that affect the economic valuation of the BLE components: (1) the fraction of natural mortality that is due to predation by economically valuable species, (2) the trophic transfer efficiency of biomass moving up through the food chain, and (3) the fishery exploitation rate.

As detailed in Section VII.C.5.a. of this Response, these three factors must be considered in any valid cost-benefit analysis incorporating the BLE estimates because production lost to natural mortality due to disease, starvation, or predation by invertebrates like jellyfish does not generate economic value. In contrast, production lost to natural mortality due to predation by economically valuable species could result in an increase in the biomass and harvest of economically valuable species, thereby generating economic value. Therefore, the fraction of natural mortality that is due to predation by economically valuable species must be taken into account. Second, only a fraction of the prey biomass consumed by a predator is turned into additional predator biomass. Third, since the benefits estimates are based on pounds of fish harvested, the fishery exploitation rate, which is the fraction of fish in a population that is harvested by the fishery, must be considered.

The only way to appropriately address the BLE estimates in the cost-benefit analyses would be by taking the above three factors into account to translate the component measures of BLE – i.e., production foregone and biomass impinged and entrained at the station -- into "equivalent catch foregone" measures. (The methods for applying these factors to translate the various components of production foregone into units of equivalent catch foregone are different for losses of forage fish and predator fish, and are discussed in Section VII.C.5.a of this Response.)

PSEG calculated estimates of equivalent catch foregone that include all three of the components of total biomass lost identified by ESSA for the predator RIS. The results show that the inclusion of omitted components would not materially affect the cost-benefit analyses. The inclusion of the BLE components identified by ESSA would increase the total catch foregone estimate for the Base Case scenario (for all predator RIS collectively) by <u>less than 8%.</u> This calculation, which doesn't even address the biasing effects of the failure to account for density-dependent compensation in the estimates, underscores why ESSA's implied claim that PSEG's estimates of catch foregone are less than half what they should be in the cost-benefit analyses has absolutely no merit. (And, as detailed in Section VII.C.5.a. of this Response, PSEG's calculations also show the same results for the nonpredator bay anchovy species: the equivalent catch foregone estimate for the base case scenario for bay anchovy is 41% <u>lower</u> than the catch foregone estimate presented in the Application.)

Thus, PSEG's analyses show that including ESSA's BLE components of biomass lost in the cost-benefit analyses, while it would still result in estimates biased high due to the failure to consider density-dependent compensation, would <u>not</u> materially affect PSEG's results if the calculation of the BLE components properly takes into account the relevant trophic transfer efficiencies. Therefore, even apart from the scientific invalidity of ESSA's BLE measures, there is no practical justification in the Section 316(b) context for ESSA's recommendation to expand PSEG's cost-benefit analysis to include them.

Finally, ESSA's Executive Summary also asserts that "Problems with the estimates of natural mortality rates contribute to the underestimation of lost biomass." (ESSA Report, page ix.) As discussed in Section IV.A.2.b. of this Response, ESSA presents no convincing evidence that the Application overestimates natural mortality rates.

3. Balanced Indigenous Community (BIC)

ESSA claimed that PSEG's analysis of fish community structure failed to acknowledge many limitations and uncertainties, and summarized three limitations in particular. Specifically, ESSA stated that the indicators used to characterize the fish community are (1) "very insensitive to stress" and do not adequately characterize the fish community; (2) that the indices are subject to high levels of natural variability and measurement error, "making it difficult to detect significant changes even if they did occur"; and (3) that "the Application does not consider other components of the ecosystem such as shellfish, plankton and benthos, as well as other indicators of ecosystem function and structure" (ESSA Report, page ix). ESSA recommended that the BIC analysis should be expanded to include a "more robust suite of stressor-specific indicators that reflect ecosystem well-being as well as impacts on the fish community." (<u>Id.</u>) ESSA further recommended the redesign of monitoring programs to meet its proposed objectives and "to complement other ongoing monitoring efforts, with indicators tested and refined through research and field studies." (Id.)

As discussed in Section VII.D, ESSA's comments regarding the limitations of PSEG's fish community analyses are demonstrably false and are contradicted by published scientific papers that were cited by ESSA in its review. Contrary to ESSA's first criticism, Section VII.D.1 shows that the quantitative indicators used in the BIC analysis – species richness and species density – are thoroughly documented in the scientific literature and have, in fact been characterized in the literature as being sensitive to environmental stress.

ESSA's second criticism, implies that PSEG's conclusions were unrealistically based on the failure to detect statistically significant changes in a few simple statistics, and that negative impacts of the Station may be masked by natural variability, high levels of measurement error, changes in sampling methods, improvements in water quality and changes in fisheries management. Section VII.D.2.b specifically addresses ESSA's concerns regarding the suitability of the data used to support the BIC analysis. PSEG's analysis of species presence/absence data and species turn-over show that the species richness of the Near-Field region has been nearly invariant from year to year over the past 30 years and that the number of species collected per sample has actually increased over that period (which is contrary to the decrease that would be expected if Station operations were adversely affecting the fish community).

Section VII.D.2.a.(2) responds to ESSA's comment that the "fluctuations in abundance" indicator is inadequate because is does not consider threatened or endangered species, and demonstrates that ESSA's review of this indicator focuses on irrelevant aspects of fish community studies rather than on the analysis actually performed by PSEG.

Section VII.D.2.a.(3) clarifies that the methods used with regard to the third indicator, "eruptions of nuisance or non-indigenous species," were sufficient to have detected outbreaks of nuisance or non-indigenous species since the startup of Station operations, had they occurred, while Section VII.D.1.c clarifies the sources of information used by PSEG for this indicator.

As Section VII.D.3 notes, no monitoring program, however intensive, could ever provide the data to prove to 100% certainty that the Station has no effect on the fish community, or that observed improvements would not have been even greater in the absence of the Station. PSEG's conclusions concerning the retrospective effects of Salem's operations on community balance are reasonable inferences from three independent indicators: (1) the analysis of species presence/absence data shows no decline in species or species richness since startup of the Station; (2) the analysis of fluctuations in predator and prey species shows trends consistent with improved water/habitat quality and reduced fishing pressure; and (3) the evaluation of nuisance species outbreaks shows that none have been observed since the startup of Station operations.

ESSA's third criticism implies that PSEG failed to perform an adequate assessment because the BIC analysis does not evaluate impacts on other components of the ecosystem, or on other, unspecified, indicators. The one shellfish species that is susceptible to Station impacts, blue crab, was addressed in the Application (although as an individual species, not as a component of the BIC analysis). The other ecosystem components mentioned by ESSA (i.e., plankton and benthos) are not susceptible to AEI from entrainment or impingement and, therefore, are not appropriate for inclusion in PSEG's analysis. ESSA's recommended program goes far beyond the requirements of any reasonable monitoring program intended to assess compliance with PSEG's permit requirements. PSEG is not required by any existing Section 316(b) guidance to assess "ecosystem well-being." While it may well be beneficial to improve the coordination of existing estuary-wide monitoring programs and to develop bettor indicators of ecosystem conditions, such a program would be remarkably ambitious and is not required to determine whether Station operations are adversely affecting the fish community of the estuary.

4. Trends and Retrospective Analysis

ESSA challenges the results of the Trends Analyses presented in the Application by stating:

> While we agree that the fisheries data suggest that some populations have increased over the last decade or so, we consider the analyses to be *exploratory* due to ... the inability to isolate the likely significant effects of changes in other ecosystem factors such as water quality and harvest. ... Further, an increasing trend in relative abundance of fish does not mean the station has no impact. It could mean that the loss of fish at the station is being offset by improved water quality and reduced harvest, and that without the station fish populations would be doing much better. (ESSA Report, page ix.)

This assertion by ESSA ignores the stated purpose of PSEG's trends analyses, which was to characterize historical trends in abundance, not ascertain causes of changes in abundance. The conclusion that PSEG drew from the trends analyses was that the data show no evidence of a continuing decline in the abundance of most juvenile finfish RIS (PSEG's second benchmark of adverse environmental impact). In fact, the data provide positive evidence of increases in the abundance of seven of nine of juvenile finfish RIS.

Furthermore, ESSA's assertion the results of PSEG's Trends Analyses are "exploratory" ignores relevant conclusions (that are consistent with the conclusions drawn by PSEG) drawn by other researchers who have examined the same data. For example, ESSA fails to note that Weisberg et al. (1996) concluded:

> Abundance of juvenile striped bass and American shad, two important game species in the river ... both increased more than 1,000-fold during the last decade.

And the Delaware Estuary Program (Santoro, 1998) concluded:

> A number of fisheries have shown a resurgence in recent years. ... Increases have been noted in the abundance of American shad,

> weakfish, striped bass, Atlantic croaker, Atlantic silversides, bay anchovy, black drum, hogchoker, northern kingfish and striped anchovy.

ESSA continues its criticism of PSEG's Trends Analyses by further mischaracterizing PSEG's purpose in conducting the Trends Analyses and misrepresenting PSEG's use of the results of the Trends Analyses:

> The conclusions of the analyses generally overextend the data or results. As an example, the increasing trends in first year (Age 0) relative abundances are likely real for species whose indices consistently increase, however, the assumption that *spawning stock biomass* shows the same trend is not supported. (ESSA Report, page ix.)

Nowhere in the Application did PSEG claim that spawning stock biomass shows the same trend as the trend in age-0 relative abundance of a stock. In fact, in several places in the Application, PSEG presented evidence that spawning stock biomass ("SSB") and age-0 abundance (also referred to as recruitment) do not show the same patterns of change over years (see Section VII.E.2 below).

ESSA also criticizes PSEG's trends analyses by alleging that other researchers working with the same datasets would come to different conclusions due to their use of different methods, and by suggesting that PSEG did not present any diagnostic information that would help a reader of Appendix J identify influential data points (see ESSA Report, page 76). As discussed in Section VII.E.1.d, the differences ESSA found most "disturbing" apparently were due to ESSA's errors in transcribing data from a paper by Weisberg et al. (1996). Section VII.E.1.d also indicates that the diagnostic plots in Appendix J are more than adequate for identifying influential data points.

Another ESSA criticism implies that PSEG did not address the assumptions underlying its trend analysis. Section VII.E.1.b of this Response notes that PSEG's Application presents summary graphics, including maps, that define the statistical populations of interest. Although PSEG agrees with the first three of ESSA's suggested improvements for Appendix J (such as expanding the discussion of statistical methods to explicitly state underlying assumptions), PSEG notes that even if these topics were not fully discussed, they did not compromise the results of the analyses. PSEG's analyses did not violate key assumptions, and potential sources of bias did not adversely influence results of the trends analyses.

Regarding PSEG's Retrospective Assessment, ESSA comments:

> The retrospective analysis synthesized a great deal of information from many sections of the Application. However, inconsistent use of terms and a lack of definition for those terms detract from the rigor of the analysis and make comprehension of conclusions difficult. We recommend a number of improvements to the trends

> and retrospective analyses which are described in the review. (ESSA Report, page ix.)

PSEG agrees that the rigor of analyses can always be improved, and PSEG appreciates ESSA's suggestions in that regard. However, PSEG also notes that ESSA's concerns regarding "inconsistent use of terms and a lack of definition for those terms" in no way challenges the conclusions presented by PSEG in its Retrospective Assessment. Furthermore, ESSA's assertion that a "common approach" needs to be developed, does not take into account that differing terminology is inherent in the nature of stock assessment analyses, where experts must take into account that each species is different and must be assessed differently, and where each managing agency does things differently. As Section VII.E.2 addresses, applying such a "common approach" to all species in all situations is a practical impossibility.

Although ESSA acknowledged the breadth of information included in Appendix H of the Application, ESSA's comments suggest that ESSA did not fully understand the implications of a synthesis of such a breadth of information. PSEG recognized that a thorough assessment of the cumulative effects of the operation of Salem would require consideration of a vast amount of disparate data and information on the affected RIS populations. PSEG also recognized that considerable uncertainty would exist within this information and data (as is always the case with data and information on aquatic populations). It was also clear to PSEG that no single formula or procedure was available that could be used to analyze all relevant information and data in a holistic manner that would lead to unambiguous answers. Finally, the assessment of cumulative effects (of which the Retrospective Assessment is a part) could not be simply a descriptive discourse on the data and information, but had to provide scientifically defensible conclusions regarding Station effects. For these reasons, PSEG engaged stock assessment scientists, with decades of experience conducting stock assessments for resource agencies, to assemble and interpret the relevant information and data.

ESSA also criticizes the Retrospective Assessment for a tendency to draw subjective and unsupported conclusions. PSEG notes that the technical foundation for each conclusion was either discussed as part of the Retrospective Assessment or by reference to other parts of the Application, and the interpretation of the technical foundation, based on professional judgment of stock assessment experts, was also discussed in the Retrospective Assessment. ESSA appears to be seeking some kind of simple, uniform algorithm through which each input can be tracked to a conclusion. PSEG acknowledges that, owing to the complexity of the topic, the conclusions in the Retrospective Assessment are not, and could not be, based on any such simple uniform algorithm.

5. Prospective Stock Jeopardy Analysis

ESSA provides comments on three components of PSEG's stock jeopardy analysis: (1) the use of "meta-analysis" to estimate compensation in the RIS species; (2) the use of Equilibrium Spawner-Recruit Analysis (ESRA) and the Spawning Stock Biomass per Recruit (SSBPR) model to estimate potential changes in spawning stock biomass; and (3) the validity of PSEG's argument that Station mortality is analogous to fishing mortality.

ESSA commends PSEG for "progress made on the difficult problem of meta-analysis applications to fish populations," (ESSA Report, page 77), but identifies four "significant difficulties":

1. biases due to measurement errors in the spawner-recruit data;

2. inherent problems with the interpretation of spawner and recruit data;

3. biases inherent in measurements over time; and

4. lack of similarity of species chosen to represent RIS species. (ESSA Report, page x.)

According to ESSA, due to the above four "limitations," the levels of compensation used in the ESRA are "not reliable." Moreover, the equilibrium analysis is also limited because "the system is unlikely to be at equilibrium." Finally, ESSA states that "The Application raises the notion of the Station being treated as another user of the Delaware River fishery" and asked (rhetorically) "what power station management mechanisms are in place to alter operations should a fish population drop below optimum abundance" (ESSA Report, page x).

ESSA's comments on PSEG's use of meta-analysis are largely theoretical and academic. Moreover, most of the "limitations" identified by ESSA are discussed in the Application. Section VII.F of this Response further discusses the three components of PSEG's stock jeopardy analysis – meta-analysis and compensation, the ESRA model and the SSBPR analysis – and details the measures taken by PSEG to ensure that, in spite of any such limitations, the estimates of compensation and calculations of Station impacts are conservative (i.e., they underestimate compensation). In the course of preparing this Response, PSEG consultants performed quantitative assessments of the potential influences of limitations: (1) measurement error and (2) time series bias. These assessments demonstrate that these two sources of bias, although potentially important in theory, are inconsequential in practice and do not appreciably influence PSEG's analysis. Moreover, new studies published subsequent to the filing of the Application demonstrate that compensation in two of the RIS species, striped bass and weakfish, is even stronger than was indicated in PSEG's original meta-analysis. (See Attachment II-B-I). ESSA's concerns regarding the limitations of equilibrium models are misplaced. Such models are commonly used in fisheries science and management. ESSA's statements and question regarding the applicability of fisheries management principles to power-plant operations mischaracterize PSEG's analysis. PSEG's stock jeopardy analysis uses data and models derived from fisheries science because these data and models are relevant to assessing effects of entrainment and impingement on fish populations. The fact that fisheries managers also use these same data and models does not imply that power plants should be managed using the same regulatory approach (i.e., changing harvest limits in response to changes in measured or estimated spawning stock abundance) used to manage fisheries.

6. Summary of Data Sets and Their Use in the Permit Application

ESSA correctly notes that the analyses presented in the Application were based on data from many sources, and that some of the monitoring programs that produced these data have experienced changes in sampling protocols since their inceptions:

> The PSE&G Application used a number of data sets as input to analyses of impact assessment. The monitoring programs that collected these data often changed in location, timing and methods of sampling. (ESSA Report, page x.)

ESSA then criticizes the Application for not providing sufficient documentation of the changes and transformations PSEG applied to field data:

> The Application does not include sufficient caveats regarding the impact of these changes, the many assumptions made to transform field measurements into model inputs, and the inherent uncertainty in original abundance estimates. (ESSA Report, page x.)

This criticism is something of a contradiction in terms because ESSA relied on the information in the Application (and supplemental information provided by PSEG to NJDEP as part of PSEG's Permit Renewal process) to develop its understanding of the changes that had occurred and the transformations use by PSEG in its analyses. Had PSEG not provided a substantial level of documentation in its Application on these topics, ESSA would not have been aware of the information to comment on it. Nevertheless, PSEG acknowledges that additional documentation and discussion is always helpful, and that the Application could have been improved if more complete documentation and discussions had been provided.

ESSA recommends that the Application list all assumptions and acknowledge uncertainty in the data. ESSA also recommends that an uncertainty analysis be conducted and that conclusions be adjusted to reflect uncertainties and confounding factors. As noted above, PSEG agrees that the Application could have been improved if more complete documentation and discussions had been provided. However, as discussed in Section VII.G.3, the fact that analyses could be made more rigorous indicates nothing about whether there is any reasoned scientific basis for rejecting the results and conclusions of the analyses. ESSA's review of PSEG's data and data collection methods, and its listing of potential improvements to rigor, do not present any scientific basis for rejecting the results and conclusions presented in the Application.

Regarding future data collection efforts, ESSA made the following recommendations:

1. the consistency of biological monitoring should be improved;

2. the implications of changes to sampling methods should be rigorously assessed;

3. uncertainty over time should be reduced through improved monitoring and analytical methods; and

4. regional collaboration between agencies should be developed to coordinate the collection, use, and interpretation of data sets. (ESSA Report, page x.)

These are laudable goals for any environmental monitoring data collection efforts. However, they exceed the scope of PSEG's obligations with regard to Section 316(b). Nevertheless, PSEG's proposed Biological Monitoring Program takes steps to address these goals.

III. RESPONSE TO ESSA'S SECTION 1: INTRODUCTION

This part of PSEG's Response addresses issues raised in the introductory discussion of the ESSA Report. ESSA's introduction sets forth its objectives and approach in reviewing portions of the Application, outlines the structure and context of its review, and identifies the ESSA review team.

A. ESSA Report § 1.1: Objectives and Approach

In § 1.1, ESSA summarizes the specific portions of PSEG's Application that NJDEP asked ESSA to review, and describes the parameters of the review as outlined in the NJDEP Scope of Work for ESSA's review (provided as Annex 1 to the ESSA Report). ESSA indicates that the major objective of the review is to review PSEG's assessment as to whether technological measures can be implemented at Salem that will reduce the numbers of organisms lost, where the economic costs are not wholly disproportionate to the benefits. (ESSA Report, page 1.) According to ESSA, ESSA's specific objectives included review of: (1) the accuracy of PSEG's entrainment and impingement mortality estimates; (2) PSEG's evaluation and determination as to available technologies to reduce impingement and entrainment mortality; (3) PSEG's assessment of economic costs and benefits associated with the technologies; and (4) the models and analyses "presented to demonstrate that the actual and potential effects of [the Station] are fully understood and adequately documented" for the RIS (id.).

PSEG agrees in essential respects with this summary of ESSA's Scope of Work. However, PSEG notes that the charge from NJDEP to ensure that the effects of Salem are "fully understood" is one that, from a scientific perspective, is poorly worded: it would be impossible for PSEG, or indeed anyone, to comply with this charge, as science cannot achieve that degree of explication regarding effects on ecosystems. PSEG has never understood the objective of a Section 316(b) demonstration as demonstrating "full understanding" of the Station's effects, but rather as demonstrating, on the basis of reasonable and reliable evidence, that the Station is complying with the requirements of Section 316(b) to minimize adverse environmental impact. PSEG believes that its Application does so demonstrate that Salem Station is not causing any AEI, and that the Station's technology alternatives are BTA for minimizing AEI.

Further, as detailed in Section I.D of this Response, PSEG notes that ESSA took a highly detailed and somewhat compartmentalized approach in conducting its review. As a result, ESSA's Report seems to focus overwhelmingly on the quality of the technical documentation of the Application, rather than on the significance of PSEG's analytical approach of using multiple lines of evidence interpreted by experts. However, as discussed throughout PSEG's Response, the ESSA Report does not, in essence, challenge any of PSEG's basic findings.

B. ESSA Report § 1.2: Structure and Context of Review

This section of ESSA's Report describes the structure and context of its review, indicating that ESSA addressed three distinct analyses in the Application: compliance with the

1994 Permit, the cost-benefit analyses of technology alternatives, and the assessment of the Station's effects on fish populations and the Delaware River ecosystem. (ESSA Report, page 2.) ESSA also indicates that the three analyses are "essentially independent" with respect to methodology and implications of results and conclusions (id.), and states that:

> ... the methodology used to assess the effects of entrainment and impingement on fish in the impact assessment and the methodology used for the cost-benefit analysis of BTA are very different, and based on distinctly different definitions of adverse impact of the Salem station. (ESSA Report, page 2.)

PSEG notes that, although ESSA is essentially correct regarding the relative independence of PSEG's analyses regarding 1994 Permit compliance, the costs and benefits of technology alternatives, and the cumulative impact assessment, ESSA is incorrect in stating that the cost-benefit analysis of BTA and the impact assessment use different definitions of adverse impact. The cost-benefit analysis is not concerned with defining adverse impact, but only with quantifying the relative costs and benefits of the various technology alternatives. In contrast, the impact assessment is concerned with defining adverse environmental impact, which, as discussed in Section I.C.3. of PSEG's Response, is defined at the population level.

1. ESSA Report § 1.2.1: Site Visit and Technical Meetings

In this section, ESSA acknowledges that PSEG "provided the review team with full support and extensive cooperation throughout the review" (ESSA Report, page 4), and describes a site visit and some technical meetings that occurred. PSEG appreciates ESSA's recognition of the efforts PSEG made to ensure ESSA had full access to PSEG's team of specialists and any other assistance that ESSA might need in understanding and evaluating the portions of the Application ESSA was charged with reviewing. However, it is not completely accurate to characterize PSEG's assistance as actually "provid[ing]" the full support and cooperation PSEG would have liked to provide. In fact, as detailed above in Section I.D.3.e., with the exception of a few instances, ESSA did not fully utilize the research assistance and expertise PSEG made available. Had ESSA done so, it is likely that ESSA would have been able to clarify many of the issues that are raised throughout its review. In particular, the ESSA Report does not incorporate or address the supplemental information PSEG provided in the May 2000 Report (see Attachment II-C) that addressed many of the concerns raised in ESSA's Report.

2. ESSA Report § 1.2.2: ESSA Review and Section 316(b)

In this section, ESSA notes that the focus of its review was the "technical and scientific analyses" presented in the Application, and that determination of the "relevance and application of the results of the ESSA review" to Section 316(b) requirements is "outside the scope" of ESSA's task (ESSA Report, pages 3-4). PSEG agrees that ESSA's task did not include making any determinations regarding how its findings should impact NJDEP's Section 316(b) determination.

While PSEG agrees that making any comments evaluating the adequacy of PSEG's Application under Section 316(b) would certainly have been outside ESSA's scope, PSEG also notes that in fact it would have been appropriate for ESSA to take into consideration the Section 316(b) context in evaluating the Application, which ESSA did not do. As detailed at greater length in Section I.D.3.d., the academic, highly critical approach taken by ESSA to evaluating the "scientific rigor" of the documentation in the Application is inconsistent with Section 316(b) legal and regulatory precedent. As a result, many of ESSA's critical comments, while they have some relevance to furthering abstract understanding of some of the highly complex technical matters in the Application, do not translate into practical guidance in assessing whether PSEG's analyses meet the standards for a successful 316(b) demonstration.

Given the potentially slippery slope between taking into account the Section 316(b) context and actually making judgments regarding the adequacy of an analysis under Section 316(b), perhaps the balance struck by the ESSA Report – i.e., ignoring the Section 316(b) context in conducting its review – is appropriate. At any rate, however, PSEG feels it is important that NJDEP and interested third parties reviewing the ESSA Report bear in mind the distinction between ESSA's academic, highly technical evaluations of the analyses in PSEG's Application and the statutory and regulatory standards applicable to those analyses. As detailed at length in Section I.D.2., those precedents consistently indicate that the goal of a Section 316(b) demonstration is not theoretical "scientific rigor," but reasonably reliable evidence sufficient to support a Section 316(b) determination.

C. ESSA Report § 1.3: ESSA Review Team

This section briefly lists and describes ESSA's team of "ecologists, fish population biologists, engineers, and resource economists" that undertook the review (ESSA Report, page 5). The information provided does not allow PSEG to evaluate the merit of the scientific skills of the individual members, but PSEG recognizes and acknowledges that collectively the team appears to possess a level of technical expertise regarding scientific issues relating to ecological and economic analysis. PSEG notes also that its own team of expert scientists, engineers and economists who sponsored the various sections of the PSEG Response are listed in Section I.A.3., with summaries of their qualifications provided in Appendix A to PSEG's Response.

IV. RESPONSE TO ESSA'S SECTION 2: ENTRAINMENT AND IMPINGEMENT

A. ESSA Report: Summary and Recommendations

1. Summary

ESSA notes the importance of impingement, entrainment and CMR estimates as inputs to PSEG's assessment of adverse environmental impact and to PSEG's Cost-Benefit assessment of technology alternatives:

> ... the results of these analyses provide key input to subsequent analyses of the effects of the [S]tation, such as fish stock jeopardy, lost fish production and biomass, assessment of the Base Case future station operations scenario, and ultimately, the cost-benefit analyses of BTA to reduce entrainment and impingement. (ESSA Report, page 6.)

PSEG agrees with the importance of these estimates as fundamental inputs to other analyses presented in the Application.

ESSA also acknowledges PSEG's efforts to account for changes in sampling protocols for entrainment and impingement sampling (which began in 1977) that have resulted in data gaps, and PSEG's efforts to avoid biases that could have been introduced by some sampling procedures:

> In order to complete the analysis of the loss of fish due to entrainment and impingement at the [S]tation, the investigators made a careful and substantial effort to fill gaps in the data and to adjust for known biases. Significant data engineering for entrainment losses had to occur before analyses could proceed. They should be commended for their efforts. (ESSA Report, page 6.)

PSEG agrees that the historical data sets contained gaps in the data and that some sampling procedures produced data that required adjustment factors to avoid biases in entrainment and impingement loss estimates. PSEG identified these facts in the Application and developed and applied data analysis methods accordingly (Application, Appendix F, Attachment 1).

a. Entrainment Loss Estimates

Regarding the entrainment loss estimates, ESSA claims that:

> ... the variance in the entrainment data warrant an uncertainty analysis to accompany the single-averaged point estimate approach taken in the analyses. (ESSA Report, page 6.)

PSEG agrees that uncertainty is present in the entrainment loss estimates, as it is in all estimates derived from field data. However, PSEG does not agree with ESSA's call for uncertainty analyses. ESSA does not explain the purpose of the recommended uncertainty analyses, how the uncertainty analyses should be conducted, what the output of the analyses should produce, or how the output would be useful to NJDEP in its permit decision-making. Without this supporting information, it is difficult for PSEG to assess the reasonableness of ESSA's recommendation.

b. Impingement Loss Estimates

Regarding the impingement loss estimates, ESSA states that:

> . . .the estimated impingement mortality rates are not representative of actual mortality rates of impinged fishes after they are returned to the Delaware River via the fish return system of the station. The extremely turbulent conditions in the return sluice and sampling pool are believed to both add stress and obscure true impingement mortality. (ESSA Report, page 6.)

PSEG agrees that the turbulent conditions in the fish sampling pools at the Station induce additional stress that likely causes PSEG's estimates of impingement mortality rates to be biased high relative to the actual mortality fish experience by the time they reach the diversion to the fish sampling pool. (See Section II.C.2.) It should be noted that this additional stress is only experienced by fish collected during sampling (which is a very small fraction of all fish impinged), and does not affect fish returned to the estuary during non-sampling events. PSEG also recognizes that fish may experience additional stress upon re-entry to the estuary. However, how much additional mortality this additional stress causes has not, to date, been subject to study. If the terms of the NJDEP Draft Permit for Salem are included in the Final Permit, PSEG will be conducting studies to address this question.

c. Conditional Mortality Rate (CMR) Estimates

In its summary of PSEG's CMR estimates, ESSA notes that PSEG used two methods for estimating CMRs: the Empirical Transport Model ("ETM"), and the Extended Empirical Impingement Model ("EEIM"). Regarding the ETM-based estimates of CMR, ESSA disagrees with one of the assumptions underlying the method:

> The ETM method uses the difference in density of entrainable life stages at the intake vs. out in the estuary, which is represented as the W factor in the method. While the W factor is set to 1 for all species in the analyses (equal inshore and offshore densities), it is believed that W is likely greater or smaller than 1 for different species at different times of the year, for different stages of the tide, and for different intake flow rates at the [S]tation. The justification for equating the density of entrainable stages at the intake with offshore density in terms of hydrological conditions at

> the intake and in terms of abundance data was not provided. (ESSA Report, page 6.)

PSEG agrees with ESSA's belief that true W-Factor may vary by species, and by time of the year, stage of tide, and intake withdrawal rates. Although it may be theoretically possible to account for the effects of factors such as time of year and stage of tide, ESSA did not provide references to any such applications, and PSEG is not aware of any application of the ETM that accounted for of these factors.

Furthermore, PSEG's decision to use a W-Factor equal to one may have caused CMR estimates to be biased *high*. In the recently submitted Draft Environmental Impact Statement ("DEIS") for three electric generating stations on the Hudson River (CHG&E Corp., et al. 1999), the results from special studies to assess W-Factors (referenced to as W-Ratios in the Hudson river Stations DEIS) were reported. W-ratio estimates (Appendix VI-I-B, Table X-12256 of the DEIS Hudson River Stations) were presented for four life stages of five species at four generating stations (a total of 78 estimates). Sixty of the 78 estimates were less than one, and all estimates for juvenile fish were less than one (ranging from 0.0018 to 0.2133). It should be noted that PSEG applied the ETM (which is the CMR estimation method that requires estimates of W-factors) only to bay anchovy and weakfish. One of the species for which W-ratios were reported in the Hudson River Stations DEIS was bay anchovy (estimates for the weakfish were not reported). The W-ratio estimates for bay anchovy were less than one (ranging from 0.0018 to 0.8944) for all life stages at all stations. If the true W-ratios at Salem were also less than one, the CMR estimates reported in the Application for weakfish and bay anchovy were too high.

Regarding the EEIM-based CMR estimates, ESSA claims that:

> Due to limited survey data, a paucity of species abundance data exists which surrounds the population estimates with a great deal of uncertainty. Further, it is believed that the natural mortality estimates obtained with the Life Cycle Balancing method are biased high as a result of: 1) not removing entrainment and impingement effects of the [S]tation from the estimates; and 2) the inherent assumption of the Life Cycle Balancing method that populations are at equilibrium. (ESSA Report, page 6.)

PSEG disagrees with ESSA's comment that natural mortality rate estimates used in the EEIM were biased high. As discussed in Section II.D.3 below, most of the early life stage mortality rates used in the analyses were literature-derived values taken from studies performed on populations in estuaries that are not affected by the Station. Therefore, there were no Station effects to remove. Mortality rates for some life stages of bay anchovy and weakfish were based on data from the Delaware Estuary. However, for these species, the mortality induced by the Station is negligibly small compared to natural mortality. For example, the estimated daily Station mortality rate is only 0.01% of the daily natural mortality rate (see Section II.D.3, page 63). Therefore, the effect of removing Station mortality from the total mortality rate would be inconsequential.

2. Recommendations

ESSA presents three short-term and six long-term recommendations to address estimates of entrainment and impingement losses and estimates of CMR. (ESSA Report, pages 7-8.)

a. ESSA's Short-Term Recommendation #1: Characterization of the Estimated Historic Annual Entrainment Loss Estimates

> The uncertainty of the estimated historic annual entrainment loss estimates should be characterized and presented as ranges with realistic maximum and minimum levels. (ESSA Report, page 7.)

As discussed in Section II.B.1 below, ESSA does not present technical support to justify its recommendation for uncertainty analyses. Nor does ESSA describe the purpose of the uncertainty analyses, how the uncertainty analyses should be conducted, what the output of the analyses should produce, or how the output would be useful to NJDEP in its permit decision-making. Furthermore, ESSA provides no definitions for "realistic maximum and minimum" levels, and no discussion of what the "ranges" should represent. Given the above, PSEG cannot reasonably evaluate the merits of this recommendation.

b. ESSA's Short-Term Recommendation #2: Investigation of Bias in Natural Mortality Rate Estimates and Uncertainty in CMR Estimates

> The likely error in the estimation of natural mortality rate (M), and the effect on CMR estimates with the EEIM should be investigated. The uncertainty with the CMR estimates should also be characterized and presented. (ESSA Report, page 7.)

As noted above and discussed in detail in Section II.D.3 below, ESSA claims that natural mortality rate estimates used in the EEIM were biased. In fact, the mortality rates used in PSEG's analyses were values derived from peer-reviewed scientific literature that were developed, using the best available scientific data and objective scientific methods, in collaboration with Dr. James H. Cowan (University of South Alabama) and Dr. Kenneth A. Rose (Louisiana State University).

PSEG agrees that the CMR estimates presented in the Application contain uncertainty, as do all estimates based on field data. However, PSEG does not agree with ESSA's recommendation that the uncertainty should be "characterized and presented." ESSA does not explain why the proposed uncertainty analyses would be useful to NJDEP in evaluating PSEG's Application and, absent such information, PSEG has no reason to believe that the analyses are necessary.

c. ESSA's Short-Term Recommendation #3: Investigation of Impingment Mortality Rates Estimates

> Mortality (initial and latent) rate of impinged fish should be determined in-situ (in the river) after fish are discharged from: 1) the existing fish return system; and 2) from the fish return system after the velocity in the return sluice is reduced significantly, ideally to the velocity of the river in front of [S]tation. In-situ mortality could be determined in a large cage positioned to receive fish as they leave the return sluice. Mortality estimates should include predation by birds and other fish upon return to the river. The in-situ mortality rate estimates and the mortality estimates obtained with the existing sampling pool should be compared. (ESSA Report, page 7).

This recommendation is in response to ESSA's concern that impingement mortality rate estimates may not be accurate:

> The central issue here is that the initial and latent mortality rates estimated via the sampling pool and holding tanks are quite likely not representative of the actual mortality rates of fish after they have been returned to the Delaware River. It is possible that the mortality rates measured using the sampling pool overestimate actual impingement mortality. It is also possible that actual mortality rates of fish after returning to the Delaware River are equivalent or even higher than those estimated via the sampling pool. Actual impingement mortality could be higher due to physical trauma caused by high water velocity in the sluice combined with the physical trauma that must occur when fish and debris abruptly hit the surface of the river. Because the sluice is open and above the river surface, fish and debris must hit the water abruptly as opposed to entering the river below the surface. Predation by fish and waterfowl of fish potentially stunned by their return to the river could be high. Thus, it is judged that the mortality of impinged fish returning to the Delaware River is likely not accurately described by the mortality estimates determined with the sampling pool and holding tanks. (ESSA Report, page 24.)

As discussed in greater detail in Section IV.C.2.b below, PSEG agrees that impingement mortality rate estimates may not be accurate for the reasons listed by ESSA. However, PSEG does not agree with ESSA's statement that the stresses experienced by fish re-entering the estuary exceed the stresses experienced by fish entering the fish sampling pools, and ESSA provides no support for this statement in its Report. Furthermore, ESSA's proposed study design (i.e., use of a large cage that would allow fish and avian predators to consume returned fish) is *ad hoc* and does not include sufficient detail to support an objective evaluation of its recommendation. For example, ESSA did not describe how predation by fish and birds would be measured, nor did ESSA describe how it proposed allowing predatory fish into the cage while retaining the test fish (from the impingement wash water). Although PSEG does not concur entirely with ESSA's recommendation, PSEG agrees that a study to produce accurate estimates of impingement mortality rates (not biased by stresses of the fish sampling pool) as fish re-enter the estuary is warranted.

d. ESSA's Long-Term Recommendation #1: Documentation of Flow Dynamics

The flow dynamics at the intakes of the Station should be documented to determine the following:

a) *The flow field in front of the intake and the existence of vortices at the intake should be observed and photographed at an extreme low tide, and when the current is strongest — at mid-tide on the flood and mid-tide on the ebb.*

b) *The pumping records of each pump should be examined to determine if the flow distribution is asymmetrical among the intake bays, particularly Bay 1 and Bay 12.*

c) *The bathymetric chart of the area should be examined to determine the potential for a strong back eddy during the ebb in Ship Wreck Bay immediately to the south of the intake. If such an eddy exists it will be observable from shore and from the air when the ebb current is at maximum. The chart may also provide insight into the flow field entering the dredged channel from the side.* (ESSA Report, page 7.)

It is unclear how ESSA's long-term recommendation #1(a) will provide reliable information that could be used to determine if "vortices" at Bay 1 or Bay 12 or any apparent nonuniformities have any significance for environmental sampling near the intake. Surface observations reveal no information regarding changes in the flow field over depth.

Although PSEG has demonstrated there can be an asymmetry in the intake flow and velocity across the bays, the small-scale vortices in the end bays are not significant as stated by ESSA. Site-specific field data (Weston 1982; WHG 1995a), do not show the existence of well-defined vortices in front of the intake. PSEG feels it is important to distinguish eddy and small-scale turbulent motions from the persistent vortices that are hypothesized by ESSA. The prevailing tidal conditions in the estuary are too dynamic and complex to permit the formation of stationary, well-defined vortices. The Weston (1982) current measurements did reveal some turbulence effects in the upper two meters of the water column on the northwest end of the CWIS during an ebb tide, which could be related to small-scale eddy formation or just general turbulence. The ADCP transects in front of the CWIS observed by WHG (1995a) also did not exhibit any well-defined vortices. PSEG acknowledges it is difficult to compile data with a spatial resolution adequate to resolve small-scale eddies and it is likely that some small eddies are formed near the intake, due to the turbulence in front of the intake structure. The spatial scale of these hydrodynamic features is likely to be highly variable and the time scale is likely to be short. Compared to the relatively large CWIS flow volume, such small-scale features would have no impact on the net entrainment and impingement of passive organisms.

ESSA's long-term recommendation #1(b) requires an examination of the pumping records of each pump to determine if the flow distribution is asymmetrical among the intake bays, particularly Bay 1 and Bay 12. The available data for this examination include hourly records of each pump's operational status (on/off) and (generally) annual measurements of pump performance. The flow distribution across the intake structure will exhibit varying degrees of nonuniformity due to differences in each pump's performance (which is normal) and the temporary removal of a pump(s) from service for reasons of maintenance or other operational requirements.

Regarding long-term recommendation #1(c), PSEG is unaware of any scientifically defensible method for using bathymetric charts to determine the existence of, much less quantify the characteristics of, a strong back eddy in Sunken Ship Cove or the characteristics of the flow field entering the dredged channel from the side. PSEG acknowledges that there are, in fact, unique features of the flow in the vicinity of the Station and Sunken Ship Cove; however, there is no evidence of a strong and persistent "back eddy" confined to Sunken Ship Cove on the ebb tide as ESSA states and illustrates in ESSA Report Figure 2.2. PSEG has, for some time, had interest in the unique hydrodynamic processes in the vicinity of the Station. Consequently, PSEG has previously addressed these issues using more rigorous and advanced methods than those recommended by ESSA. As NJDEP is aware, PSEG has completed extensive field measurement programs well above and beyond the scope of the observations from the shore and air and investigations of bathymetric charts recommended by ESSA, as well as numerical and physical modeling investigations that provided very detailed information related to the site-specific flow patterns.

As discussed in PSEG's Response to Section 2.1.3 of ESSA's Report, the concept of a strong back eddy being formed within Sunken Ship Cove on the ebb tide, as proposed by ESSA, is not possible. The prevailing tidal conditions in the estuary are too dynamic, and cause a near constant change in the flow patterns. Although there can be "eddy-type" motions south of the Station that are generated by shear within the estuary, these motions occur on the change of the tide, are of short duration (less than 2 hours), and are much larger in scale than Sunken Ship Cove alone. In fact, these motions can encapsulate Sunken Ship Cove on occasion.

e. ESSA's Long-Term Recommendation #2: Potential Reassessment of Design of Entrainment Sampling

> If the analysis in recommendation 1(c) corroborates our hypothesis of a back eddy and hence a possible pattern of regular episodic entrainment, the design of entrainment sampling should be reassessed.

a) An analysis of the optimum sampling frequency for entrainment and impingement should be conducted, especially with regard to potential episodic nature of the entrainment process. This needs to take explicit account of the shape of the zone of entrainment. (ESSA Report, page 7.)

b) Sampling frequency should then be reassessed and adjusted if the analysis recommended in 2(a) indicates that a stratified sampling program (e.g., according to tidal stage) would reduce the variance of entrainment estimates. (ESSA Report, page 7.)

PSEG does not agree that simply a "possible pattern" or a "potential episodic" process is reason enough to adjust the sampling design for entrainment sampling at the Station. As discussed in Section II.B.3, below, regular periodic *hydrodynamic* processes do occur in the vicinity of the Station. However, the presence of those processes does not imply a specific periodicity of entrainment densities for all species and life stages of organisms subject to entrainment. Each species and life stage interacts with those hydrodynamic processes differently depending on the spatio-temporal distribution of the organisms and the behavior and buoyancy of the organisms. Although, in general, stratified random sampling designs can be effective for reducing the variance of estimates of a single parameter (e.g., density of one life stage of one species), it is naïve and scientifically incorrect to assume that any one sampling design could "reduce the variance of entrainment estimates" for all species and life stages. Furthermore, PSEG's proposed Biological Monitoring Plan (see Section II.I) includes very intensive, 24-hour entrainment sampling during periods of entrainment vulnerability of key RIS. PSEG believes that intensive sampling around the clock is a more scientifically valid approach for producing entrainment estimates, with acceptable levels of precision, for a wide range of species and life stages in a highly variable estuarine environment. For these reasons, PSEG questions the scientific validity of ESSA's recommendation.

f. ESSA's Long-Term Recommendation #3: Consistent Application of Sampling Design

There should be a consistent application (year-to-year) of the sampling design to reduce and preferably eliminate the requirements for future interpolation/extrapolation of data. (ESSA Report, page 7.)

PSEG agrees with this recommendation and has proposed a Biological Monitoring Plan to the NJDEP which is consistent with this recommendation.

g. ESSA's Long-Term Recommendation #4: Investigation of Alternative Sampling Methods

Alternative sampling methods with less process error need to be investigated and implemented. (ESSA Report, page 7.)

ESSA defines "process error" in entrainment sampling as being net extrusion:

> Corrections necessary to adjust the data for physical processes related to entrainment sampling include: a re-circulation adjustment, an adjustment for sampling *process error* (*net extrusion*) and sampling bias (net avoidance). (ESSA Report, page 10. (*emphasis added*))

ESSA's justification for this recommendation appears to be based on its interpretation of the effect on entrainment loss estimates of PSEG's adjustment factor to account for net extrusion. As discussed in Section II.B.1 below, ESSA misinterpreted the effects of PSEG's use of an adjustment factor, and, therefore, erroneously concluded that the use of an adjustment factor resulted in biased estimates. PSEG, therefore, questions the scientific validity of the recommendation.

h. ESSA's Long-Term Recommendation #5: Feasibility of Addressing Sampling Bias Associated with Net Avoidance

> The feasibility of employing the data from the *Survival Sampling* data set (1981, 1982) to address the question of sampling bias associated with net avoidance should be examined. If feasible, the data should be used to attempt to characterize the sampling bias on a species-specific basis. (ESSA Report, page 7.)

PSEG agrees with this recommendation.

i. ESSA's Long-Term Recommendation #6: Potential Redesign of Fish Return System

> If impingement mortality rates of fishes measured in-situ are lowest when water velocity in the return sluice is reduced, then the fish return system of the station should be redesigned to provide the lower sluice velocity and protection from initial predation by birds and other fish if required. (ESSA Report, page 8.)

This recommendation by ESSA to install a technology alternative simply because it may be effective in reducing losses for some species is not consistent with NJDEP's stated approach to evaluating technology alternatives for compliance with Section 316(b). NJDEP's decision paradigm is clearly stated in the Fact Sheet:

> Under Section 316(b), a permitting agency has the ultimate burden of persuasion that any BTA measure that it requires is "available" for a given facility, and that its *costs are not "wholly disproportionate"* to environmental benefits. (Fact Sheet, page 69, *emphasis added.*)

ESSA's recommendation to redesign the fish return system, with no reference to associated costs or benefits, is thus inconsistent with NJDEP's decision-making paradigm. The recommendation thus is inappropriate in the context of the Department's review of PSEG's Section 316(b) demonstration.

B. ESSA Report § 2.1: Entrainment

ESSA identifies two major uses of entrainment sampling data in the Application. First, the entrainment samples taken at the Station are expanded to yield estimates of historical annual entrainment losses and Base Case estimates of potential future losses. Second, the entrainment samples are used to calculate conditional mortality rates (CMRs), which are used in the Stock Jeopardy analysis to evaluate the population-level consequences of the losses. (ESSA Report, page 8.)

ESSA expresses two overall "concerns" with the entrainment sampling program: year-to-year variations in the sampling program, and "significant" biases in the sampling protocol. ESSA states:

> The authors of the Application are aware of these difficulties and have done a good job of trying to account for them. (ESSA Report, page 8.)

However, ESSA argues that PSEG neither explicitly accounted for uncertainty concerning the magnitude of the entrainment losses nor acknowledged this uncertainty in the conclusions of its analysis.

ESSA's review consists of three components: (1) evaluation of entrainment sampling and loss estimation methods; (2) evaluation of methods used to estimate entrainment CMRs; and (3) evaluation of hydrodynamics at the cooling water system intake. This section of PSEG's Response deals in turn with each of the above components of ESSA's review.

1. ESSA § Report 2.1.1: Sampling and Estimation of Entrainment Losses

Section 2.1.1 of ESSA's Report identifies changes in entrainment sampling methods that have occurred since the Station began operations in 1977, and discusses the implications of these inconsistencies. ESSA also discusses biases, previously identified by PSEG, in the raw entrainment data and the methods PSEG used to correct the data for those biases. In addition, ESSA comments on methods used to estimate mechanical mortality, and on entrainment sampling fractions. Specific issues raised by ESSA in these discussions include: inconsistencies in sampling due to inter-annual changes in program design, adjustments made by PSEG to account for net avoidance and extrusion, the data and methods used to estimate entrainment survival, and adjustments made by PSEG to account for daytime vs. nighttime sampling. ESSA also argues that despite the efforts made by PSEG to account for inconsistencies and limitations in the available data, a quantitative uncertainty analysis of the loss estimates is needed that includes the calculation of "realistic maximum and minimum levels." ESSA's main concerns are addressed in the sections below.

a. Historical Changes in Entrainment Sampling Methods

ESSA summarizes changes in entrainment sampling methods that have occurred since 1977 in Table 2.1 of its Report. ESSA notes that:

> Since the data are used for analysis which spans a series of years, the shifts in the protocols necessitate the use of adjustments (e.g., to correct for the absence of night time sampling during the period 1985 through 1994). Interpolation and extrapolation were also necessary to estimate missing data where the program design did not provide for consistent coverage. Additionally, the predominant intake sampling locations and protocols have know biases that also require "correction" of the data. (ESSA Report, page 8.)

PSEG was aware of these limitations of the historical entrainment data and developed methods to account for the limitations when those data were analyzed for the Application. ESSA concludes that PSEG's methods were reasonable and made the most of the available data:

> The methods employed for interpolation/extrapolation of data are reasonable and generally conservative. Weaknesses in the data are explicitly acknowledged and various adjustments or correction coefficients have been developed and applied to attempt to correct for know[n] biases. In this regard, the overall approach taken by the investigators working with the data is not unreasonable; in fact their attempts to make the most of an incomplete and biased data set are laudable. (ESSA Report, page 10.)

PSEG acknowledges the difficulties posed by historical changes in entrainment sampling methods and has taken steps to ensure consistent sampling in recent years. Since 1995 (the beginning of the last permit period), entrainment sampling has been conducted year-round (except for nine months during the period June 1995 through August 1997, when the Station was not in two-unit operation) with daytime and nighttime sampling. Furthermore, PSEG's proposed and expanded Biological Monitoring Program for the next permit period includes provisions for continued year-round entrainment sampling with daytime and nighttime sampling.

b. Corrections for Gear Avoidance

ESSA suggests that the adjustment to the raw entrainment data to correct for possible avoidance of the sampling gear should have been developed in species-specific basis:

> Our *a priori* expectation regarding the correction for "net avoidance," i.e., a sampling bias in the physical mid-water draw from the fixed intake sampling standpipe (Attachment F1 —

> Figure 4), was that the adjustment would be species and size specific and that it would reflect differences in the sampling efficiency for pelagic and demersal species. (ESSA Report, page 10.)

PSEG agrees that gear avoidance likely is species-specific; however, due to the very limited number of paired intake-discharge *abundance* samples (only 14 paired samples from June 1980), species-specific estimates for all RIS could not be computed. However, as discussed below, intake-discharge survival samples collected in 1981 and 1982 may provide an additional source of data to address the questions of gear avoidance.

ESSA acknowledges the limitations of these data:

> [the lack of species-specific correction factors] appears to be the result of limitations in the data; a relatively small data set of 14 paired samples during a three week period in June of 1980 was available for the analysis. Based on discussions with PSE&G investigators during our site visit to the [s]tation, we understand that physical problems with the discharge sampling program necessitated its discontinuation, and that the paucity of data is not for lack of trying. (ESSA Report, page 10.)

However, ESSA suggests the use of an additional data set for estimating correction factors for net avoidance. Specifically, ESSA suggests using data from entrainment survival sampling that was conducted in 1981 and 1982. A total of 367 samples (intake plus discharge) were collected, each with a volume similar to that of the standard abundance sample. PSEG agrees with ESSA that these data should be reviewed to determine whether they are appropriate for estimating gear avoidance factors. PSEG will perform this analysis and report the results to NJDEP.

c. Corrections for Extrusion

Of the various correction factors PSEG applied to the raw entrainment data, ESSA comments that the one of most concern was the correction for extrusion through the entrainment collection net:

> As noted in the text of the Application, the multiplier for the smallest life stages is ≈9, i.e., for each larvae observed, 8 would have been extruded through the net. The implications of such a large process error seem profound. (ESSA Report, page 11.)
>
> . . .[I]t is feasible if not likely that low rates of entrainment will appear as zeros in the data set. Since there is no way to distinguish between a true observation of zero entrainment and one which arises from this source of sampling error, this source of error has remained uncorrected thereby resulting in a reduced estimate of entrainment losses. (ESSA Report, page 12.)

ESSA's interpretation of the effects of the adjustment factor for extrusion is incorrect, and ESSA's Table 2.3, presented in support of ESSA's interpretation, is misleading. It is not true, as implied by ESSA's Table 2.3, that extrusion is a deterministic process in which every sample with 8 or fewer organisms will be recorded as having a count of 0 due to extrusion. Rather, extrusion is a stochastic process and the number of fish extruded in each sample is random, with each fish collected having a chance of being extruded.

For very small larvae, PSEG estimated that the chance of a fish being extruded was approximately 8 out of 9. Assuming each fish (of a particular size) collected has the same chance of being extruded, the probability of observing X fish in the sample [i.e., Pr(X)], when in fact N fish actually were collected can be described by the binomial probability distribution:

$$\Pr(X) = \binom{N}{X} P^X (1-P)^{N-X} \qquad (1)$$

where the number of fish observed (X) can be any integer from 0 to N, and P is the probability of not being extruded (e.g., 1 out of 9). One of the properties of a binomial distribution is that it has a known average value, also referred to as the expected value and denoted as E(X) (Johnson and FDTZ, 1969), that is defined in terms of the underlying parameters (i.e., N and P):

$$E(X) = \sum_{X=0}^{N} [\Pr(X) \times X] = N \times P \qquad (2)$$

On average, the number of fish observed in a sample, after extrusion has occurred, is the true number collected times the probability of not being extruded.

PSEG's correction factor for extrusion (e.g., 9 for this example of small larvae) was multiplied times the observed number of fish in the sample. Since the correction factor is the reciprocal of the estimated probability of not being extruded (i.e., 1/P), the expected value of the product of the correction factor and the observed number of fish in the sample is equal to the actual number of fish collected:

$$E\left[\left(\frac{1}{P}\right) \times X\right] = \left(\frac{1}{P}\right) \times E(X) = \left(\frac{1}{P}\right) \times [N \times P] = N \qquad (3)$$

For example, suppose the actual density of small larvae is 0.16 fish per cubic meter of water, and each sample has a volume of 50 cubic meters, so that 8 fish (i.e., 0.16 times 50) are actually collected in each sample. Given that each fish collected has only a 1 in 9 chance of being retained in the sampling net, the number of fish observed in each sample could be any integer from 0 and 8. For this example, the probability of observing a sample with 0 fish is greater than observing a sample with 8 fish, although both outcomes are possible. The probability associated with each possible outcome (i.e., number of fish observed in a sample) and the adjusted number of fish in the sample (i.e., after multiplying the observed number in the sample by the correction factor of 9) are listed in Table IV-1.

For this example, the average adjusted number in the sample is 8:

$$E[9 \times X] = 9 \times E(X) = \sum_{X=0}^{8} [\Pr(X) \times (9 \times X)]$$

(i.e., the sum of the entries in the last column of Table IV-1) which is equal to the actual number collected. Although 39% of samples would have observed counts of zero (i.e., probability that X=0 is 39%), and therefore 39% would have zero values for the adjusted number of fish, the remaining 61% of samples would have observed counts of 1 or greater (i.e., probability that X>0 is 61%) with adjusted values in excess of the true number collected (i.e., 8). On average, the individual samples with adjusted values equal to zero are balanced by the samples with adjusted values above the true number collected so that the average adjusted number is equal to the actual number collected. The equality between the average adjusted number in the sample and the actual number collected is a general result that derives from equations (2) and (3), above.

ESSA's argument that PSEG's method for correcting for extrusion leads to reduced estimates of entrainment losses is not scientifically valid, and ESSA's conclusion is incorrect.

d. Corrections for Daytime Only Sampling

Regarding the correction factors for years in which entrainment sampling was conducted only during daytime hours, ESSA reviewed and concurs with our approach:

> [I]n their estimation of the adjustment factor for the lack of night time samples from 1985 to 1994, the investigators used a generalized linear model which incorporated an extra-Poisson error structure in . . .*recognition of the highly aggregated nature of schooling fish*" (Application Appendix F, Attachment F-2, page 15). We concur with the approach taken. . . (ESSA Report, page 12.)

e. Entrainment Sample Size Requirements

ESSA notes that because the distribution of entrained fish is very patchy, special attention should be given to the design of the entrainment sampling program:

> . . .[T]he probability of successful sampling of populations which are highly aggregated and which come in contact with the [s]tation will depend upon the temporal frequency distribution and size of the schools encountering the [s]tation together with the sampling intensity. For example, given the current sampling rates of six samples per day . . . the sample intensity is 6.02×10^{-3} %. . . Depending on the frequency distribution and size of the larval

> schools there would seem to be a reasonably high probability of observing samples with low or zero numbers and missing periods with high numbers. (ESSA Report, page 13.)

ESSA's implication that a low sampling fraction (i.e., the fraction of the withdrawal volume that is actually sampled) could lead to estimates of entrainment losses that are biased low is not scientifically valid. A low sampling fraction, per se, does not cause estimates of entrainment losses to be biased low. However, the precision of estimates of entrainment losses can be affected by the sample size and sampling fraction. Fortunately, the sample size (i.e., the number of samples collected) and not the sampling fraction (i.e., the fraction of the withdrawal volume sampled) determines the precision of the estimates of entrainment losses. Sample size, rather than sampling fraction, is the determinant of precision in estimates for most types of environmental sampling where the population (i.e., volume or area) sampled is very extensive. For example, in the EMAP-Estuaries program for Delaware Bay (USEPA 1990), the sampling fraction for benthic sampling was only 2.2×10^{-9}% (1320 cm^2 per sample, and 25 samples covering 1,534 km^2). Accordingly, variance estimators developed for large estuaries (including Delaware Bay) by USEPA for the EMAP-Estuaries program (USEPA 1995) do not include terms for sampling fraction in recognition of the fact that the variance (a measure of imprecision) of those estimates is determined by sample size, not sampling fraction.

PSEG agrees that the patchy distributions of ichthyoplankton in entrainment samples need to be considered in the design of the entrainment sampling program. PSEG conducted analyses to determine the samples sizes needed to achieve acceptable levels of precision in estimates of entrainment losses. These analyses were conducted as part of PSEG's efforts to develop a plan for an improved Biological Monitoring Program. That Plan was presented to NJDEP and to the Monitoring Advisory Committee (MAC) in June 2000, and currently is under review by NJDEP. Based on results from those analyses, PSEG is recommending 60 samples per week during periods of high entrainment vulnerability in years when data for CMR estimates are collected, and 24 samples per week at other times.

PSE&G estimates that 60 samples per week would produce *weekly* entrainment losses estimates with confidence intervals of ± 50% of the mean density. The analyses also indicate that 24 samples per week would produce *weekly* entrainment losses estimates with confidence intervals of ± 80% of the mean density. Confidence intervals for estimates of *annual* losses would be substantially narrower because they would be based on multiple weeks of data, and therefore on many more samples.

f. Other Factors Potentially Affecting Accuracy of Entrainment Loss Estimates

In addition to the concerns discussed above, ESSA noted that impingement of larvae could occur when the intake screens become clogged with debris:

> An additional source of entrainment mortality, not discussed in the documentation, might also be expected whenever the screen system becomes clogged with debris. Depending on the nature of

> the debris (e.g., algal mats), it is possible that smaller larvae and eggs could become impinged on the material clogging the screens rather than passing through it. (ESSA Report, page 12.)
>
> How much mortality might be accounted for by this mechanism is unknown. (ESSA Report, page 12.)

PSEG agrees that a quantitative estimate of losses attributable to eggs and larvae impinged on debris is not available. Although debris is collected for weighing as part of the impingement abundance sampling program, and is examined for small organisms, this examination is limited to those organisms large enough to be visible. Therefore, eggs and small larvae likely are not enumerated in impingement samples.

Another concern raised by ESSA is that the estimated mechanical mortality rates did not account for additional stresses that fish encounter when re-entering the estuary:

> Estimates of mechanical mortality are based on studies in which larvae were held either in jars or aquaria.
>
> [T]he *in vitro* environment does not reflect the rigors faced by the larvae on exiting the discharge. Consequently it is difficult, if not impossible, to know if the station has an incremental effect on post-discharge mortality beyond that strictly attributable to death from direct mechanical damage observed in the *in vitro* study environment. (ESSA Report, page 12.)

g. Mechanically-Induced Damage

The ESSA Report raises concern regarding the significance of the discharge environment on mechanically-induced damage of entrained organisms. ESSA states:

> While the study protocol provides information on the survival of larvae due to mechanical damage alone, i.e., the physical damage which alone is sufficient to cause death, the in vitro environment does not reflect the rigors faced by the larvae on exiting the discharge. Consequently it is difficult, if not impossible, to know if the station has an incremental effect on post-discharge mortality beyond that strictly attributable to death from direct mechanical damage observed in the in vitro study environment. (ESSA Report, page 12.)

Based on this uncertainty, ESSA recommends assuming a 100% mortality rate for all life stages as an upper bound together with the current estimates in an uncertainty analysis of Station effects.

ESSA's concern must be based on an assumption that the discharge environment introduces significant mechanical stresses to entrained organisms. To address this concern, PSEG analyzed the relative potential for the discharge environment to cause mechanical damage to organisms on a consideration of the energy dissipation rates per unit mass at three different points within the Station: condenser tubes; discharge pipes; and the river immediately following discharge. Energy dissipation rate per unit mass was analyzed because it determines the shear stresses that entrained organisms experience. Higher energy dissipation rates correspond with an environment that can potentially cause greater damage to entrained organisms. Energy dissipation rate determines the fluid velocity gradients at the scale of the organism that control mechanical stresses to the organism, which, in turn, control the forces exerted on an entrained organism. These forces can vary across the surface of the organism to the point where mechanical damage can occur. This analysis was limited to a consideration of hydrodynamic processes alone, and did not include an assessment of the biological conditions governing mechanical damage.

Energy dissipation rates per unit mass in the condenser tubes and discharge pipes were calculated using a standard formulation for cross-sectionally averaged dissipation in pipe flow ($(f/2)(u^3/d)$, where f is Darcy-Weisbach friction factor, u is cross-sectionally averaged velocity, and d is the pipe diameter) (Schlichting 1979). Energy dissipation rate in the region immediately after discharge into the river was estimated by two methods: an approximate analysis based on characteristics of the discharge plume obtained from the 1999 Section 316(a) Demonstration (PSEG 1999), and a more precise but idealized analysis based on semi-empirical results for a turbulent jet discharging into a stagnant, semi-infinite fluid (Schlichting, 1979).

The analyses showed that the energy dissipation rate per unit mass decreases by a factor of 30 from the condenser tubes to the discharge pipe. After the exit from the discharge pipe to the river, the dissipation first increases slightly (by a factor of less than 2) for a short distance (roughly 5 times the diameter of the discharge pipe), and then decreases monotonically with increasing distance from the discharge. Thus, the energy dissipation rate in the discharge environment is more than an order of magnitude smaller than that experienced within the condenser tubes. Consequently, the stresses introduced to the organisms within the discharge environment are smaller than other rigors faced by organisms as they travel through the Station. The upper bound for the entrainment mortality rate should not be raised due to a consideration of discharge environment as recommended by ESSA.

2. ESSA Report § 2.1.2: Estimation of CMR

In Section 2.1.2 of the ESSA Report, ESSA alleges that Application, Appendix F, Section VII.C.I.A, is "misleading." This section of the Application includes a hypothetical example that compares the number of fish surviving through the first year of life, starting from an initial population of one million eggs, with and without Salem's operations. The purpose of the example was to illustrate the relationship between Station-induced losses, natural mortality rates and the conditional mortality rate (CMR) due to Station operation. ESSA terms this example misleading because it compares plant losses to the number of individuals dying of natural causes. According to ESSA, the example should have expressed the losses in terms of the fraction of the initial population that would have survived, if they had not been entrained. ESSA also noted a typographical error in the figure associated with this example. In Figure 18, the CMR then should have read 10% not 20%.

The example provided by PSEG in Application, Appendix F, Section VII.C.1 was not misleading. It was intended simply to illustrate the fact that large loss estimates, especially large losses of early life stages, do not imply large impacts on populations. (See Application, Appendix F, Section VII.C.1.) ESSA's point, i.e., that plant losses can also be expressed (using the CMR) in terms of the fraction of the initial population that would have survived in the absence of Station-related mortality, was noted by PSEG *as part of the same discussion*. Prior to introducing the example (Application, Appendix F, Section VII, page 28), PSEG discussed the definition of the CMR (Equations 1-3, pages VII-27 and VII-28) and described the use of the CMR as an input to the stock jeopardy analysis. The example to which ESSA objected to could be misleading only to someone who skipped the beginning of the section in question and began reading in the middle of page VII-28.

a. ESSA Report § 2.1.2.1: Data Used in the Estimation of CMR

In Section 2.1.2.1 of the ESSA Report, ESSA reviews the data PSEG used to estimate entrainment CMRs for the RIS. ESSA notes that the ichthyoplankton data needed to estimate CMRs using the ETM method were only available for bay anchovy and weakfish, and questioned why the CMRs could not be estimated for white perch using the ETM. ESSA then discusses the data limitations that restrict the years for which CMR estimates could be estimated for each RIS. ESSA also notes that one of the few years with data to support CMR estimates for most RIS was 1996, and that the Station was not in operation in that year.

The reason the ETM could not be used to estimate CMR for white perch is that PSEG's baywide ichthyoplankton monitoring program did not sample the freshwater reaches of Delaware River where white perch spawn. As is clear from the information presented in Section III.D.11 of Application, Appendix F (and further elaborated in Application, Appendix C and Attachment 3 to Appendix C), white perch spawning occurs primarily in freshwater above RM 125, and in tributaries to the Delaware. These areas are well outside the boundaries of the baywide study area, and therefore PSEG's ichthyplankton data for white perch violate a principal assumption of the ETM (i.e., that the entire population of interest resides within the study area).

Regarding the data limitations affecting CMR estimates using the EEIM method, ESSA reiterates the data limitations documented by PSEG in Attachments F-1 and F-2 of Appendix F of the Application, and summarized by PSEG in presentations to the MAC in June 1999. As part of its discussion of these data limitations, ESSA comments on PSEG's CMR estimates for spot, American shad, alewife, blueback herring, and white perch. The summary of data limitations for CMR estimation and ESSA's comments on the topic in Section 2.1.2.1. of its report are repeated in Section 5.6.2 ("Impact Assessment of Station – Data and Use of Data – Issues with Use of Data") and are addressed by PSEG in Section VII.G.2 of this response to the ESSA Report. (Application, Appendix F, Attachments 1 and 2).

Regarding the fact that 1996 was one of the few years with data to support CMR estimates for most RIS, ESSA notes:

> It is unfortunate that this [year] also happens to be one of the years that the [s]tation was out of service (from the period May – June

> 1995 through April 1998) and operating at minimum flows . . . . (ESSA Report, page 16.)
>
> Although entrainment losses are calculated from entrainment densities, and these can be scaled up by the full pumping rate of the [s]tation, the restricted flow regime will cause the station to sample a more restricted zone of along-shore larval transport than under normal operating conditions. This may give biased results relative to years when the station is operating at full capacity. (ESSA Report, page 17.) Further discussion of this is provided in the following section of this Report that deals with the W-factor in the ETM model (page 18). (ESSA Report, page 17.)

ESSA's concern regarding the possibility of unusual "along-shore larval transport" is addressed in PSEG's Response (Section IV.B.3 below) to Section 2.1.3 ("Hydrodynamics at the Cooling Water System Intake") of ESSA's Report. Also, the effects of including the 1996 data in PSEG's estimates of Base Case CMRs are discussed in Section IV.E below.

b. ESSA Report § 2.1.2.2: Methods Used in the Estimation of CMR

In Section 2.1.2.2 of ESSA's report, ESSA notes that PSEG assumed a value of 1 for the W-factor used in the ETM-based estimates of CMR. However, ESSA incorrectly stated that "the authors of the Permit Application "assumed" a W-factor of 1 for all species." (ESSA Report, page 18) In fact, since the ETM was only used for bay anchovy and weakfish, the assumption that the W-factor was 1 was applied to these two species only. ESSA also incorrectly states that ". . . the W-factor. . . specifies the ratio of the density of larvae in water entrained by the [s]tation to that in the rest of the system" (ESSA Report, page 18). In fact, the W-factor specifies the ratio of density of ichthyoplankton in water entrained to the average density within the Nearfield region of the Estuary (i.e., a segment of the Estuary roughly 20 miles long centered at the Station), not the entire estuarine system. Regarding PSEG's use of a W-factor equal to 1 for bay anchovy and weakfish, ESSA speculates that "Hydrological considerations . . . suggest a potentially complex episodic interaction with the [s]tation, which would not be consistent with this assumption" (ESSA Report, page 18). ESSA elaborates on its hypotheses about hydrodynamics affecting the W-factor in Section 2.1.3 of its Report. PSEG's Response to ESSA's hypothesis is presented in the following section that address Section 2.1.3 of ESSA's Report.

3. ESSA Report § 2.1.3: Hydrodynamics at the Cooling Water System Intake

ESSA speculates that Sunken Ship Cove (incorrectly referred to as "Sunken Ship Bay" by ESSA)

> probably sustains a strong back eddy during the ebb tide. During the 12 or so hours of the ebb, this eddy may concentrate organisms

> that drift with the current. . . . When the tide turns, the incoming flood may sweep the concentration of organisms into the intake field. Thus, it is likely that the concentration of organisms in the intake is often not representative of the overall [E]stuary. (ESSA Report, page 19.)

This conclusion follows ESSA's assertion in Section 2.1.2.2 that "[a]ny data collected outside the entrainment field would not be representative of the [s]tation entrainment and consequently not suitable for calculation of W". (Id., page 18.) ESSA cites PSEG's estimate that the zone of entrainment varied from approximately 100 to 150 feet offshore and PSEG's description of the sampling method for W-factor trawls. (Id.) According to the sampling method for the near-station tows "when conditions allowed samples, samples were collected on a course parallel to and within 88-210 feet of the intake structure; distance offshore never exceeded 180 m," (i.e., 585 ft.). (Id.) There is the implication that there are eddies of a spatial scale smaller than the offshore trawl sampling distance, and that such eddies could bias the sampling.

ESSA's paradigm that a strong back eddy is sustained for 12 hours in Sunken Ship Cove during ebb is not supported by the extensive record developed by PSEG over the past 20 years, or even the most basic information that tides in the Estuary are semi-diurnal and that the ebb duration is approximately 6 hours. Data and analyses which disprove ESSA's paradigm can be found in:

- Near-Field and Far-Field Current Velocity and Circulation Studies in the Vicinity of the Salem Generating Station, Delaware River Estuary (Weston 1982) that were used to characterize horizontal and vertical variations in flow near the intake structure, and to track the flow paths of drifters/drogues in the far-field regions of the CWIS.

- Numerical Circulation Model Implementation: Salem and Hope Creek Nuclear Generating Stations, Field and Data Report (Woods Hole Group ("WHG"), Inc. 1995a) that included measurements of current profiles throughout several tidal cycles using an acoustic Doppler current profiler ("ADCP"), long-term electromagnetic directional current meter measurements, and bathymetry measurements.

- Numerical Circulation Model Implementation: Salem and Hope Creek Nuclear Generating Stations, Modeling and Data Analysis Report (WHG 1995b) on a calibrated and verified three-dimensional numerical hydrodynamic model of the entire estuary with a focus on the area in the vicinity of the CWIS. The model was developed to assess and evaluate the complex hydrodynamics surrounding the intakes.

- Comprehensive Thermal Monitoring Program and Thermal Plume Modeling Studies performed by Lawler, Matusky and Skelley (1998, 1999) in support of the PSEG's 1999 316(a) Demonstration (PSEG 1999).

Neither the hydrodynamic models nor the observations that are reported in these investigations show a persistent eddy of the spatial scale or duration proposed by ESSA. WHG (1995b) completed a three-dimensional numerical circulation model of the estuary focusing on the near-field area surrounding the intake and discharge structures, including Sunken Ship Cove. Based on this study, a large-scale eddy-like motion was identified south of the Station that can encapsulate Sunken Ship Cove during the later portions of the ebb cycle. The eddy-like feature appears towards the end of the ebb cycle as the estuary begins to flood first on the tidal flats, while a lingering ebb flow lags in the momentum-carrying main channel of the estuary. The shear between the flood currents on the flats and the ebb flow in the main channel creates an eddy-type motion that lasts for approximately 1-2 hours near the turn of the tide. This dynamic process is shown by Figure IV-12. There is no persistent "back eddy" over the entire six hours (ESSA says 12 hours) of the ebb cycle, as ESSA states, nor is it confined only to Sunken Ship Cove. The motion is highly dynamic and short-lived (e.g., less than two hours) as it is created by the shear between oppositely directed ebb currents in the momentum carrying shipping channel and flood currents on the shallow margins of the estuary. As the tide changes from ebb to flood, the eddy that originally formed south of the Station then spins off toward the main body of the Estuary as the flood tide currents prevail (Figure IV-13). The incoming flood does not sweep the eddy and any contents onto the intake field, as stated by ESSA. During the ebb flow conditions, velocities south of the intake and between Sunken Ship Cove and Hope Creek Jetty are slightly reduced relative to the main shipping channel particularly when Hope Creek Jetty goes dry (Figure IV-14), but no eddy is evident. Rather, there is simply a divergence of flow south of the Station on an ebb tide. During the ebb cycle, the ebb currents maintain water motion through Sunken Ship Cove.

Another short-lived eddy-type motion develops during the change from flood tide to ebb tide, as the estuary begins ebbing on the tidal flats while lagging flood currents exist in the main shipping channel (Figure IV-15). This also is a short-term shear-induced motion, and the flow is directed south of the Station as the ebb tidal currents prevail (Figure IV-12).

These eddy-type motions are not indicative of a persistent and stationary "back eddy" as ESSA supposes. ESSA hypothesizes that "[d]uring the 12 or so hours of the ebb, this eddy may concentrate organisms that drift with the current" (ESSA Report, page 19). PSEG emphasizes that such an eddy does not occur on the ebb tide, but rather short-lived eddy-type motions occur during the change in the tide. In short, because of the ephemeral and dynamic nature of the eddy, there is little opportunity to accumulate particles in a particular location, such as Sunken Ship Cove.

In the Weston (1982) study, the drifter/drogue tracking indicated that none of the released drogues were ever trapped in an eddy in Sunken Ship Cove (Figure IV-13). A few of the drogues advanced to the Sunken Ship Cove and traveled southward, or passed directly through the Sunken Ship Cove and continued to travel southward. Because none of the drogues were trapped in the Sunken Ship Cove and some of the drogues passed through the Sunken Ship Cove, there is strong empirical evidence that there is no eddy confined to the Sunken Ship Cove.

The concept that ESSA proposes, of a strong back eddy being formed within Sunken Ship Cove on the ebb tide, is not possible. The prevailing tidal conditions in the estuary are too dynamic, and cause a near constant change in the flow patterns. Although there can be "eddy-type" motions south of the Station that are generated by shear within the estuary, these motions occur on the change of the tide, are of short duration, and are much larger in scale than Sunken Ship Cove alone. In fact, these motions can encapsulate Sunken Ship Cove on occasion. Thus, ESSA's concept of an episodic event of a concentrated mass of organisms being swept into the zone of entrainment every tidal cycle is mere conjecture and not supported by any of the available information.

Over most (i.e., approximately 10 hours) of the tidal cycle, the flow past the intake structure is aligned more or less with the principal flow orientation within the estuary and there are no near-field eddy like features in either direction from Salem. Hence, there is no physical feature or process, as suggested by ESSA, that would support an assertion that sampling slightly outside the "zone of entrainment" would somehow bias the trawl data during these periods.

Following is an itemized response to Sections 2.1.3.1 through 2.1.3.5 of the ESSA Report.

a. ESSA Report 2.1.3.1: The Intake Structure

ESSA states that "[t]he total flow into the intake is 4,200 cfs (1,050,000 gpm) and the velocity is between 1.5 and 2.5 ft/sec, depending on location within the bays." ESSA states also that "[t]he total discharge is probably not uniformly distributed among the bays because of a slight intake vortex in Bay 1 or Bay 12, depending on which way the tide is running. Also, when the tide is running, there is probably a weak horizontal vortex in the shear flow entering from the side of the dredged channel. Thus, the horizontal and vertical velocity distributions are often non-uniform in front of the intake. These conditions may have significance for environmental sampling near the intake." (ESSA Report, page 20.)

The normal total flow into the intake is approximately 2,100,000 gpm. The current NJPDES permit limits the 30 day average intake to 3024 MGD. PSEG also emphasizes the importance of clarifying terms related to the smaller scale hydrodynamic motions referenced by ESSA. ESSA refers to "small-scale vortices" confined to the terminal bays comprising the CWIS. PSEG takes exception to the use of the term vortex, since there is no evidence of stable and persistent vortices as implied by ESSA. Certainly the CWIS introduces a variety of small-scale turbulent motions to the near-field environment; however, these motions also have been shown to be dynamic highly variable and short-lived. The transient and small-scale nature of these processes compared to the volume of CWIS flow indicates such small-scale processes also would not introduce a bias into the entrainment sampling.

PSEG is aware that the vertical and horizontal velocity distributions within and near the intake structure are non-uniform and vary with the tide. During the design of Salem, Hydro Research Science (1969) used physical models to evaluate the layout, alignment, and orientation of the intake structure to ensure the development of velocity fields in accordance with maximum permissible velocities imposed by fish, entrapment (entrainment) considerations and pump cell requirements. Numerous pump configurations and maintenance conditions were modeled to optimize the design. The study provided descriptions of flow near the intake structure.

Additional studies performed after Salem became operational (Weston (1982), WHG (1995a and 1995b) and PSEG (1999) provide data on the uniformity and variability of velocities near the intake.

With respect to ESSA's discussion of a non-uniform distribution discharge (presumably ESSA means flow) amongst the intake bays, the variation of the flow distribution among the intake bays was first evaluated in the 1969 HRS physical modeling study. HRS found that during the ebb tide flow, velocity asymmetry was detected between the upstream (northwest) pumping bays and the downstream (southeast) pumping bays (Figure IV-14). Current velocities into the intake were higher within the northwest bays than within the southeast bays during the ebb tide. Current measurements collected by Weston (1982) on the ebb tide correspond to the HRS conclusions regarding the asymmetry in front of the intake (Figure IV-15). During a flood tide, HRS found little asymmetrical distribution of current velocities across the intake. The currents measured by Weston (1982) during flood tides, also, showed little variability in velocity across the CWIS (Figure IV-16).

Additional studies (WHG 1995a) have also measured the velocity patterns in front of the intake. WHG used an ADCP to measure currents in front of the CWIS. During the surveys, the vessel transversed within 50 ft. of the intake structure (farther offshore than the HRJ and Weston measurements), while ambient ebb and flood currents of the estuary dominated the measurements. These ADCP data had relatively high spatial resolution, yet did not reveal any significant velocity asymmetry between the bays. These measurements showed that there were no significant variations in velocity directed toward the intake at this relatively short seaward distance.

Pump records have been reviewed as well to gain insight regarding the potential for flow asymmetry across the intake structure due to variable pumping rates and patterns. The two Salem Units are cooled by water derived through 12 intake bays. Each bay has identical pump design capacity. Actual flow rates are measured annually via a dye test. Records are also kept regarding the operational status (e.g., off/on) of each pump. Individual pumps only are shut down for maintenance/repair of that portion of the CWS. Appendix B of the 1999 NJPDES permit renewal application summarizes the individual pump flow rates. Inspection of the pump records shows there is potential for more variability (e.g., reduction) in the intake flow rate at the southern bays (Figure IV-17). This supports the HRS (1969) physical modeling and the Weston (1982) field measurements, which showed the potential for higher velocities at the northern bays for certain ebb tidal conditions. Although tidal effects are not discernible from the pump records, the HRS and Weston data both show stronger shore-normal currents into the northern bays on the ebb tide, with little evidence of asymmetry on a flood tide. The consistent indication that there is little asymmetry on the flood tide refutes ESSA's implied hypothesis that organisms may be concentrated in Sunken Ship Cove on the ebb tide, then entrained at high concentrations into the southernmost intake bays as the flood tide begins. Additionally, PSEG re-emphasizes that flow asymmetry alone does not equate to a concentration gradient.

ESSA also expresses interest in vertical velocity asymmetry at the CWIS. The WHG (1995a and 1995b), HRS (1969), and Weston (1982) studies indicated that the current velocities at the surface are generally higher than the current velocities near the bottom. This was expected due to bottom friction, which reduces the near-bottom current velocities. The WHG (1995b) modeling study indicated that the vertical distribution of the velocities is also dependent on the magnitude of the ambient currents during the peak flood and ebb cycles. During time periods of peak tidal flow in the estuary, slightly higher velocities can enter the CWIS from the lower mid portion of the water column (above the bottom bay layer), where the influence of the pumps is greatest. During the time periods of slack flow, higher velocities enter the intake from the surface layers, where the intake dominates the ambient current in the near-field zone, and bottom friction impedes bottom flows.

Although PSEG has demonstrated there can be an asymmetry in the intake flow and velocity across the bays, the small-scale vortices in the end bays are not significant contrary to statements in the ESSA Report. Site-specific field data were collected in front of the intakes (Weston 1982; WHG 1995a), and there was no identification of the existence of well-defined vortices in front of the intake. The Weston (1982) current measurements did reveal some turbulence effects in the upper two meters of the water column on the northwest end of the CWIS during an ebb tide, which could be related to small-scale eddy formation or just general turbulence (Figure IV-9). PSEG reiterates the importance of distinguishing eddy and small-scale turbulent motions from the persistent vortices that are hypothesized by ESSA. The prevailing tidal conditions in the estuary are too dynamic and complex to permit the formation of stationary, well-defined vortices. The ADCP transects in front of the CWIS observed by WHG (1995a) also did not exhibit any well-defined vortices. However, it is difficult to compile data with a spatial resolution adequate to resolve small-scale eddies and it is likely that some small eddies are formed near the intake, due to the turbulence in front of the intake structure. The spatial scale of these hydrodynamic features is likely to be highly variable and the time scale is likely to be short. Compared to the relatively large CWIS flow volume, such transient small-scale features would have no impact on the net entrainment and impingement of drifting organisms.

ESSA's statement regarding the significance of a weak horizontal vortex in the shear flow from the side of the dredged channel during the running tide also is not accurate. This response presumes that the dredged channel referenced by ESSA is in front of the intake bays. This intake basin is dredged periodically by PSEG to keep the intake bays relatively free of sediment. The basin is dredged by clamshell dredge, following which the sediment is barged away. Typically, the sides of the basin have an angle of 30 degrees or less (the angle of repose of sand), and are not vertical. As the basin fills in with sediment, these side slopes diminish even further. Consequently, lateral turbulent mixing produced by the sides of the dredged basin is mild compared to the intense bottom boundary layer tidal mixing, pump-induced inflow, and lateral shear mixing described above. It is just one of several sources of turbulent mixing in this highly energetic environment, and likely a minor contributor to flow dynamics near the intake.

b. ESSA Report 2.1.3.2: Intake Design and Operation

In this section of its report, ESSA noted that the flow rate through the intake screens may be affected by debris loads on the screens, but even if debris is absent strong tides may cause asymmetries in flows, as discussed at length in the previous section, measurements show the flow rate into the northern bays can exceed the flow rate into the southern bay on an ebb tide.

This has no relevance to entrainment sampling, though. As previously demonstrated, flow asymmetry does not equate to a concentration gradient.

c. ESSA Report 2.1.3.3: Impingement

Regarding impingement, ESSA makes the statement that fish, eggs and larvae may collide with the wire mesh of the screens and that the level of impact depends on the pressure holding them against the wire. ESSA asserted that increasing the flow area (and thus the velocity through the screens) would reduce this mortality. ESSA then correctly noted that the modified screens installed at Salem are an improvement because (among other properties of the modified screens that reduce fish mortality) "the flow area is larger because the wire is thinner than that used in the older screens." PSEG agrees that the modified screens are an improvement and (as documented in Application Appendix G, Exhibit G-1-2) have reduced impingement mortality rates.

d. ESSA Report 2.1.3.4: Entrainment

ESSA states that entrainment of eggs, larvae and small fish through the cooling system may be a more significant problem than impingement and that reduction of the cooling water volume would reduce the number of animals killed. ESSA also states that measures to reduce the near-shore entrainment field may reduce the numbers of eggs and larvae entrained. PSEG has addressed the first two issues in Appendix F of the Application. (Application, Appendix F.) All losses, both entrainment and impingement, are included in the plant loss estimates (Application, Appendix F, Section VII). Furthermore, PSEG considers all technological as well as operational alternatives (including flow reductions) in the Evaluation of Fish Protection Alternatives (Application, Appendix F, Section VIII) and identifies whether these alternatives would affect entrainment or impingement. In Section IX of Appendix F, PSEG applies the standard required under Section 316(b) when it compares the economic benefit of the reduced losses due to the alternatives against the costs of the installation and operation of the alternatives. (Application, Appendix F, Section IX.) It was based upon this analysis that NJDEP has concluded that the Station's once through cooling system in conjunction with the existing flow restriction, an enhanced fish return system and the study and potential implementation of a multi-sensory hybrid system constitutes best technology available.

e. ESSA Report 2.1.3.5: Escape Routes

Section 2.1.3.5 of the ESSA Report discusses fish escape routes within the CWIS. ESSA has the impression that the fish escape routes were behind the travelling screens. ESSA also suggests modifications to the flow field to make the routes more attractive to fish, and presumably more effective at reducing impingement/entrainment losses. Specifically, ESSA states the fish escape routes should be moved seaward of the travelling screens. ESSA also states that a strong flow vector with a component parallel to the screens could be established by modifying the relative water levels between the intake bays (i.e., via adjusting pump head losses), and that this flow vector would make the escape routes more attractive to fish. ESSA finally states that re-entrainment could be reduced by extending the fish escape routes farther away from the intake.

PSEG first needs to clarify that the fish escape routes are, in fact, already seaward of the travelling screens. These 3 foot-wide surface to bottom openings provide a potential route for fish to move between the bays, as well as back into the estuary via curved sections adjacent to the end bays. ESSA's notion that their effectiveness can be improved by establishing a strong flow vector in a direction parallel to the screens by modifying the relative water level between the bays is incorrect, however. Basic hydraulic principles dictate that the streamlines within the CWIS will be directed toward the pumps. It would be impossible to establish a current parallel to the screen face without introducing a crossflow volume on par with the intake flow. As long as the CW pumps are in operation, the flow entering the intake will pass straight through the screens and into the pumps. Although technically a slight flow could potentially be established between the bays via a head differential (requiring a substantial modification to the pump system), the dominant direction of flow will still be toward the pumps. Currents setup by small volumes of water moving between the bays would be confined to a small region at the entrance to each adjacent escape route, and these water volumes would be quickly captured into the CW pumps. As long as the CW pumps are in operation, the streamlines will, by definition, be directed to the intake pumps. Within the confines of the existing CWIS, there is no feasible method for constructing such a large-scale active pump system between the escape routes. The concept of extending the fish escape route exits farther away from the CWIS structure also is not feasible within the confines of the existing intake structure.

C. ESSA Report § 2.2: Impingement

1. ESSA Report § 2.2.1: Impingement Sampling

ESSA concludes that the historical sampling program for impingement provides good temporal coverage on which to base impingement loss estimates:

> The historical sampling program for fish and crab impingement at the CWS intake of the Salem station enabled the development of a relatively dense database of weekly and then monthly estimates of impingement. (ESSA Report, page 22.)

As part of its review, ESSA prepared a summary table (Table 2.7 of its Report) that purportedly delineates the number of days per week samples were collected and the number of samples per day for all months from 1977 through 1998. Table 2.7 of the ESSA Report contains several errors (factual and/or typographical); Table IV-2 of this Report presents corrected entries. Based on its summary table, ESSA incorrectly states that impingement sampling was not conducted in 1983 and 1984. In fact, impingement sampling was conducted during those years (see Table IV-2).

ESSA notes an apparent inconsistency between the impingement data record, and the years of impingement loss estimates presented in the Application:

> The records of impingement sampling vs. impingement loss estimation provided by the Application and subsequently by the PSE&G consultants slightly disagree with respect to whether

> sampling and loss estimation began in 1977 or 1978. (ESSA Report, page 22.)

Impingement sampling was conducted in 1977; however, annual loss estimates were not computed for that year because Unit 1 was not in operation for a full year in 1977, and because entrainment sampling (required for estimating total Station losses for the year) was only conducted in September and December of 1977.

2. ESSA Report § 2.2.2: Impingement Loss Estimation

ESSA's review of PSEG's methods for estimating impingement losses identifies two concerns: uncertainty in estimates of sampling efficiency and uncertainty in estimates of impingement mortality. (ESSA Report, pages 23-25.) Estimates of sampling efficiency were used to correct counts of impinged fish for the possibility that some fish are accidentally overlooked by technicians who collect impinged fish in the fish counting pool. Estimates of impingement mortality were used to estimate the number of impinged fish that were alive when collected, but likely would die subsequently due to the effects of impingement.

a. ESSA Report § 2.2.2.1: Sampling Efficiency

ESSA questions why only dead fish were used in the tests to estimate sample collection efficiency:

> The Application does not explain why only dead and not some live fish were used in the tests, or address the potential effects of only using dead fish on the sampling efficiency estimates. (ESSA Report, page 23.)

The main reasons for using dead fish were that large numbers of fish were required for the tests, and accumulating (and holding until sufficient numbers were collected) live fish would have been very difficult or not possible, and the test fish had to be dyed so that the test fish could be distinguished from other fish that were impinged. Also, as ESSA notes:

> [D]ead fish were used so that they would immediately float into the Ristroph screens and become impinged, and not be able to swim away. (ESSA Report, page 23.)

ESSA suggests that the use of dead fish, rather than live fish, by PSEG in its tests to estimate impingement sample collection efficiency introduced uncertainty into the estimates of sample collection efficiency:

> The use of only dead fish may have biased the efficiency estimates because normally a collection of live, injured and dead impinged fish are sampled in the sampling pool, and live fish may be easier or more difficult to catch in the sampling pool in the presence of detrital debris. (ESSA Report, page 23.)

ESSA further questions the validity of the impingement sample collection efficiency estimates based on a reference in the Application to debris loads present during the tests:

> If low detrital conditions prevailed, these conditions presumably maximized the efficiency with which technicians would collect the marked fish; and if so, it follows that the high sampling efficiency rates when applied to abundance samples during periods of high detrital loads, say during the spring, could result in underestimation of the size of the abundance samples. (ESSA Report, pages 23-24.)

PSEG rejects these speculations presented by ESSA without any evidence or data of any kind. Also, ESSA offered no suggestions regarding feasible alternative testing procedures that would be preferable to the methods used by PSEG.

The use of dead fish and the debris load during the tests likely had little influence on the sample collection efficiency due to the standard impingement sampling protocols. The impingement sampling protocol requires all free-swimming and free-floating fish to be collected, and all debris to be collected and examined for entangled fish. At the end of the sample collection event, the water in the counting pool is empty of fish and debris. The pools are slowly drained through the screens during manual dipping for fish. Fish and debris are separated into containers for subsequent processing. All debris is carefully examined for entangled fish/crabs by manually teasing apart the debris prior to weighing. A sample is determined to be complete when repeated passes with the dip nets reveal no more fish, all of the debris is collected and examined, and the pool is drained. After draining, the floors and walls are carefully examined for adhering fish and any remaining detritus is swept up, examined, and weighed. Once this is completed, the pool is readied for subsequent sampling. Since ESSA did not refer to the impingement sampling protocol in its review, it is not clear whether ESSA was aware of these facts when it formulated its speculation.

Furthermore, a point not mentioned by ESSA is that one reason for not recovering (in the counting pool) all fish released in front of the Ristroph screens could be that the fish pass over or through the screens and become entrained. The fact that juvenile fish are reported in entrainment collections supports this explanation. In this case, the use of the impingement collection efficiency factor would cause double counting of certain fish (i.e., they would be counted as being entrained *and* impinged), and result in overestimation of total Station losses. For example, suppose 100 juvenile fish enter the intake every hour. Further suppose that on average only 90% (i.e., 90 fish per hour) of juvenile fish are impinged and enter the (impingement) fish return system, while 10% (i.e., 10 fish per hour) pass over or through the intake screens. Also, suppose the impingement collection efficiency was estimated under these conditions to be 90%. If impingement sampling were conducted during some hours of the day, and entrainment sampling were conducted during other hours of the day, the estimate of the average number of juvenile fish impinged per hour would be 100 (i.e., 90 fish divided by the estimate of collection efficiency of .09). The estimate of the number of juvenile fish entrained (based on estimates of density or entrained fish and hourly water withdrawal volumes) would be 10 per hour. Therefore, the estimate of the total number impinged and entrained for a 24-hour day would be 2,640 juvenile fish, i.e., 2,400 impinged (100 per hour times 24 hours) plus 240 entrained (10 per hour times 24 hours). Whereas the actual number of juveniles entrained and impinged in this hypothetical example would be 2,400.

b. ESSA Report § 2.2.2.3 [sic]: Impingement Mortality

In its review of methods for estimating impingement mortality (i.e., the fraction of fish impinged that die due to impingement), ESSA correctly notes that the apparatus used to collect impinged fish causes additional stress and mortality that fish transported directly back to the estuary do not experience:

> . . . [T]he high velocity of water in the fish return sluice, and the extremely turbulent conditions in the sampling pool to which fish are diverted and collected to determine impingement mortality, are exposing fish significant stress that would act to increase or at least obscure true impingement mortality. (ESSA Report, page 24.)
>
> The central issue here is that the initial and latent mortality rates estimated via the sampling pool and holding tanks are quite likely not representative of the actual mortality rates of fish after they have been returned to the Delaware River. It is possible that the mortality rates measured using the sampling pool overestimate the actual impingement mortality. (ESSA Report, page 24.)

PSEG agrees that impingement mortality estimates based on fish collected in the counting pools are biased high, relative to the actual mortality caused by the intake screens and the return sluices (to the point of diversion into the counting pools). Fish that enter the counting pools undoubtedly are exposed to additional stress due to the extreme turbulence at the bottom of the diversion slide (from the return sluice to the counting pool), and due to additional stresses of handling during collection by the technicians.

ESSA also suggests that fish are exposed to additional stress at the point the screen wash water (carrying the impinged fish) re-enters the estuary:

> It is also possible that actual mortality rates of fish after returning to the Delaware River are equivalent or even higher than those estimated via the sampling pool. Actual impingement mortality could be higher due to physical trauma caused by high water velocity in the sluice combined with the physical trauma that must occur when fish and debris abruptly hit the surface of the river. . . .
>
> Predation by fish and water fowl of fish potentially stunned by their return to the river could be high. (ESSA Report, page 24.)

ESSA recommends studies to determine the additional stress and mortality that may be caused by the re-entry of wash water to the estuary. As part of those studies, ESSA recommends a comparison of impingement mortality rates estimated using fish collected in the fish counting pools to rates estimated using fish that have re-entered the estuary with the screen wash water. (ESSA Report, page 25.)

PSEG agrees that fish are exposed to additional stress when the screen wash water re-enters the estuary, but suspects that additional stress is less than the stress caused when fish are diverted into the counting pools (i.e., stress from the diversion gate from the fish return sluice to the counting pool sluice, and the vertical stop at the end of the slide to the counting pool). Assuming NJDEP Draft Permit Condition G.2.b.i is incorporated into the final permit, PSEG will be conducting special studies to address this question.

In addition to the concerns discussed above, ESSA notes two topics in the Application that require clarification or correction. The first is the description in Attachment F-2 of the method used to estimate impingement losses due to the service water system (SWS) (ESSA Report, page 25) (see Application Appendix F, Attachment F-2, page 25). That description apparently lead ESSA to believe that a 100% impingement mortality rate was not used for the SWS. (ESSA Report, page 25.) The second is the listing in Application, Appendix L of estimates of annual impingement density (# / 10^6 m^3) (Application, Appendix L, Tab 8). ESSA questions how impingement density estimates were computed, given that the impingement loss estimates were computed without using withdrawal volume as an input. (Id.)

(1) Clarification of Method Used to Estimate SWS Impingement Losses

ESSA notes that in the computation of the number of fish lost due to impingement at the SWS, the total number of fish *impinged* at the CWS should be used, not the total number of fish *killed* at the CWS. ESSA's concern is that if the number killed at the CWS were used this would be inconsistent with the assumption of 100% impingement mortality at the SWS since the estimated impingement mortality rate for fish impinged on the traveling screens of the CWS is less than 100%. (Id.) The Application incorrectly states that the estimate of impingment losses at the SWS was based on the number *killed* at the CWS (Application Appendix F, Attachment F-2, page 25). In fact, the number impinged at the CWS was used. Hence, the calculations were performed correctly. (Application, Appendix F, Attachment F-2, page 25).

(2) Clarification of Method Used to Estimate Annual Impingement Densities

ESSA questions how the impingement density (# / 10^6 m^3) estimates and annual impingement loss estimates presented in Appendix L of the Appendix were computed (Application, Appendix L, Tab 8). ESSA notes that "[i]t is not clear from the documentation how the weekly densities and total annual losses based on flow were calculated, and how they relate to the monthly estimates derived from the loss model" (ESSA Report, page 25). PSEG acknowledges that the method used to compute those impingement density estimates was not described in the Application, although the methods used to estimate annual impingement losses was documented (see Application, Appendix F, Attachment F-2, page 25). The estimates of impingement density were included in the Application simply to document results of the impingement monitoring program, and were not used directly for computing estimates of annual impingement losses. The following method was used to estimate impingement densities. The density for each impingement sample was computed as the number of fish collected in the sample divided by the total cooling water volume that was withdrawn by the CWS during the time interval when the sample was being collected. The estimates of average weekly impingement densities (presented in Application, Appendix L) were computed as the average, over all samples collected within the week, of the sample-specific estimates of impingement densities.

D. ESSA Report § 2.3: Uncertainty in EEIM Estimates of CMR

ESSA notes that Conditional Mortality Rates (CMRs) for entrainment and impingement "form critical input to analyses of stock jeopardy and the forecasts of the effects of the station during the next permit period" (ESSA Report, page 25). Two methods were used by PSEG to estimate CMRs for Delaware estuary fish populations: the Empirical Transport Model (ETM) and the Extended Empirical Impingement Model (EEIM). ESSA's review addresses three topics: (1) the precision of the CMR estimates; (2) the accuracy of the CMR estimates; and (3) the life-cycle balancing approach to estimation of mortality rates for early life stages. These topics are discussed in the following three sections.

1. ESSA Report § 2.3.1: Precision of CMR Estimates

In Section 2.3.1 of ESSA's Report, ESSA presents what it claims to be an assessment of the precision of the CMR estimates from the Application. ESSA's method for conducting this assessment was to calculate the among-year variance in historical CMR estimates, and to assume that variance was indicative of the estimation error for individual CMR estimates. ESSA applied its method to CMR estimates for bay anchovy, weakfish and spot, based on CMR estimates for the years 1981, 1982, 1996 and 1998.

ESSA's assessment is seriously flawed, to the point that the results of its assessment are meaningless. ESSA's method assumes that the only differences in the historical CMR estimates among the years included in its analyses (i.e., 1981, 1982, 1996, and 1998) was due to imprecision in the estimates. This assumption means that there is only one *true* CMR (under historical Station operations) for each species which is exactly the same in each year included in its analyses, i.e., there was no true inter-annual variability in the CMRs. This fundamental assumption of ESSA's method clearly was violated due to inter-annual variability in Station operations. In particular, in 1996, the Station was not generating power, and generally only one cooling water pump out of twelve was in operation. Therefore, the *true* CMR in 1996 clearly was not the same as in the other years, for any of the species. For that reason, ESSA's method does not provide any meaningful indication of the level of imprecision in the CMR estimates.

ESSA was well aware of the fact that the Station was not generating power in 1996, and that the water withdrawal rate of the Station in 1996 was roughly 1/8th of the water withdrawal rate in years of normal Station operation. In several other sections of ESSA's Report, ESSA highlighted the low water withdrawal rates in 1996 in its criticisms of the Application (e.g., see ESSA Report, pages 16, 31, 91, 94, 125, 128, 131 and 132). Similarly, ESSA's willingness in this section of its Report to assume Normality in the distribution of estimates of mean CMR (based on sample sizes of only 4), is in contrast to ESSA's expressed concern over PSEG's assumption of Normality in Trends Analyses (see pages 119 and 120 of the ESSA Report) where sample sizes ranged from over 200 to over 3000. As ESSA noted on page 120 of its Report, averages based on low sample sizes generally are not normally distributed:

> The sampling distribution for averages calculated from large sample sizes (high degrees of freedom) tends to be normal. However, as the degrees of freedom decrease (<30), the sampling distribution becomes better represented by the t distribution. (ESSA Report, page 120.)

Furthermore, if ESSA's failed attempt to assess the precision of CMR estimates is any indication of how ESSA approaches assessments of uncertainty, it is a strong argument against ESSA's repeated recommendations for uncertainty analyses.

2. ESSA Report § 2.3.2: Accuracy of CMR Estimates

In Section 2.3.2 of its Report, ESSA discusses a variety of factors that, in ESSA's opinion, could potentially have caused systematic biases in PSEG's CMR estimates. Specifically, ESSA comments that PSEG's estimates of population sizes and natural mortality rates could have been biased in various ways. The following subsections address each of ESSA's concerns.

a. ESSA Report § 2.3.2.1: Population Estimates

ESSA notes that the baywide population sizes for bay anchovy, weakfish, and spot were calculated by scaling up CPUE estimates obtained from PSEG's baywide trawl program. ESSA identifies four "assumptions" that could have affected the estimates of juvenile population size used in the CMR calculations:

> 1. The distribution of fish in the estuary was sampled in a representative way by the distribution of the trawls;
>
> 2. Trawls were at appropriate depths to catch representative densities of fish;
>
> 3. Net avoidance was not a problem; and
>
> 4. The use of ratios of paired species abundance as a means to estimate the population abundance of one of the species in the Delaware River assumes like habitat and life history parameters between the species. (ESSA Report, page 28.)

With respect to the first assumption, which relates to the representativeness of the trawl sampling locations with respect to the distributions of the fish, the sampling stations were selected using a stratified random sampling scheme (Application, Appendix F, Attachment F-1) and therefore there is no potential bias due to the spatial location of sampling. With respect to the second assumption, which relates to the depths at which samples were collected, depth strata were not sampled randomly by the pelagic trawl, and therefore some potential for a bias due to unrepresentativeness of depths sampled may exist. The direction of any such bias is, however, unknown. With respect to the third assumption, which relates to net avoidance, PSEG was fully aware that net avoidance affects population abundance estimates scaled up from CPUE data. The fourth assumption, which relates to using ratios of paired CPUE estimates to scale abundance estimates between species, is not relevant. Such ratios were not used to calculate baywide abundance of weakfish, bay anchovy, or spot.

It is important to note that, although citing every conceivable factor that could have potentially led to an overestimation of population abundance (and therefore to underestimation of Station impacts), ESSA does not mention the most important assumption in PSEG's population estimation procedure: the assumption that the entire population of interest is contained within the sampled region. PSEG did not adjust the population estimates to account for fish residing outside the sampled region, e.g., within tributaries, or in tidal marshes. Other sections of the Application document extensive utilization of marshes by weakfish and spot. Failing to account for these fish clearly leads to an underestimation of population size and an overestimation of Station impacts. That could easily offset the biases discussed by ESSA, if these biases actually exist.

b. ESSA Report § 2.3.2.2: Natural Survival Rate Estimates

ESSA comments that:

> population estimates from earlier and later time periods than the trawl survey are extrapolated by using estimates of natural mortality. As noted in the Application and in various appendices and sections of Attachment F, there are insufficient data to appropriately determine these estimates. Uncertainty in natural mortality rates is particularly important because CMR estimates are more sensitive to this than other inputs such as population (see Life Cycle Balancing below). (ESSA Report, page 28.)

The Application freely acknowledges the data gaps and uncertainties that affect the natural mortality rate estimates. PSEG employed a number of steps to ensure minimization of errors and biases in natural mortality rate estimates, including: (1) a complete review of the available literature on natural mortality rates for each life stage of each RIS; (2) development of preliminary estimates; and (3) a use of the life-cycle balancing procedure to fine-tune the preliminary estimates and ensure that the final parameter sets could reasonably represent the life histories of the actual populations. This procedure was documented in the Application. (Application, Appendix L, Tab 18.)

c. **ESSA Report § 2.3.2.3: Dilution of CMR by Proportion in Delaware Estuary**

Ranges of estimates were used to calculate the contribution of the Delaware Estuary to coastwide weakfish and spot populations. The Biological Monitoring Program conducted during the next permit period will address many uncertainties related to the estimation of population sizes and natural mortality rates.

d. **ESSA Report § 2.3.2.4: Compensatory Mortality and CMR**

In its comments, ESSA ignores the most important aspect of compensation – increased recruitment, increased growth and fecundity rates when the stock is reduced. ESSA states (on page 29 under 2.3.2.4) – "In an impact assessment mode, given all the uncertanties in estimating the shape of stock recruit curves, we feel it is inappropriate to assume any 'compensation' for station mortality in a stock that is reduced substantially below unharvested levels unless a clear mechanism can be prepared for this". This is an incredible statement. All stock assessment scientists know that compensation is very important. In fact, fishery management is based on the reduction of abundance to at least 50% of its unharvested level to increase production to the MSY level. The most healthy fish stock is one that is at least moderately exploited. As stocks get very large, as weakfish and striped bass population are now, they actually benefit from an increase in mortality.

Compensatory mortality was not included in estimates of the CMRs for any species. Neither the ETM or EEIM models contain a density dependent mortality function. The Life Cycle Balancing procedure adjusts early life stage mortality rates to balance exactly the rates of fecundity, natural mortality, and fishing mortality estimated for age 1 and older fish. The procedure involves no assumptions concerning the form of the spawner-recruit function. When the CMRs are calculated, the adjusted early life stage mortality rates are assumed to be density-independent. The use of compensation in the ESRA and SSBPR models for Salem RIS was thoroughly justified in the Application, and is discussed in Section VII.F.1 of this Response. A list of peer-reviewed studies documenting the existence of compensation in fish populations is provided in Appendix 3.

3. **ESSA Report § 2.3.3: Life-Cycle Balancing and Implications for CMR, Production Foregone and Impact Assessment**

In Section 2.3.3 of its review, ESSA argues that PSEG's life-cycle balancing approach to estimate early life stage mortality rates results in overestimation of the actual natural mortality rates for many species and life stages and underestimates the impacts of the Station on the RIS. These biases, according to ESSA, lead to systematic underestimation of plant losses (expressed as equivalent 1-year-olds), CMRs, biomass/pounds lost, and stock jeopardy. ESSA's reasons for concluding that these biases exist include:

1. ESSA states that the adult mortality rates used in the life-cycle balancing calculations are highly uncertain, and the partitioning of adult mortality (Z) into natural mortality (M) and fishing mortality (F) was not

clearly documented by PSEG. White perch was cited as a specific example of a species for which assumed values of Z and F were insufficiently justified. Moreover, according to ESSA, PSEG erred in stating that only total adult mortality (Z) is required in the life-cycle balancing procedure, and that PSEG's analysis was confounded because estimates of Z included Station mortality. Bay anchovy was cited as a specific example of this problem.

2. The LCB approach assumes that populations are at an equilibrium; however, many of the RIS populations are growing. The LCB method would overestimate natural mortality (M) in a growing population.

3. The LCB method is technically incorrect, because the resulting values aren't corrected to remove mortality due to entrainment and impingement. This error would contribute to overestimation of natural mortality rates. (ESSA Report, pages 29-30.)

ESSA's comments on the LCB method misstate the purpose of the approach and reflect a misunderstanding of the way in which the approach was applied. Moreover, most of the comments are technically incorrect or irrelevant. As was clearly explained both in the Application and in the December 1999 meeting with ESSA, the purpose of the LCB method was to reduce uncertainty related to the incomplete and often conflicting estimates of life-stage-specific mortality rates for RIS finfish species by constraining the final parameter sets to biologically realistic combinations. Averaged over many years, the net growth rates of nearly all populations are close to zero. Otherwise, they would either grow to infinite size or decline to extinction. For this reason, mortality rates were adjusted to achieve a zero net growth rate. Because early life stage mortality rates are generally believed to be more variable and uncertain than mortality rates for older fish, only the values for eggs, larvae, and early juveniles were adjusted as noted in the Application in Appendix L, Tab 18. This procedure was employed to provide consistency between the parameter estimation procedures applied to different species, and does not imply that PSEG believes that only mortality rates for early life stages are uncertain.

Both the literature-derived estimates used as starting values for the LCB calculations and the final results of those calculations used in the Application were developed in collaboration with Dr. James Cowan (University of South Alabama) and Dr. Kenneth Rose (Louisiana State University). Despite being highly critical of PSEG's approach, ESSA does not suggest an alternative that would achieve the same objective with an equivalent degree of consistency and rigor.

Responses to each of ESSA's major criticisms are provided below.

a. Degree of Uncertainty in Adult Mortality Rates

PSEG agrees that the adult mortality rates used in the LCB calculations are uncertain; however, the degree of uncertainty varies greatly among species. Uncertainty in Ms is probably lowest for striped bass, weakfish, and American shad because the Atlantic States Marine Fisheries Commission ("ASMFC") has performed recent stock assessments for these species. (ASMFC 1998, ASMFC 1999, NMFS 2000.) Uncertainty is probably highest for spot and Atlantic croaker, because neither stock assessments nor population-specific monitoring studies are available for these species. Although stock assessments are not performed for the two species - bay anchovy and white perch - specifically cited by ESSA as examples of high uncertainty and supposed bias, estimates of adult mortality for both species are available from research and monitoring studies as cited in the Application. (Application, Appendix L, Tab 18.) Examination of these studies shows that ESSA's concerns are unfounded.

Data on adult mortality are available for two bay anchovy populations: The Delaware Estuary (PSE&G 1984) and the Chesapeake Bay (Newberger and Houde 1995). ESSA stated that the value used in PSEG's assessment, taken from the PSE&G (1984) study, is biased high because the data were collected during years when the Station was operating and no adjustment was made to remove station-related mortality. According to ESSA's theory, if there were no entrainment or impingement, the mortality rate for adult bay anchovy would be lower. However, the other available estimate (Newberger and Houde 1995) is actually substantially *higher* (89% per year vs. 80% per year) than the Delaware Estuary estimate (Application, Appendix L, Tab 18).

In the case of white perch, both Delaware Estuary and Hudson River data were examined during the review of age-specific mortality rates. Data were available from several Delaware Estuary studies, but all of the published studies were performed in the early 1970s and sample sizes were small. The Hudson River data provided mortality rates that were roughly comparable to the rates estimated in the Delaware Estuary studies, but the sample sizes were much larger and were collected over a longer period of time. Therefore, natural mortality rate estimates based on data from the Hudson River were chosen for use in the Application. These data, which were reproduced in the Application, clearly show an increase in mortality in age 5 and older fish. ESSA asserts in its review that the alternative value used by Goodyear (1999) in his review of PSE&G's application is equally plausible, even though Goodyear provided no data to support his estimate (Application, Appendix L, Tab 18, Table 11).

Subsequent to the filing of the Application, PSEG obtained more recent data concerning age-specific adult mortality rates in Delaware Estuary white perch, collected by DNREC. These data imply an adult rate intermediate between the rate used in the Application and the rate assumed by Goodyear. PSEG's response to Goodyear's review (PSEG 2000a) contains a re-analysis of Station impacts on white perch, using a revised life table derived from the new DNREC data. The re-analysis was provided by letter dated February 18, 2000 to Dennis Hart (NJDEP) from R. Edwin Selover (PSEG). The new data do not alter PSEG's original conclusions.

Therefore, although adult natural mortality rates are uncertain, ESSA's specific concerns regarding bay anchovy and white perch are unfounded. If the bay anchovy adult mortality rate derived from Delaware Estuary data had been rejected (because of a presumed upward bias due to the confounding effect of Station mortality) in favor of the Chesapeake Bay-derived estimate, the result would have been to increase, rather than decrease, the adult mortality rate used in the

LCB calculations. Recent data on age-specific adult mortality rates in Delaware Estuary white perch clearly contradict the low value assumed by Goodyear (2000). As demonstrated in PSEG's response to Goodyear, PSEG's conclusions in the Application are not altered by the use of the new data.

b. Use of the Equilibrium Assumption

ESSA comments that populations probably aren't at equilibrium and that violations of the equilibrium assumption would cause biases in estimates of early life stage natural mortality rates, especially for growing populations. (ESSA Report, page 30.) This could be true only if higher than average early life stage survival were responsible for the observed population growth. However, there is no reason to expect that the rates of population growth documented in Appendix J of the Application are due entirely to reduced early life stage mortality. In fact, many of the populations discussed in the Application have benefited from reduced mortality of adults, resulting from harvest restrictions. Because harvesting affects many age classes, a small change in mortality due to fishing can produce the same increase in population growth rate as a large change in early life stage survival. (Application, Appendix J.) For these stocks for which we have calculated levels of recruitment abundance (such as weakfish and striped bass) we can compare directly the spawning stock biomass ("SSB") for each year with the production of recruitment (age-1 fish) and abundance of subsequent age groups, which are a function of fishery mortality as well as natural mortality. Recruitment is only a function of early life stage survival and the SSB that produced it. Mortality from fishing is not a factor. Population growth from a reductions in fishing is readily apparent and associated with reductions in known fishing mortality rates that occur after age 1.

For example, suppose the weakfish population were doubling every generation. If all of the population growth were attributed to early life stages, then achieving this rate of growth would require a doubling of the Age 0 survival probability used in the Application (from 3.2×10^{-6} to 6.4×10^{-6}). If the population growth were attributed instead to the survival of Age 1 and older fish, then only a 10% increase in the survival probability of each age 1+ fish would be required. This increase could be obtained by reducing the fishing mortality rate used in the LCB calculations by 40%, from 0.25 to 0.15. The most recent stock assessment for weakfish (NMFS 2000) shows that the actual reduction in fishing mortality over the past 10 years has been much greater than 40%. Because reductions in fishing mortality are more than enough to account for the recent growth of the weakfish population, there is no reason to assume that any of the recent growth in the size of the weakfish population is due to high early life stage survival, and no reason to adjust any of the early life stage survival rates used in the Application to account for this population growth. Harvest restrictions have also reduced fishing mortality imposed on striped bass and American shad (ASMFC 1998, ASMFC 1999), and have clearly contributed to the growth observed in both of these populations.

Regardless of the specific life history parameters contributing to the growth rates observed in most of the finfish species discussed in the Application, a population cannot continue to grow indefinitely. In the example discussed above, the assumed doubling of the weakfish population each generation would result in a quadrupling of the size of the population over two generations and a factor of eight increase over three generations. Within a relatively short period, a rapidly growing population will approach the carrying capacity of its environment, and compensatory processes documented in Appendix I of the Application will cause population growth to cease. For example, recent spawner-recruit data for weakfish and striped bass (NMFS 2000; ASMFC 1999) show that reproductive success in both species, as measured by the number of recruits produced per unit spawning stock biomass, is decreasing (Figures IV-8 and IV-9). Early life-stage survival in both of these stocks is clearly decreasing, not increasing. (Application Appendix I.)

c. Partitioning of Mortality Rates

ESSA comments that the LCB approach is "technically incorrect" because "it neglects to back out the existing entrainment rates and impingement rates from the adjusted Ms" (ESSA Report, page 30). As a result, ESSA claims, "what the Appendix calls an M is actually Z = (M+E+I) where E and I are the entrainment and impingement rates that existed in the populations during the time period basis for the adult Zs" (ESSA Report, page 30).

ESSA's concern is founded on an incorrect interpretation of PSEG's early life stage mortality rates. According to ESSA, the parameters being estimated using the LCB approach are total mortality rates that include Station impacts. If this were true, Station-related mortality should (at least in theory) be subtracted from total mortality to obtain an unbiased estimate of the underlying natural mortality. However, most of the early life stage mortality rates used in the analysis were literature-derived values taken from studies performed on populations in estuaries that are not affected by the Station. For these species and life stages, there are no Station effects to be subtracted. The only values derived from Delaware Estuary data were the juvenile and adult mortality rates for bay anchovy and the egg, larval, postlarval, and juvenile mortality rates for weakfish. For these species, ESSA's claim is theoretically valid; however, the bias introduced is negligibly small because Station mortality is negligibly small compared to natural mortality. For weakfish, for example, the coastwide CMR of 0.033, estimated using the ETM, is equivalent to a daily instantaneous mortality rate of 0.000092 applied over all of the age 0 life stages. The total age 0 mortality rate estimated using the LCB approach, as can easily be calculated from the life table presented in the Application, is equivalent to a daily instantaneous mortality rate of 0.0346. Subtracting Station mortality would reduce this value by only 0.01%, to 0.0345. (Application, Appendix L, Tab 18, Table 4.) Applying the same procedure to bay anchovy would produce a similar result.

d. Relationship of Natural Mortality Rates to Published Values

ESSA claims that "all of the natural mortalities (M) for young fishes are likely overestimated" (ESSA Report, page 31). This statement is directly contradicted by published values that are summarized in the Application. (Application Appendix L.) Table IV-3 summarizes these published estimates from which the starting values for the LCB calculations were derived, and compares these to the adjusted values that were used as inputs to other components of the assessment. Table IV-3 shows that 11 of the adjusted rates are lower than the published rates, 10 are higher, and 7 are within the range of the measured values. These estimates documented in Appendix L of the application were provided to ESSA. Moreover, in Section 5.2.4.3 of the review ESSA performed a sensitivity analysis of the influence of the mortality rates on estimates of pounds lost to the fishery. ESSA found that in most cases substituting the starting values prior to adjustment resulted in *decreases* in the pounds lost estimates, not the *increases* implied by ESSA's comments. (ESSA Report, page 31.)

e. Summary Regarding Lack of Bias in LCB Methodology

ESSA's criticisms of PSEG's use of the LCB approach to estimate early life stage mortality rates are in some cases invalid and in other cases quantitatively insignificant. ESSA's proposed adjustment to account for observed population growth rates conflicts both with the known history of the best-studied populations and with basic principles of population biology. The data summarized in Table IV-3 reflect a wide variety of studies, conducted on different populations, using different methods, under varying environmental conditions. The LCB approach provides a consistent, unbiased, and scientifically credible means of using these data to develop estimates of early life stage mortality rates. Based on these facts, PSEG disagrees with ESSA's recommendation for a sensitivity analysis of the effects of a "range of alternative Ms."

E. ESSA Report § 2.4: The Base Case

In Section 2.4, ESSA reviews and comments on the Base Case scenario that PSEG used in its assessment of future Station effects and in its Cost-Benefit analyses of technology alternatives. ESSA questions whether entrainment and impingement density data from years during which the Station was not in operation should be used in computing loss estimates for the Base Case scenario. ESSA also suggests that a range of loss estimates (based on the years of data used as input to the Base Case loss estimates) for the Base Case scenario, rather than an average value for each RIS, should be explored. Furthermore, ESSA claims that the stock jeopardy analyses should have considered scenarios of low stock abundance, even though it is likely that stock abundances will remain relatively high in the near future.

From June 1995 through August 1997, the Station was not generating power and generally only one cooling water pump was running (an exception was that during June, July and August 1995, additional pumps were operated for the side-by-side screen effectiveness study). Entrainment sampling (to estimate entrainment density) was conducted in front of the pump that was in operation. ESSA speculates that a "restricted zone of entrainment" that was "not representative of typical operating conditions" was present in those years (ESSA Report, page 31). However, ESSA presents no data to support its speculation. Furthermore, as discussed in Section IV.B.3 above, the tidal flows past the station are substantial and expand the effective zone of entrainment well beyond the area immediately in front of the station.

In addition to its concern over its hypothesized "restricted zone of entrainment," ESSA expresses concern over PSEG's use of interpolations to fill data gaps created by the lack of entrainment sampling in some months during this period when the Station was not generating power, and over PSEG's use of correction factors to account for the lack of night time entrainment sampling in some years (ESSA Report, pages 31-32). This position in Section 2.4 of ESSA's Report contradicts its previously stated conclusion in Section 2.1 of the ESSA Report that PSEG's methods were reasonable:

> The methods employed for interpolation/extrapolation of data are reasonable and generally conservative. Weaknesses in the data are explicitly acknowledged and various adjustments or correction coefficients have been developed and applied to attempt to correct for know[n] biases. In this regard, the overall approach taken by the investigators working with the data is not unreasonable; in fact their attempts to make the most of an incomplete and biased data set are laudable. (ESSA Report, page 10.)

ESSA does not present any scientifically credible evidence to support its claim that data from 1995-1997 somehow compromised the validity of the Base Case scenario loss estimates. Furthermore, whether data from those years are included or excluded from the analyses has little effect on the Base Case scenario loss estimates (see PSEG 1999b and Figure IV-4). The estimates of pounds lost to the fishery (on which the Cost-Benefit analyses of technology alternatives were based) for striped bass and spot would be slightly higher if data from 1995-1997 were excluded. The estimate of pounds lost to the fishery would be slightly lower for Atlantic croaker, and would be substantially lower for weakfish, if the data from 1995-1997 were excluded. Estimates of pounds lost to the fishery for all other finfish RIS were negligibly small in comparison to the pounds lost estimates for these four species. The estimate of total pounds lost to the fishery (from all finfish RIS) would be slightly lower if data from 1995-1997 were excluded from the calculation of losses for the Base Case scenario. Similarly, excluding data from 1995-1997 from base case CMR estimates would have little effect on the estimates (see Figure IV-5). For spot and American shad, the base case CMR would increase slightly; for bay anchovy and weakfish, the base case CMR's would decrease. Data to estimate CMRs for white perch, blueback herring and alewife were only available from 1996; therefore, this type of comparison cannot be made for those species. As is the case for the base case loss estimates, the data from 1995-1997 did not have a major effect on the base case CMR estimates. The most noticeable effects are that excluding data from 1995-1997 tends to reduce base case loss and CMR estimates.

ESSA also comments in Section 2.4, as in many other sections of the Report, that an uncertainty analysis is needed. (ESSA Report, page 32.) Also as in almost every other section of its Report, ESSA does not specify the purpose of the uncertainty analysis, nor how NJDEP's decision-making process would incorporate the results from the uncertainty analysis, nor does ESSA specify details of how the uncertainty analysis should be conducted and what types of outputs the uncertainty analysis should generate.

PSEG challenges the merits of ESSA's request for uncertainty analyses. PSEG acknowledges that uncertainties exist, and in fact are quite ubiquitous. However, PSEG's position is, and has been, that the permit decision-making process is best served by consideration of the *best* available estimates, based on the best available data and on scientifically defensible analytical methods. PSEG notes that this position is consistent with EPA's 1977 Draft Guidance. The findings presented in the Application were developed accordingly, and PSEG continues to advocate this approach. ESSA's recommendations for uncertainty analyses are unsubstantiated, unconvincing and have not changed PSEG's position on this point.

ESSA's particular criticism in Section 2.4 of its Report is that inter-annual variability in entrainment and impingement densities should be considered:

> Although the approach taken does include a series of years which likely vary in their entrainment and impingement impacts, averaging the values into a single value serves to mask the variance and potential significance of impact under varying conditions. (ESSA Report, pages 31-32.)

This statement by ESSA reflects some confusion about the purpose and use of the loss estimates for the Base Case scenario. The Base Case scenario was a baseline condition against which technology alternatives were compared using Cost-Benefit methods (see Application, Appendix F, Attachment F-4). The projected benefit from each technology alternative was based on the difference between the Base Case scenario losses and the projected losses under the technology alternative for each year from 2001 through 2021. The projected benefit in each of these years was computed by translating the projected increase (due to the technology alternative) in pounds of fish in the commercial and recreational catch to its value in dollars. The overall benefit then was computed as the present value of the 22 years of annual benefits. Computing the present value is like computing an average; it requires taking a weighted sum over annual values, and results in a single value. It is irrelevant whether the inter-annual variability in entrainment and impingement densities from 1991-1998 is assigned to the future 22 years (as suggested by ESSA's comments) or not. The bottom line number (i.e., the present value over 22 years) would still be a single value.

ESSA's final criticism in Section 2.4 of its Report is that:

> While we understand the assertion that the more recent values in the data series may be more representative of future conditions, we also note that from the perspective of stock jeopardy, understanding the impact of the station when stocks are at low levels is likely just as important, if not more so, than understanding the impacts during high abundance. (ESSA Report, page 32.)

This statement is an academic criticism. It ignores the purposes of the stock jeopardy analyses in the context of PSEG's Section 316(b) demonstration for Salem. The stock jeopardy analyses were part of a predictive assessment intended to provide insight into likely Station effects during the upcoming permit period. The analyses were not intended as a general exploration of fish stock dynamics. Furthermore, PSEG notes that the historical record provides some information relevant to ESSA's concern about understanding the effects of the Station on fish stocks at low abundance levels. In the late 1970s and early 1980s, the striped bass, weakfish and American shad stocks were at historical low levels in the Delaware estuary (Appendix H, pages 25-47). The Station began operation at that time, when those stocks were already at low levels. Since then, all of those stocks have experienced tremendous increases in abundance. The increases in abundance occurred during the 23-year period of Salem's operation.

V. RESPONSE TO ESSA'S SECTION 3: COMPLIANCE WITH 1994 PERMIT

A. ESSA Report: Summary and Recommendations

1. Summary

In Section 3, ESSA compliments the Ristroph screen modifications undertaken at Salem pursuant to the 1994 Permit, stating that the modifications "are innovative, and represents BTA at the screens for reducing fish mortalities" (ESSA Report, page 33). ESSA further notes that PSEG "should take credit for taking time and effort to modify the earlier Ristroph Screen to improve performance." (Id.) ESSA goes on to state, however, that the Ristroph screens alone "cannot fully address fish impingement losses at the Salem station," (id.), and recommends a number of additional measures for accomplishing that goal.

PSEG concurs that the screen modifications accomplished at Salem are innovative and believes that these modifications, in conjunction with the other measures undertaken in accordance with the 1994 Permit, represent BTA for the Station. As discussed in the remainder of this section of the ESSA Response, however, PSEG disagrees with several of ESSA's statements regarding the need for additional fish protection measures.

The summary also addresses the sound studies undertaken pursuant to the 1994 Permit. ESSA states that "the investigators did a thorough job in data collection and analysis," and that the study "is indeed one of the most comprehensive data collections on sound and fish response to date" (ESSA Report, page 33). In addition, ESSA states that while sound technology "show[s] promise" for some species, it "cannot recommend sound as a single deterrent system" for Salem. (Id.) ESSA therefore suggests that sound be considered as part of a hybrid fish protection approach.

PSEG agrees with ESSA's statements regarding the quality and usefulness of the Salem sound studies. PSEG also agrees with ESSA that sound technology shows promise for deterring some species, and for this reason PSEG is proposing to submit a Plan of Study that will consider additional fish protection technologies, including sound deterrents.

2. Recommendations

ESSA makes a number of recommendations regarding fish protection technologies evaluated pursuant to the 1994 Permit and in connection with the Application. In general, ESSA recommends that the Ristroph Screens, the fish trough, and the sound study "be integrated more closely . . . rather than be addressed as individual components [since] "[a]ny Fish Diversion System at Salem [s]tation must consider all these components together and focus on what each technology can do (to either reduce impingement and/or reduce mortality)" (ESSA Report, page 33). ESSA then goes on to offer several specific recommendations designed to accomplish this goal, including short-term recommendations involving the analysis of existing information, recommendations involving improvements to current Station operation, and a long-term recommendation.

The short-term recommendations are the following:

> The Ristroph Travelling [sic] Screen, although considered to be very innovative technology, is still not 100% effective in reducing fish mortality. This is especially true for species most susceptible to injury. NJDEP should require PSE&G to include in the current Application a species list for which the system is expected to work (a) best and (b) worst (i.e., the most vulnerable ones). This list should also include species not tested, with an estimate of how well the modified screens might be expected to work for them.
>
> We recommend that the information on Intake Screen Improvements (Ristroph Screens, Fish Return System), and Sound be integrated more closely as part of a Fish Protection System rather than being addressed as individual components. (ESSA Report, page 34.)

ESSA's recommendations involving improvements to current Station operation are that:

> Further studies at the Salem [s]tation of a "fish defense system" where multi-sensory or hybrid technologies are involved should be undertaken. . . . A study should also be done of the feasibility of a jetty area in front of the intake. (ESSA Report, page 34.)

As discussed in Section V.E below, PSEG believes that certain aspects of the multi-sensory hybrid technology approach proposed by ESSA – in particular, the strobe light/air bubble curtain, combined with the existing Ristroph screens, and possibly sound – have the best potential for reducing fish losses at Salem. PSEG agrees with ESSA that integrated approaches to technologies should be considered, and PSEG has consistently evaluated combinations of technologies. See Application Appendix F, part VIII; PSE&G's September 1993 Comments on the 1993 Draft NJPDES Permit, Appendices J and M; PSE&G's January 1994 Comments on the 1993 Draft NJPDES Permit, Appendices J-1 and M-1. However, PSEG does not believe that the addition of attraction light technologies or jetties would be biologically effective, or economically practicable. Finally, as outlined in Section V.B.4 below, the modifications to the fish return system proposed by ESSA are based on an erroneous understanding of the Salem fish return system and therefore ESSA's concerns are misplaced.

As noted, ESSA also recommends that NJDEP require submission of a list of species according to screen effectiveness. As discussed in Section V.B.4 below, should NJDEP carry this recommendation forward into the final permit, PSEG will submit such a listing for species collected in sufficient numbers to support valid estimates of impingement mortality. PSEG disagrees with ESSA's recommendation that the list "should also include species not tested" (ESSA Report, page 34). Inclusion of species not tested in the ranking would be pure speculation and not scientifically justified.

Finally, ESSA's long-term recommendation is that:

> Fish mortality associated with the modified fish return system should be evaluated independently from the Ristroph Screens to determine mortality rates as fish enter the estuary. Emphasis should be placed on reducing potential mortality of susceptible species. (ESSA Report, page 34.)

The issue of the potential additional stress placed on fish at the point when the screen wash water re-enters the Estuary is discussed in Sections IV.A.2.c and IV.C.2.b of this Response.

B. ESSA Report § 3.1: Intake Screen Improvements

1. ESSA Report § 3.1.1: Background and Overall Review

In Section 3.1.1 of ESSA's Report, ESSA summarizes the changes PSEG has made to the intake screens and fish return system, and concludes that the modified Ristroph traveling screens are the best technology available:

> The fish defense system currently in place at Salem GS features modified Ristroph Travelling Screens, which are the best technology available at the screens for handling certain species of fish. PSE&G's modified lip design represents a notable improvement over the original Ristroph design by Fletcher (1990). *The utility is commended for its efforts to improve the screens.* (ESSA Report, page 35, emphasis in original.)

PSEG agrees that the modified Ristroph traveling screens are the best technology available; however, PSEG takes exception with several of the implications of ESSA's statement. ESSA implies that the modified Ristroph traveling screens are not BTA for all species, but ESSA does not identify for which species the modified Ristroph traveling screens are not BTA. Also, ESSA does not indicate why the modified screens are not BTA for some species, nor does ESSA identify what other technology is BTA for those species. This lack of support for the comment suggests that it is simply speculation, and precludes further response. ESSA further speculates that "[t]he velocity of the water flowing through this fish return flume is likely too high" (ESSA Report, page 35); again ESSA provides no support for this statement.

2. ESSA Report § 3.1.2: Review of Mortality Estimates (Screen Comparison Tests)

In Section 3.1.2 of its Report, ESSA comments on PSEG's assessment of the Biological Efficacy of Intake Structure Modifications (Application Appendix G, Exhibit G-1-2). ESSA notes that Exhibit G-1-2 did not include a discussion of the precision of estimates of impingement mortality rates:

> . . . differences in survival do not account for any variability in mortality estimates. For instance, is the difference between 31% survival (modified Ristroph) and 18% survival (original Ristroph

design) for weakfish in July statistically significant? There appeared to be no raw data available with which the ESSA team could assess data variability. (ESSA Report, page 35.)

PSEG notes that ESSA's comment on this topic contains several inaccuracies. First, the impingement *mortality* rates (not *survival* rates as stated by ESSA) for weakfish were 31% with the original screens and 18% with the modified Ristroph screens. Second, the information needed to assess the precision of impingement mortality rates estimates is presented in Exhibit G-1-2. Because the number of fish examined that died is a binomial random variable (N=number of fish examined, and X=number of fish that died), confidence limits for estimates of impingement mortality rates can be computed from N and X (see, e.g., Johnson, N.L. and S. Kotz, 1969). The lower confidence limit (*L*) for the estimate of the impingement mortality rate is found by solving the following equation for *L*:

$$\frac{\alpha}{2} = 1 - \sum_{y=0}^{X-1} \binom{N}{y} L^{y} (1-L)^{N-y}$$

The upper confidence limit (*U*) for the estimate of the impingement mortality rate is found by solving the following equation for *U*:

$$\frac{\alpha}{2} = \sum_{y=0}^{X} \binom{N}{y} U^{y} (1-U)^{N-y}$$

where α is the probability level (e.g., 0.05). Tables 1 through 4 in Exhibit G-1-2 list the number of fish examined (N), and the number that died (X) is the product of N and the estimate of the impingement mortality rate (Application Appendix G, Exhibit G, Tables 1 through 4). For example, as listed in G-1-2 Table 1, 473 weakfish from the modified screens were examined in July 1995; the estimated impingement mortality rate was 18% and the lower and upper confidence limits are 15% and 22%, respectively. Similarly, as listed in G-1-2 Table 2, 367 weakfish from the original screens were examined in July 1995; the estimated impingement mortality rate was 31% and the lower and upper confidence limits are 26% and 36%, respectively. Thus, while PSEG agrees that a discussion of the precision of estimates of impingement mortality rates would have been helpful, the example demonstrates that data were available for this discussion.

ESSA made two comments regarding changes in the fish return system and methods for estimating impingement mortality rates that may have affected PSEG's assessment of the effectiveness of the improved intake system. One comment addressed modifications to the fish return sluice (i.e., change from steel and concrete to fiberglass), which may have affected *actual* impingement mortality rates. The other comment addressed modifications to impingement sampling protocols that may have affected *estimates* of (but not actual) impingement mortality rates. Each of these comments is addressed separately below.

Regarding modifications PSEG made to the fish return sluice, ESSA notes that the 1996 ECSI/LMS report on the 1995 side-by-side comparison study suggests that an observed decrease in mortality from 1978-82 to 1995 might have been due to modifications to the fish return sluice that were made in 1990-91. ESSA raises the question:

> Were adjustments made for this confounding factor in the comparison of the 1978-82 and 1997-98 data? (ESSA Report, page 35.)

The answer is that, as documented (Application Appendix G, Exhibit G-1-2, pages 5-6), the estimates of reduction in impingement mortality rates (1978-82 vs 1997-98) include no adjustments to isolate factors affecting impingement mortality. PSEG acknowledges that the modifications to the fish return sluice may have reduced mortality of fish returned to the estuary via the sluice, but notes that results from the 1995 side-by-side comparison study would not have been affected by PSEG's improvements to the fish return sluice.

As a follow-up to its comments regarding the improvements to the fish return sluice, ESSA states:

> The relative contributions of the improved fish passage facility and the improved travelling screen design need to be taken into account in any further analyses. (ESSA Report, page 35.)

However, ESSA neither explains the rationale for its recommendation, indicates what input data should be used in the analyses, nor describes how the results from the analyses would be used. Therefore, PSEG questions the relative merits of conducting such further analyses.

Regarding modifications to impingement sampling protocols that might have affected *estimates* of impingement mortality, ESSA notes that, as documented in Application Appendix G, Exhibit G-1-2, pages 8-10, protocols for the impingement survival studies were different in 1978-82 and in 1997-98. Without any apparent justification or supporting information, ESSA concludes:

> Perhaps the biggest concern is the fact that latent mor[t]ality was generally done off-site for the 1978-82 study and on-site for the 1997-98 study. (ESSA Report, page 35.)

ESSA provides no discussion of why it believes conducting the latent mortality studies offsite would have a greater effect on study estimates of impingement mortality than would other changes that were described in Exhibit G-1-2, which states:

> With respect to the intake structure and fish return system, one unintended factor not present in earlier studies may have been present during the 1997 and 1998 studies. Gaps may have been present in the flap seals that separate the fish and debris troughs. Gaps in the seals were detected during a 1998 impingement

> collection efficiency study (conducted at the end of the 1997 through the early 1998 impingement survival study period). Fifteen tests were conducted at pump 11A, each involving the release of 100 dyed fish in front of the screen. Roughly 60 percent to 80 percent of the recaptured fish were recovered from the debris trough rather than the fish trough. Fish slipping into the debris trough would have been subjected to additional stresses of high debris load and the high-pressure sprays of the debris removal system. After discovering this problem, PSE&G began an inspection program to identify flap-seal gaps and make adjustments, as needed. (Application Appendix G, Exhibit G-1-2, page 12.)
>
> Several changes to the experimental protocols may have also affected mortality estimates. First, as part of modifications to the fish return system that were made from 1989 to 1990, the J-shaped slide from the fish return trough to the fish collection pool was replaced by a slide with a vertical stop at the end of the slide. The water and contents from the wash flow down the slide into the stop before entering the pool. The additional stresses likely created by this feature would have been amplified by higher flows (due to the improved wash water system of the new screens) and associated higher velocities down the fish slide. (Application Appendix G, Exhibit G-1-2, page 12.)
>
> A second factor that could have biased mortality estimates without affecting actual mortality was the type of screen installed in the fish collection pools. During the 1978 to 1982 and 1995 studies, the 3/8-inch-square mesh was installed in the fish collection pool. Use of this mesh in the collection pools may have allowed some small fish to escape through the collection pool screen. For the 1997 and 1998 studies, the new screen with smaller pore openings was installed in the fish collection pools. As a result, smaller fish were collected in 1997 to 1998 than would have been in 1995. Therefore, some small fish that were impinged on the Modified Screens in 1995 may have been small enough to slip through the 3/8-inch-square mesh in the collection pool screen. Since smaller fish generally exhibit higher mortality to stress, the loss of small fish through the 3/8-inch mesh in the collection pool may have induced a downward bias in mortality estimates . . . . (Application Appendix G, Exhibit G-1-2, page 13.)

All of these factors, apparently ignored by ESSA, may have caused the impingement mortality *estimates* from 1978-82 to be biased low in comparison to estimates from 1997-98. Biases of this kind would have caused the *estimates* of effectiveness of the modified intake system to be biased low, not biased high, as implied by ESSA.

ESSA's final comment in Section 3.1.2 of its Report addresses the effect of size on impingement mortality rates:

> The ECSI and LMS (1996) report shows differences in mortality rate as a function of fish size (comparing modified to original Ristroph screens). For instance, for fish less than 40 mm in length, the difference in survival between modified and original screens was only 11.8% compared to over 50% for larger fish. This difference should be discussed in Appendix G, especially in reference to size classes of fish entering the intake. (ESSA Report, page 35.)

ESSA's suggestion that Exhibit G-1-2 does not include a discussion of the effects of fish size on impingement mortality rates and on estimates of improvements in impingement survival is inaccurate. The effect of fish size on impingement mortality rates was recognized by PSEG:

> . . . separate estimates are computed for each month with available data because size (in addition to other factors such as temperature, salinity, etc.) affects fish susceptibility to injury. Since fish size increases over the year as fish grow, month is a rough surrogate for fish size. (Application Appendix G, Exhibit G-1-2, page 5.)

Furthermore, biases in impingement mortality rate estimates for fish less than 40 millimeters in length are discussed in some detail in Exhibit G-1-2:

> When interpreting impingement mortality estimates, it should be noted that some smaller fish (e.g., fish less than 40 millimeters) that would have passed through the Original Screens (i.e., would be entrained) would be impinged on the Modified Screens (ECSI and LMS 1996). The greater impingement of smaller fish on the Modified Screens affects the assessment of the effectiveness of the Modified Screens. Because mortality rates on the Modified Screens tend to be greater for smaller fish, the inclusion of these smaller fish, that otherwise would have been entrained, increases the estimates of impingement mortality rates for the Modified Screens. However, the entrainment mortality rate for many species is greater than the impingement mortality rate. For example, the estimated entrainment mortality rate for weakfish greater than 10 millimeters is 50 percent (ECSI and LMS 1996) excluding the effects of exposure to elevated temperatures while passing through the plant, which occasionally cause the entrainment mortality rate to exceed 50 percent. Therefore, the actual effectiveness of the Modified Screens for smaller weakfish is greater than the estimates in G-1-2 Table 6 indicate. The actual reduction in mortality for these fish is the difference between the entrainment mortality rate (e.g., 50 percent or more for weakfish) and the estimated

> impingement mortality rate under the Modified Screens (e.g., 17 to 18 percent for weakfish in June and July when weakfish are smaller, see G-1-2 Table 5) rather than the difference between the impingement mortality rate with the Original Screens (e.g., 33 percent and 31 percent for weakfish in June and July respectively) and the estimated impingement mortality rates with the Modified Screens. Limited data does not allow a comprehensive analyses of this issue, but the estimates of effectiveness for the Modified Screens may be biased low in some circumstances because of these factors. (Application Appendix G, Exhibit G-1-2, page 11.)

Finally, ESSA's statement that:

> [t]his section of the Permit Application has not been integrated with the other sections of the document, but should be as there may be differential mortalities as a function of fish size which will eventually have to be incorporated into the fish loss models (ESSA Report, page 35)

is inaccurate. PSEG's estimates of impingement losses were computed using month-specific estimates of impingement mortality rates. PSEG specifically used the month-specific rates to account for the effects of size (and ambient water temperature) on impingement mortality.

3. ESSA Report § 3.1.3: Fish Return System

Regarding the fish return system, ESSA states that

> [t]he section in the Permit Application about the fish return system beyond the point of fish collection is limited (Appendix G-1). We became concerned about fish survival in the trough after observing the system during our December 9 site visit. At that time, the velocity of the water flowing through the troughs was very high (estimated at over 1 m/s based on casual observations; this rate of flow could not be verified since flow data were not available from PSE&G at the time of writing). Another unknown is the mortality rate for fish as they enter the [e]stuary from the fish return trough (see also Section 2.2). It is probable that mortality occurs during passage, and it will likely to be species specific. (ESSA Report, page 36.)

ESSA also states that the "[f]ish mortality of the fish return system should be evaluated independently from the Ristroph Screens to determine mortality rate[s] as fish enter the [E]stuary" (ESSA Report, page 36). It appears ESSA would recommend assessing fish mortality associated with trough transit independent of the mortality component perceived to occur from the impingement process on the screens. While this may have some academic interest, the results could not be applied to the effectiveness of the fish return system. Test and control fish that would not have been exposed to the impingement stress would have to be collected from the river by some netting technique. Obviously, they would be held for a suitable time to assure they were over the capture/transport stress. They could then be released into the fish return and ostensibly collected by some other technique than is currently used. However, the survival information derived from these specimens would not be applicable to fish that have experienced the impingement process and the associated existing collection process stresses. The results of such an analysis therefore would not be meaningful in addressing ESSA's stated concern regarding mortality rates of fish entering the estuary.

Regardless of the probable lack of meaningful results, sampling the discharge of the fish return trough for latent impingement mortality may not be feasible. To assess the survival of aquatic organisms at the discharge accurately, a sufficiently large collection system must be designed, constructed and deployed that would accommodate the large flows and large volumes of debris commonly encountered at the Station without impeding fish movement. The large size of the collection system would also be necessary to decrease the likelihood of cannibalization and predation by piscivorous fish. A covered collection system would likely be necessary to eliminate predation by birds.

It would be difficult to anchor a collection system of this size in the tidal currents at the Station. The ability to maintain a large net in a suitable fishing position to ensure safe recovery of fish under the constantly changing tidal velocities and directions is questionable. Additionally, methods would need to be developed to crowd organisms (isolated from debris) into a smaller area. Once isolated, organisms would need to be collected and transported to a latent mortality holding facility without causing greater injury. Additional handling of fish, whether at the flume discharge or in the existing fish sampling system, would result in an increase in injury and mortality that would be difficult to quantify in the absence of true control specimens. Fish collected in the existing sampling pools would not be appropriate for use as controls due to the independent injury and stress imparted by that system. Without true control specimens, it would not be possible to separate the effects (potential stress, injury, or mortality) of the trough discharge from those caused by the additional handling and transport of test fish to the holding facility. Sampling the fish return system independently from the Ristroph Screens thus is impractical.

4. ESSA Report § 3.1.4: Comments on Intake Screen Improvements and Recommendations for Fish Return System

ESSA states that:

> NJDEP should require PSE&G to include in the current Application a species list for which the system is expected to work (a) best and (b) worst (i.e., the more vulnerable ones). This list should also include species not tested, with an estimate of how well the modified screens might be expected to work for them. (ESSA Report, page 36.)

With regard to the fish return, ESSA recommends that "[t]he fish return flume should be redesigned by a hydraulic engineer to specifications for flows, velocities, and depth profiles made by a biologist with expertise in the area of fish behavior" (ESSA Report, page 36). ESSA further notes that:

> It is also possible that actual mortality rates of fish after returning to the Delaware River are equivalent or even higher than those estimated via the sampling pool. Actual impingement mortality could be higher due to the physical trauma that must occur when fish and debris abruptly hit the surface of the river. Because the sluice is open and above the river surface, fish and debris must hit the water abruptly as opposed to entering the river below the surface. (ESSA Report, page 24.)

As noted above, the issue of the additional stress placed on fish at the point when the screen wash water re-enters the estuary is addressed in Sections IV.A.2 and IV.C.2.b. Also, if the Department includes Section G.2.b. in the final permit, PSEG will submit a ranking of RIS with respect to screen effectiveness, and will submit a Plan of Study to address this issue. Nonetheless, PSEG has a number of concerns with ESSA's comments.

ESSA notes that the Ristroph screens are "state-of-the-art" but believes that the fish return flume is imparting injury and stress to fish. However, ESSA's assumption that fish suffer trauma when hitting the surface abruptly, as opposed to entering below the surface, does not reflect actual system operation. The following description of the return system design demonstrates that ESSA's assumption is incorrect.

Within the screenhouse, the flume is flat over its 240-foot length. Water depths in the fish trough range from 5.0 to 7.5 inches and velocities are calculated to be less than approximately 2.0 ft/sec. At each end of the screenhouse building, the trough slope increases as the flows from the fish and debris troughs are combined. Velocities in this section, which is approximately 65 feet long, are calculated to range from about 7 to 17 ft/sec (10 fps for the south trough and 17 fps for the north trough) depending on location. The troughs then discharge into the river via 40-inch diameter pipes. The fish return system is designed to allow for discharge in the direction of the tide to minimize the potential for recirculation onto the intake screens. Mean low water in the Delaware estuary at the Station is 86 feet Public Service Datum (PSD). The bottom of the pipe at the south fish return point is at 83 feet PSD and is therefore below the surface at all times. The bottom of the pipe at the north fish return is at approximately 84 feet PSD and is 2 feet under the surface at mean low water. However, at this tide stage (slack ebb), the discharge is always south. When the tide floods, water level rises and the north fish return is immersed. It is under this condition that the fish return sluice is diverted to the north discharge point. Thus, the discharge point is submerged; the organisms are returned to the estuary in a full pipe. Therefore, the trauma and stress hypothesized by ESSA as a result of a free-fall would not be experienced.

There is an hydraulic jump that occurs in the discharge pipe that creates a zone of turbulence in the pipe. However, this turbulent zone is potentially less injurious to fish than that which occurs in the fish sampling pool. In the sampling pool, the flow is turned upward prior to discharge into the pool. Fish fall from the sampling trough into at least three inches of water in the pool, which serves as a cushion. The pool is then drained and fish are netted into buckets for transfer to holding facilities. In the discharge pipe, on the other hand, the flow does not change direction at the hydraulic jump but rather becomes turbulent while transporting fish to the release point. Without the additional handling associated with collection, fish are exposed to less potential injury and stress in the return pipe than in the sampling pool. PSEG recognizes that the existing fish sampling pools may not be optimally designed to collect fish without stress and injury. However, even with a sub-optimal sampling pool design, the survival rates reported at Salem are amongst the highest reported for traveling screens at any power plant, including those reported for species considered to be fragile. (See Application Appendix F, Attachment F-2, Table 15.)

Supporting evidence for the efficacy of Salem's fish return system design comes from studies conducted at Indian Point Unit 2 (Con Ed and NYPA 1992). Combined with the high survival rates observed among fish collected in Salem's sampling pools, these studies would indicate that Salem's fish return system handles fish in a way that does not cause undue stress to fish. The objectives of the Indian Point studies were to identify (1) the potential for fish recirculation (not an issue at Salem) and (2) possible injury or stress resulting from the proposed fish return system design. The design tested was in many ways similar to that currently employed at Salem and incorporates a steep section in which an hydraulic jump occurs. The return system included screenwash collection sluices, channel bends (up to 180 degrees on a 3-foot radius), elevation changes over steep slopes (e.g., 45 degrees), the confluence of flows from two channels, and a chamber installed at the location of an hydraulic jump to vent entrained air from the return flow. Discharge velocities ranged from 2 to 7 ft/sec. Tests of the system were performed in a full-scale test facility located in an abandoned rock quarry near Indian Point. Test fish were collected from the Hudson River or obtained from bait dealers. Results indicated that the full system did not impose injuries to fish. In general, fish exiting the fish return pipe discharge exhibited normal behavior. Adjusted survival of golden shiners was 100 percent during all testing periods, as was the adjusted survival of striped bass. White perch experienced 100 percent survival on three of the four testing periods. On one day of testing, adjusted survival for white perch was 43.7 percent; however, it was hypothesized that this lower survival was caused by cold shock attributable to differences in water temperature between the release and collection points and was not attributable to the fish return system. The researchers stated:

> Survival rates of test and control fish in most tests were about the same, which suggested that the return system was not the cause of the mortality observed. Further, test fish incurred little or no damage such as bruises, loss of scales or hemorrhages as a result of passage through the system, including a chamber designed to allow entrained air to escape from the return pipe flow. Stresses associated with collection (trawling) and handling appear to be the primary causes of mortality among the species tested. (Con Ed and NYPA 1992.)

The researchers concluded that "results indicate that effects of the return system design planned for Unit 2 will be slight . . . ." The results of extensive biological testing using a full-scale physical model of the Indian Point fish return system thus suggest that ESSA's statement that the "[a]ctual impingement mortality could be higher due to the physical trauma that must occur when fish and debris abruptly hit the surface of the river" (ESSA Report, page 24), would not be substantiated.

C. ESSA Report § 3.2: Sound Studies

1. ESSA Report § 3.2.1: Background

ESSA notes that as part of Salem's 1994 Permit requirements, PSEG conducted feasibility studies of the use of sound as a fish deterrent. ESSA also notes that sound is "being considered as a Fish Protection Option . . ." Although not recommended as one of the seven options discussed in Appendix F (Application Appendix F, Section VII), (ESSA Report, pages 36-37.) ESSA is correct in stating that sound was not one of the seven options selected for detailed evaluation in the Application; this is because PSEG's assessment of the available information on sound technology indicated that, even though sound studies show some promising results for deterring selected species at certain times of the year, the technology's biological effectiveness is not sufficiently proven to make it a viable fish protection option at the current time.

2. ESSA Report § 3.2.2: Issues with Cage Tests

a. ESSA Report § 3.2.2.1: The 1994 Cage Tests

Regarding the sound studies, ESSA correctly states, "[t]he objective was to identify those sounds that could potentially be effective in repelling fish from the CWIS during subsequent in-situ tests..." (ESSA Report, page 37). ESSA then proceeds to make a number of statements that appear to indicate a lack of appreciation for the logical, step-wise methods used by PSEG for evaluating the potential for sound to reduce fish losses at Salem. It may be useful to repeat from the Application the objective of each step in the Salem sound studies:

> [T]he 1994 POS [Plan of Study] called for a series of cage tests to identify sounds that might elicit responses from the nine Salem finfish RIS that would cause the fish to move away from the sound source. (Application Appendix G, Exhibit G-7, page 6.)

Thus, in the first step, PSEG was looking only for the basic behavioral response of each RIS to individual sounds.

Next, "[t]hese tests were to be followed by in situ tests to determine the actual effectiveness of the selected sounds for deterring fish from approaching the Salem CWIS" (id.). In this step, PSEG was using the signals considered to have the best potential for repelling the RIS (based on the cage test results) to determine whether projecting those signals at the CWIS would actually reduce the numbers of fish impinged. ESSA appears to have ignored the stepwise methodology reflected in these objectives. The particular issues raised by ESSA regarding the sound studies are addressed below.

(1) Size of Cage

ESSA contends that the "size of the cage facility seems to have been a little small (3 feet x 3 feet x 12 feet)" (ESSA Report, page 37), yet provides no basis for such contention nor any guidance regarding what size would have been more appropriate. In fact, the size of the test cage used at Salem was selected to be consistent with other test cages used to evaluate fish responses to behavioral stimuli (e.g., Nestler et al. 1992; Jahn and Herbinson 1999; Dunning et al. 1992; Ploskey and Johnson 1998; Goetz et al. 1998; EPRI 1998). PSEG recognized that cage tests of any type may influence the outcome of the experiments and clearly stated so in Attachment G-7. (See Application Appendix G, Exhibit G-7-5, page 7.) It is for this very reason that PSEG proposed to conduct in situ tests at the intake based on the preliminary results obtained in the cage tests.

Despite their shortcomings, cage tests are very useful for obtaining largely qualitative information on fish response to many different stimuli efficiently and in a reasonably short time. Most importantly, they provide a means to observe the behavior of the fish and determine whether there may be subtle responses that could be used in the design of better stimuli. The scale of these tests must be appropriately proportional to the goals of the tests.

The references cited above describe cage tests that were conducted by other researchers precisely for the reasons that PSEG performed the Salem tests. The environmental conditions under which the Salem tests were conducted, however, were far more challenging than in earlier studies. Thus, cage size became a practical matter in that strong tidal currents limited the size of the cage relative to the drag created by the cage itself. For this reason, the conduct of submerged cage tests was generally limited to the periods around slack tides. In addition, the test platform presented practical issues as well. Wave action was sufficiently large at times that testing at the offshore test platform could not be performed safely. The use of a larger cage at this site may have limited testing even further. It is difficult to interpret what ESSA's contention regarding the cage size means, nor does the Report provide guidance as to what size cage would be deemed adequate for the studies that PSEG performed. ESSA provides no evidence that a larger cage would have resulted in different fish responses, and the available literature indicates that the Salem cage size was consistent with those used in many other studies.

(2) Acclimation Period

ESSA states that "[a]cclimation periods for behavioral tests probably should be longer since fish were likely very stressed from being handled (capture[d]). We recommend at least one week" (ESSA Report, page 37). As with the size of the cage facility, ESSA offers no scientific support for a longer holding period prior to testing. In fact, there are known significant downsides to longer acclimation periods. Holding test organisms for longer periods following collection commonly leads to the spread of infection or disease that can greatly weaken fish and influence behavior. Long-term holding also requires stringent control of water quality and feeding schedules to avoid cannibalism or general weakening of the fish. Moreover, in a study of the scale performed at Salem, the timing of experiments, including acclimation periods, becomes a practical matter. Attempting to conduct replicate tests with multiple sound stimuli at two different cage depths with multiple species requires substantial time that may not be accomplishable during the period of time the species are present in the vicinity of the Station. Furthermore, the often hostile work environment at Salem (e.g., strong wind and high waves) limits the time available to perform large numbers of replicates. Finally, as with the size of the cage, the acclimation periods of cage test organisms were selected to be consistent with cage tests conducted by other researchers.

ESSA further comments that the 30-minute holding period in the test cage is too short (ESSA Report, page 37), without providing scientific support for the contention. It should be noted that observations of test fish during all tests with all species indicated that the fish were behaving in what appeared to be a normal fashion at the initiation of a test period and that behavior did not change during each test, except when a sound signal eliciting a response was projected. While different species displayed different "normal" behavior (generally either slow milling from one end of the cage to the other or stationary positioning), the behavior observed within a species was consistent across different test groups over the duration of the cage test studies. Again, the 30-minute value also was selected as a practical matter to allow the large number of tests specified to be completed in a reasonable period of time.

(3) Number of Fish

With regard to the number of fish tested, ESSA states that "[t]he number of individuals per test was between 20 and 30; this was adequate but perhaps a few tests should have been conducted for larger numbers of fish (50 - 100)" (ESSA Report, page 37). The number of fish tested was selected to be large enough to avoid individual responses that might differ from small school responses and, at the same time, small enough to avoid crowding that might artificially impact fish behavior. While it acknowledges that the number of fish used in the tests was adequate, ESSA does not identify what additional information would have been obtained by conducting "a few tests" with larger numbers of fish.

(4) Near- and Far-Field Effects

In assessing the types of effects tested, ESSA states that:

> The design does not include investigating any far-field effects (i.e., responses beyond 4 m). This is only a minor point in these cage tests but becomes important since no methods were used in the 1998 "in-situ" tests to address far-field effects. It should have been looked at somewhere. (ESSA Report, page 37.)

The terms "near-field" and "far-field" are no longer considered to be useful measures by fish bioacousticians (Kalmijn 1988; Popper and Fay 1999) with respect to the perception of sound (either the particle displacement [near-field] or pressure [far-field] components) by fish. The historic literature on fish hearing indicates that the transition between near and far-fields is at a distance of $\lambda/2\pi$, where λ is the wavelength of the sound (e.g., van Bergeijk 1967). The lowest frequency evaluated in the Salem cage tests was 100 Hz. The wavelength for a 100 Hz signal is about 15 meters (where the speed of sound in sea water is approximately 1500 m/sec) and so the transition point is 2.4 meters (15/6.28). All other signals evaluated were of higher frequencies, with shorter wavelengths, thus the transition points were even closer to the sound sources. Therefore, utilizing ESSA's definition, all sounds used in 1994 and 1998 cage tests were *outside* of the near-field and in the far-field. As such, fish in both the cage tests and in situ tests were exposed to "similar" sounds.

(5) Duration of Tests

Finally, with regard to the duration of the cage tests, ESSA states that "[t]here appear to have been no cage tests beyond 10-15 minutes in duration. This is a very short time given the 3 hour 'in-situ' tests that were conducted" (ESSA Report, page 37). Once again, ESSA offers no scientific support for its position, nor any guidance as to a preferable approach. It appears that ESSA may have misunderstood the stated goals of the cage tests. The objectives of the cage and in situ tests were different. Cage tests were conducted to explore basic behavioral responses to different sounds. Based on prior experience, PSEG's fish hearing expert hypothesized that if the fish did not respond to the sound within the first few minutes of their detecting the sound, they probably were not going to respond at all, thereby supporting the use of this time period in all cage tests. In the in situ tests, the goal was to look for evidence of avoidance of the sound field that could occur as individuals or groups of individual fish passed by the intake over time (i.e., a dynamic process). Since fish in the open water environment could remain in the vicinity of the intake for periods of time longer than 15 minutes, the longer test period was deemed necessary to ensure that any avoidance of fish to the sound field was sustained for an extended length of time.

b. ESSA Report § 3.2.2.2: The 1998 Cage Tests

ESSA observes that the 1998 cage tests were "a noticeable improvement" over the 1994 tests, and "very thorough in data collection" (ESSA Report, page 38). PSEG concurs that the 1998 cage test were very thorough and well done. ESSA goes on to make a number of comments regarding the tests. As with the comments regarding the 1994 cage tests, ESSA fails to provide any scientific basis underlying, nor any guidance to rectify, these issues. ESSA's comments on the 1998 cage tests are addressed separately below.

(1) Size of Cage

Regarding the reduced size of the cage in the 1998 tests, ESSA states that

> . . . the size of the test cage was reduced from 3 feet x 3 feet x 12 feet in 1994 to a channel of only 1.3 feet x 2 feet x 11 feet. . . . Such constraints on movement stress the fish by restricting schooling behavior . . . . *The cage area for fish movement was reduced by 73%, from a volume of 108 ft^3 in 1994 to 28.6 ft^3.* With this sort of volume reduction (i.e., side restrictions of the cage), it would be very difficult to assess responses of large groupings of

> fish or school responses to sound. (ESSA Report, page 38, emphasis in original.)

PSEG responds to ESSA's general concerns about the size of the cage used in these types of tests in Section V.C.2.a(1) above. PSEG modified the size of the cage used in the 1998 tests to facilitate data collection on the observed response of fishes. ESSA's comment again seems to ignore the primary goal of these tests, which was to identify those sounds that could potentially be effective in repelling fish from the CWIS during any subsequent in situ tests. PSEG recognizes that artifacts associated with cage tests of any type may influence the outcome of the experiments, and it is precisely for this reason that the cage tests were followed up by in-situ testing at the site.

The cage used for the 1998 testing was modified primarily by decreasing the depth and width as necessary to support the installation and use of video camera recording that would allow quantification of the movements of fish, in contrast to the more qualitative analyses performed in 1994. The minor decrease in length is not considered to be any more restrictive than the conditions under which the 1994 tests were conducted, and observations during the 1998 cage tests do not suggest that the reduction in cage size influenced behavior as compared to the behavior recorded in the 1994 cage tests. While different species displayed different "normal" behavior (generally either slow milling from one end of the cage to the other or stationary positioning), the behavior observed within a species was consistent between different test groups in both years. PSEG concurs that a larger cage size may be necessary to test sound effects on larger schools of fish, but that was not the objective of PSEG's cage testing.

(2) Acclimation Period

ESSA states that:

> As in 1994, the acclimation period for fish prior to testing was only 2-3 days. Acclimation periods should perhaps be longer since fish were likely very stressed after being captured in the otter trawl. The acclimation period in the cage facility was also too short. As in 1994, as little as 30 minutes was allowed for acclimation to the test cages. This is probably too short, especially considering the small area in which the fish were confined. (ESSA Report, page 38.)

ESSA's comments regarding acclimation periods used in the sound studies are addressed in Section C.2.a(2) above. As noted in that section, there are a number of valid reasons for the holding periods used in the sound studies.

(3) Far-Field Effects

ESSA states that "[t]he design does not allow investigating any far-field effects (i.e., responses beyond 4 m)" (ESSA Report, page 38). However, ESSA notes that "this is only a minor point." (Id.) PSEG agrees that this is a minor point, and one that is fully addressed by the discussion of near- and far-field effects in Section C.2.a(4) above.

c. ESSA Report § 3.2.2.3: Additional Comments on 1994 and 1998 Cage Tests

In addition to the previous comments on the cage tests, ESSA also makes the following observations:

> Cage tests in both 1994 and 1998 appeared to involve only one type of signal for each test (e.g., low-frequency). There don't seem to be any cage test data on the responses of fish to different types of simultaneously transmitted sound (e.g., low and ultrasound transmitted simultaneously from different projectors). We believe that the 'in-situ' tests involved the use of different projectors emitting two types of sound. . . . It is not clear why this was not done for the cage tests. (ESSA Report, page 39.)

The objective of the cage tests was to identify individual signals to which individual species might respond. For the in situ tests, the objective was to assess the efficacy of deterring multiple species in a multi-species environment in the presence of ambient and plant operating background noise. Thus, the cage tests provide the information needed to select the most appropriate sound signals for the in situ tests. Also, ESSA appears to believe that the different sounds presented in the in situ tests were simultaneous. Instead, while PSEG did simultaneously present the very high (ultrasound) signals and the lower frequency signals, the various low frequency signals, including the fish sounds, were presented sequentially. Indeed, it is highly unlikely that the non-*Alosa* species even heard the ultrasound since their hearing range is no higher than 1 to 2 kHz at a maximum as demonstrated in the literature (e.g., Popper and Fay, 1999). In contrast, it is likely that the *Alosa* species would have responded to the ultrasound even with the presence of lower frequency signals since ultrasound appears to elicit a strong escape response in at least one species of *Alosa* (Mann et al. 1998; Popper, 2000). Thus, it is clear that the lack of response to the ultrasound in situ was certainly due to factors other than the sound per se.

3. ESSA Report § 3.2.3: In-Situ Test

Regarding the in situ sound study tests, ESSA makes two observations regarding the test protocol:

- The justification for conducting the "in-situ" tests is unclear since there were no consistent avoidance responses for several RIS species based on the cage test results.

- In many of the comparisons of control and experimental (with sound) data sets, sample size was inconsistent among species and may have played a role in the inconsistency of the results. This influences the relative importance of many of

> the statistical tests since in many instances, although the number of replicates may have been high, there were very small numbers of fish . . . . (ESSA Report, page 39.)

The cage tests were designed to "identify sounds that might elicit responses from the nine Salem finfish that would cause the fish to move away from the sound source" (Attachment G-7, page 6). PSEG was looking only for the basic behavioral response of each RIS to individual sounds. "These tests were followed by in situ tests to determine the actual effectiveness of the selected sounds for deterring fish from approaching the Salem CWIS" (Attachment G-7, page 6). During in situ testing, PSEG utilized signals considered to have the best potential for repelling the RIS (based on the cage test results) to determine whether projecting those signals at the CWIS would actually reduce the numbers of fish impinged. Specifically, along with two low frequency signals, PSEG tested high frequency signals to which the *Alosa* species had responded in the 1994 cage tests.

ESSA has raised some concerns regarding the sample size and number of fish observed during the in situ tests. PSEG's experimental protocol for the in situ test included consideration of historical impingement data in determination of the appropriate sample size and sample duration; however, organism abundance and impingement rates are variable and not within PSEG's control. PSEG's conclusions regarding results of the in situ tests reflect this variable as well as other uncontrollable factors that may influence the effectiveness of any sound deterrent system tested at the Station.

Regarding the impingement results of the in situ tests, ESSA states:

> Although total impingement is not reduced, there are many examples of statistical reductions for specific RIS fish (Appendix G-7, Table 2). However, the results are inconsistent; sometimes sound repels the species in the summer but has little effect on the same species in the fall, or the reverse. Furthermore, in the text there seems to be a focus on the statistical significance of results rather than the percent reductions; a statistical difference may occur but the percent reduction may not be very high. . . .We would like to see effectiveness approach 70% exclusion for some key target species. (ESSA Report, page 40.)

Naturally, PSEG also would have liked to achieve a 70% reduction or higher. However, PSEG questions whether a 70% effectiveness rate is relevant in the context of determining BTA under Section 316, and notes that ESSA provides no support for its suggestion. PSEG is very careful and thorough in the Application to point out possible problems with these studies and to provide rational and scientifically defensible potential reasons for the dramatic differences in the summer and fall test results. (Application Appendix G, Exhibit G-7, pages 38-40.)

In its discussion of the in situ tests, ESSA also raises the issue of possible fish residency in the forebay. ESSA notes that:

> During our December 9 visit to the Salem GS, we witnessed up to 5 fish in one small area of the screenwells orienting to flow, and not being impinged on the screens. If even half this number of fish remain in the current over a 3-hour period, and are counted in the next 3-hour sub-sampling period (impinged due to fatigue), they could seriously influence the results (next set of tests being either control or experimental). This is an extreme example but underscores the potential risks associated with using few fish per sample. This 'residency' problem would be minimized if the number of fish counted were higher, such as that for weakfish (Table 3.2). The question of fish residency in the forebay prior to being collected on the screens needs to be addressed. If residence occurs, counts for specific species such as bay anchovy could be seriously influenced. A longer time period for conducting these tests would minimize the impact of this error. (ESSA Report, page 42.)

PSEG considered the "residency" issue in developing the experimental protocol employed during the in situ tests. This is but one of many parameters that could potentially influence the ability to detect reductions in impingement numbers attributable to the sound system. The protocol used was developed by a statistician with 30 years of experience in analyzing impingement data from CWS impingement studies and 20 years of analyzing Salem data. The protocol was designed to maximize the number of replicates conducted within the time that each species occurs in sufficient numbers at the Station to provide statistically meaningful results. Longer test and control durations may or may not have resulted in the collection of greater numbers of fish, but certainly would have reduced the number of replicates and the power of the analyses conducted. Further, PSEG specifically addressed the concern for short-term residency (one hour) by collecting impingement samples at the end of each one-hour sub-sampling period. This insured that the sound system had been activated or deactivated for at least 45 minutes before a sample was collected.

4. ESSA Report § 3.2.4: Snap Shot Summary of Sound Studies

This section of the ESSA Report summarizes the issues outlined in the preceding sections of the ESSA Report. Those issues are addressed in the comments above.

5. ESSA Report § 3.2.5: Sound Impact on Larval Survival

ESSA finds that the results of PSEG's larval survival study "are encouraging," but notes several concerns, including:

- More replicates and better controls are required to make the results of this study more meaningful. The coefficient of variation for these data (which is a reflection of variability in the samples) is quite high, ranging from 28% in one of the experimental tests to as high as 41% in the controls. Test results would be more reliable if this variation could be reduced to 20% or less.

- In general, since control mortality exceeded 40% (mean, G-7-2 Table 22), work should be repeated for at least some of the sound frequencies. Furthermore, one of the experimental tests had lower mortality than the controls (over 10% lower). Typically, if control mortality exceeds 20%, the results should be considered suspect. (ESSA Report, page 44, emphasis omitted.)

PSEG agrees that the study results are encouraging, and notes that the Application considered many of the concerns raised by ESSA. (See Application Appendix G, Exhibits G-7 and G-7-2.) As stated in the Application:

> Since the sound levels used in the mortality study were considerably higher than ultimately used in the in situ tests at the CWIS, the lack of obvious damage to the postlarvae in this screening study suggests that the CWIS sound levels are not likely to have had a deleterious effect. Clearly, it is necessary to be cautious in extrapolating to other species. However, since the sound levels at the CWIS are so much lower than in mortality experiments, it is logical to believe that the lack of effects in the experiments at high sound levels indicate that there will be few, if any, effects at lower sound levels to other species' postlarvae. While this study was not comprehensive, the results of the study and an examination of the literature suggest that additional study is not warranted. (Application Appendix G, Exhibit G-7, page 31.)
>
> This study showed no damage to the organisms. While this study had limitations, the preliminary evidence does not warrant further study. Because the levels used in the in situ tests are lower than those investigated in the preliminary tests, there is even less likelihood of damage under conditions of the tests. Studies by other investigators (Banner and Hyatt 1973), albeit few in number, support this observation. (Application Appendix G, Exhibit G-7, page 32.)

The Application thus recognizes concerns similar to those raised by ESSA, but nonetheless finds further study unwarranted.

D. ESSA Report § 3.3: Biological Modeling of Fish Protection Alternatives — Mortality Estimates of Different Technologies/Approaches

ESSA observes that:

> for many of the technologies investigated, there is limited information on the biological effectiveness of each system with respect to the RIS at Salem GS. Furthermore, many of the study results are lab-based, and their applicability in the field for specific target species is uncertain. (ESSA Report, page 44.)

The Application presents ranges of mortality associated with three technologies (fine-mesh screens, modular inclined screens and air/strobe light hybrid). The ranges are derived from values obtained in journal articles, technology workshop proceedings, utility reports and other sources of gray literature. For each technology, the available data were reviewed and a "best estimate" of potential effectiveness was derived. The best estimate is based on results from other sites at which effectiveness evaluations were performed. In most cases, a range of effectiveness values was available for a given species/life stage and technology as a result of evaluations at more than one site. For some species and life stages, there was little data available on which to base a range of estimated mortality. In such cases, data available from closely-related species (i.e., those in the same family with similar morphologies) were included to make the data more robust. In some cases, where sample size or study design was questionable, professional judgment was required to determine the most appropriate data to use for estimating effectiveness.

ESSA states that PSEG "appears to have used 'mean' mortality reductions for their parameter inputs . . . PSE&G's calculations should be revised to consider the ranges of mortality losses, not just the means" (ESSA Report, page 44). In actuality, PSEG uses the mid-point (not the mean) of effectiveness ranges only for three of the technologies that were evaluated in detail (fine-mesh screens, modular inclined screens and air/strobe light hybrid). For the remaining flow reduction alternatives (closed-cycle cooling, variable speed pumps and revised outages), the actual reductions in flow are used to calculate benefits.

ESSA does not question the validity of the values included in the Application on the effectiveness of the various fish protection alternatives, but recommends that the calculations of fish protection should be revised to consider the ranges of biological effectiveness, calculations which ESSA believes "would allow a more realistic and meaningful comparison of alternative fish protection technologies" (ESSA Report, page 44).

Providing the additional calculations recommended by ESSA would not provide "a more realistic and meaningful" analysis, as ESSA suggests. As stated above, these ranges are only relevant for three of the fish protection alternatives. Moreover, ranges are only provided for some species and some life stages for the three alternatives.

But the more important reason for not calculating the values that ESSA recommends is that they would provide a very partial and *ad hoc* treatment of uncertainty. Indeed, as discussed below in Section VI.C.2.a(2), a study cited by ESSA argues against just such an *ad hoc* approach to uncertainty. The study criticizes efforts to develop a set of "low," "middle," and "high" values that is not based upon some knowledge of the underlying probabilities of the possible values. In fact, the approach recommended by ESSA is even more partial and limited than the approach criticized in the study cited by ESSA. At least in the approach criticized in the study, some attempt is made to determine values for all factors of the analysis. The ranges in biological effectiveness of the three control technologies represent just one factor affecting the overall costs and benefits of fish protection alternatives. As discussed below in Section VI.C.2.a(2), there is inadequate information to quantify probability distributions for the many variables affecting the cost and benefit estimates. In the case of the biological effectiveness, the mid-point of the range of plausible values provides a good estimate of the expected level of effectiveness; but there is no information on the full distribution. An analysis based upon the high and low values from the range of reported values for this one factor may be very misleading, ignoring information on the likeliness of these high and low values as well as on all of the other factors that would influence the cost-benefit assessments. Therefore, such *ad hoc* calculations would not provide "a more realistic and meaningful comparison," as ESSA states. PSEG notes that ESSA does not indicate how such calculations would be used in the assessments and what "realistic" or "meaningful" comparisons they would provide.

E. ESSA Report § 3.4: Fish Protection Alternatives

With regard to the Application's approach to evaluating technology alternatives, ESSA finds that "the section in the Permit Application on Fish Protection Alternatives was quite well done" (ESSA Report, page 45). PSEG agrees; the Company believes that the methodology used for evaluating the various fish protection measures is fully consistent with applicable regulatory guidance and legal precedent, and provides a thorough and appropriate analysis of the various alternatives. ESSA notes, however, that "it is difficult to compare and rank the efficacy of alternative technologies since the data vary with species, location, and type of test (laboratory vs. field)" (id.). This issue is discussed in Section V.D above.

The process that PSEG used in performing its evaluation of alternative fish protection measures is presented in the Application Appendix F, Section VIII. The process provides a cohesive, logical approach for identifying from the large suite of available technologies and other protection measures those that are most likely to minimize the potential for adverse environmental impact at Salem. The information presented in Attachment F-3 of the Application provides sufficient detail on alternative technologies to support PSEG's decisions on which technologies to carry forward into the detailed review process.

Regarding the particular technologies evaluated for Salem, ESSA states:

> Like other behavioral systems such as sound (as tested at Salem), there is a species-specific response, and a strobe light / air bubble system will not work for all 11 RIS at Salem (neither will sound alone). There is evidence, however, that this system will work for several species found at Salem. However, its use as a sole deterrent system at Salem would be limited. To be considered at Salem GS, a strobe light / air bubble system must be used with other technologies as part of a hybrid system . . . . ESSA recommends that an integrated system approach be considered as opposed to a single system approach . . . . ESSA recommends that NJDEP require PSE&G to investigate and/or study a hybrid alternative (beyond a strobe light / air bubble combination . . . . An option should consider an integrated system with all its components . . . . (ESSA Report, pages 45-46.)

These findings and recommendations are addressed in the following section.

1. ESSA Report § 3.4.1: Improved Fish Defense System for Consideration at Salem GS

ESSA states that:

> An improved 'fish defense system' using multi-sensory or hybrid technologies is recommended for further study at Salem GS. This recommendation is based on the observation that sound alone has shown limited success as a deterrent at Salem (the notable exception being ultrasound based in the 1994 cage tests, and external literature). Other systems should be integrated with sound to better reduce fish impingement. Initially, this integration should focus on behavioral systems since these are less costly and easier to implement than physical systems. (ESSA Report, page 46.)

Pursuant to these findings, ESSA recommends "[t]hree avenues of study" in order to "explore and evaluate improvements to Salem's fish defense system" (ESSA Report, page 46). The recommended study avenues involve a multi-sensory system, jetties, and the fish return system (ESSA Report, pages 47-49). The fish return system is discussed in Section B.4 above. The multi-sensory system and jetty recommendations are discussed below.

a. Multi-Sensory System

ESSA proposes a multi-sensory system of technologies to reduce total impingement. ESSA finds it "probable" that individual technologies, such as sound and strobe lights, are inadequate for protecting the large number of species at Salem (ESSA Report, page 46). Similarly, ESSA states that due to the large number of species involved at Salem, "the likelihood that a single behavioral system, such as sound or strobe lights, will be effective for all species is very very low. . ." (id., page 47). PSEG concurs; these statements are consistent with PSEG's findings as presented in the Application. However, ESSA recommends that "[f]urther studies involving strobe lights (with or without air bubbles) combined with sound should be considered as part of the solution at Salem GS" (ESSA Report, page 47).

Furthermore, ESSA recommends that a "second line of defense" involving mercury lights (associated with a "flume" or "fish pump") be tested along with the strobe light/air bubble curtain and sound technologies evaluated in detail in the Application by PSEG. ESSA states that

> the objective of such a system at Salem would be to lure fish, particularly the alosids and bay anchovy, towards a fish bypass before they are contained on the screens (survival of these species on the Ristroph is likely poorer than for the more robust species). These lights should be positioned between the screenwells and the Ristroph screens in such a way as to only influence fish behavior in the immediate vicinity (i.e., not to attract fish from the river; see Van Anholt *et al.* 1998). The infrastructure for such a system may already be in place at Salem . . . . (ESSA Report, page 47.)

ESSA's proposed multi-sensory system is addressed in the following discussion based on the appropriate criteria for evaluating intake technologies: potential biological effectiveness and engineering practicability.

(1) Potential Biological Effectiveness

The idea of multi-sensory stimulation is not new. In fact, PSEG proposed a strobe light/air bubble curtain in the Application and performed a detailed evaluation of this hybrid technology (Application Appendix F, Section VIII, page 2). Strobe lights have been shown to be effective in repelling certain species, including American shad, alewife, blueback herring, white perch, and spot (Application Appendix F, Attachment F-3, page 6). Studies on the Hudson River and recent studies in the Midwest indicate that a combination of strobe lights and air bubble curtains may be more effective than each device alone. In the Midwest studies, passage of bullhead and shiner species into a hydroelectric facility was reduced from control levels by 43 percent and 81 percent when the air bubble curtain was operated alone and in combination with strobe lights, respectively (McCauley et al. 1996). In the Hudson River studies, the strobe/air combination was the most effective behavioral barrier tested, resulting in an overall Effectiveness Index of 61.8 percent (EPRI 1994; Matousek et al. 1988).

Strobe light technology for repelling fish has advanced substantially in the last decade (Brown 1997). For example, waterproof enclosures now exist that are watertight to great depth, computer controlled systems are available for actuating the lights when fish are detected, and light intensities and flashtube life have been increased. Based on the results of the studies cited above, as well as those conducted by others (McIninch and Hocutt 1987; Patrick et al. 1988; Ichthyological Associates 1997), PSEG believes that strobes combined with an air bubble curtain offer a reasonable potential for reducing fish losses at the Station. ESSA agrees that strobe lights with or without air bubbles "should be considered as part of the solution at Salem GS" and further states that sound as an additional component to a sensory system could improve overall system effectiveness (ESSA Report, page 47).

As noted above, ESSA then proposes the use of a "second line of defense" system using light attraction technologies in association with a fish return system. Two references are cited in support of the concept of using light attraction. Both are limited in their application to Salem. Haymes et al. (1984) present results of both laboratory and field studies conducted to evaluate the potential for using mercury vapor lights to attract fish into a fish pump and return system. Laboratory studies conducted with alewife indicated that this species was significantly attracted to areas lit by filtered mercury light. Such results led the researchers to conduct a prototype field study at the Nanticoke Generating Station CWIS on Lake Erie. During the study, alewife, smelt and gizzard shad were attracted to the mercury vapor lights, but the extent of attraction "varied with the lighting array employed, ambient light (day/night) and turbidity" (Haymes et al. 1984). Under conditions where fish could perceive a trash rack located upstream of the fish pump suction (daylight and artificial light, particularly at low turbidity levels), fish tended to accumulate in front of the rack. This behavior reduced the potential for fish to enter the pump. Under night time and no light conditions, particularly at higher turbidity levels, fish passed more readily through the racks. In any case, the actual increase in numbers of fish entering the pump could not be accurately determined. The authors concluded that it "would be reasonable to assume, however, that if large numbers of fish could be concentrated in the area of an extractor (fish pump in this case) the effectiveness of the extractor would be increased" (Haymes et al. 1984). This conclusion appears to be highly speculative in light of the absence of actual data on the numbers of fish passed under test and control conditions. Further, other than the alewife, the species evaluated are not of concern at Salem. Since sound and air bubbles/strobe lights have already been evaluated for possible application to repel fish at Salem, it would appear that the addition of an attraction system for this species would represent unnecessary redundancy with little potential to reduce losses. Finally, it would appear that turbidity levels at Nanticoke are relatively low compared to Salem. Concerns over attracting some species and thereby increasing impingement levels, coupled with high turbidity levels, are among the primary reasons why mercury lights were excluded from detailed evaluation at Salem.

The second reference used by ESSA in support of the use of mercury lights as an attractant (Sager et al. 1985) lends little weight to its argument. This study was conducted in the laboratory with menhaden to examine specific wavelengths in the visible spectrum that appeared to preferentially attract this single species. While a preference for the 460-540 nm range was noted, the application of these results to the potential for protecting the RIS at Salem is uncertain.

As further support for the concept of using mercury lights to improve attraction into pumps, ESSA cites a publication by Rogers and Patrick (1985). The studies presented were conducted with alewife and rainbow smelt in the clear water of a laboratory test tank. The pump capture efficiency was shown to increase significantly when the mercury vapor light located over the pump suction was illuminated. However, behavioral responses obtained under laboratory conditions would not be expected to reflect what would be obtained at the Station in the presence of, among other things, lower water clarity, currents and debris. Smelt are not present at Salem. There have been no studies conducted with full-scale light/pump systems for the RIS at Salem.

A system similar to the one suggested by ESSA was tried at Southern California Edison Company's (SCE) San Onofre Nuclear Generating Station (SONGS) on the Pacific Ocean in California. SONGS has a system of guiding vanes and louvers that divert fish away from the traveling water screens and into a collection area. From the collection area, fish are lifted in a basket and discharged into a return trough. Studies of the fish return system have demonstrated that it is highly effective; on average, 80 percent of the fish entering the intake system are returned alive to the ocean.

In 1999, SCE conducted a study to determine whether the addition of mercury light to the existing fish return system (FRS) would enhance guidance of fish along the louvers and into the bypass (California Coastal Commission [CCC] 2000). Results of the one-year study "showed no evidence that using lights in the cooling water systems of Units 2 and 3 would reduce fish impingement losses." The CCC and SCE scientists involved with the study concluded that low levels of light "might have caused fish to linger and avoid being directed to the FRS" (CCC 2000).

(2) Engineering Practicability

Given existing space limitations in and around the screenhouse, a detailed engineering study would be required to determine whether an attraction light/pumping system could be practicably installed. With the existing layout it would be necessary to install individual lights and submersible pumps and associated piping (or pump suctions connected via pipes to deck-mounted pumps) in each screen bay. The pumped flow would be conveyed to a common collection and transport trough or pipe that would run the entire length of the screenhouse. The trough or pipe would be designed for two-directional flow to allow fish to be returned into the prevailing river flow. The trough or pipe flow could then be diverted in the appropriate direction at each change in tide (as with the existing screen system). It is unclear whether such a pumping system could be practicably installed at Salem.

ESSA suggests that the "infrastructure" for bypassing fish within the screenwells "may already be in place at Salem" (ESSA Report, page 47). This issue is addressed specifically in Section 2.1.3.5 of the ESSA Report where fish "escape routes" are discussed. It is suggested that "[t]hese escape routes could be made more attractive to fish if flow is induced in them" (ESSA Report, page 21). ESSA's discussions of providing a gradient across the intake from the center outwards or adjusting the headlosses in the bays to create a "parallel velocity component" (id.) demonstrate a lack of understanding of hydraulic principles. As long as the CW pumps are in operation, the majority of the flow entering the intake will pass straight through the screens and into the pumps. It might be technically possible to create a head differential across bays by installing headloss devices in each bay in such a way that water would be induced to move through the 2-foot wide "fish escapes." However, the movement of water would be confined to the area within the 9-foot lateral expanse of the openings. It is a physical impossibility to induce a current parallel to the screen face as long as the CW pumps are operating since flow streamlines cannot cross each other. With the predominant flow into the screens, any small amount of flow exiting the fish escapes would be immediately captured by the CW pump flow and redirected into that flow in the downstream direction. It is highly unlikely (if not impossible) that the existing escape routes could be made to function in the manner suggested.

Alternatively, an active pump system could be installed within the existing "fish escape" openings between the individual screen bays similar to that proposed by ESSA and discussed above. In this way, fish that enter the fish escape openings might be pumped out of the screenwell area. However, it is unlikely that it would be possible to create favorable (i.e., uniform) flow conditions into such bypasses that fish would readily follow should they be able to find them. Further, as stated previously, the feasibility of installing a pump and piping system within the confines of the existing Salem intake is questionable.

In order to implement the proposed repulsion versus attraction studies, ESSA "recommend[s] that all the above tests be done at the cage site . . . rather than as 'in-situ' tests; in-situ tests would be more costly and data would be more difficult to interpret" (ESSA Report, page 48). ESSA recommends that the proposed studies be conducted at the offshore location used in previous Salem sound studies using an "extended cage facility" (ESSA Report, page 48). However, ESSA does not indicate what the scientific basis for that design might be or what the cage might look like. Given the severe tidal and wind conditions that exist at this proposed location, testing of an "extended cage facility," which is assumed to mean "larger," may not be practical. As stated previously, it was extremely difficult to maintain the 1994 and 1998 test cages in position for testing.

(3) Conclusion

PSEG continues to believe that the strobe light/air bubble curtain subjected to detailed evaluation in the Application has the best potential for reducing fish losses when combined with the existing Ristroph screens and possibly sound. For reasons discussed previously, PSEG does not believe that the addition of attraction light technologies to the hybrid mix would reduce losses further, particularly from a cost/benefit viewpoint. Further, as discussed previously, it is unlikely that an attraction light/pumping combination would be practicable from an engineering perspective or biologically effective at Salem. In any case, PSEG believes that the appropriate methodology for evaluating the multi-sensory alternative would be first to conduct controlled laboratory studies, then to perform a cost-benefit analysis, and finally to undertake field studies.

As a final matter, ESSA provides a target of a 70% reduction in fish loss for a technology to be determined effective. The questionable relevance of the 70% effectiveness rate is discussed above in Section V.C.3. Moreover, ESSA provides no support that its proposed "fish defense system" would approach this level of protection.[1]

b. Jetties

ESSA proposes the addition of jetties to the Salem intake as a means of potentially reducing entrainment and impingement. ESSA makes several suggestions regarding jetties:

- jetties may "[r]educe fish movement into the station by deflecting them back along the river rather than shore migration, possibly reducing impingement . . . "
- if entrainment near the Station is greater than offshore, "then an extended jetty may have potential for reducing station entrainment . . . "
- jetties may "[a]llow simple diversion technologies to be integrated into the system at the end of the jetty where flows may be reduced."
- jetties may "[a]llow the integration of simple behavioral systems at the intake screens to work in concert with the modified Ristroph system . . . " (ESSA Report, page 48.)

[1] PSEG notes that ESSA also states in Section 3.4.1 that "if behavioral systems fail to significantly reduce impingement, then the more costly alternatives would need to be considered (Section 3.4.2)" (ESSA Report, page 46). This statement is addressed below in the response to Section 3.4.2.

The potential biological effectiveness of a jetty at Salem is predicated on the assumption that the water close to the riverbank has higher concentrations of fish eggs, larvae, and juveniles than waters further offshore. Existence of such a density gradient would suggest that withdrawal of water for cooling water purposes from farther offshore (i.e., lower density) would reduce the entrainment rate of such organisms.

In order to consider the possibility that jetties might actually reduce impingement and entrainment at Salem, PSEG reviewed the results of previous efforts in which the Company considered whether jetties would reduce sedimentation at the intake. Although the previous efforts were not directed at evaluating the possibility that jetties could provide a potential means for reducing impingement or entrainment, the information previously collected is still useful for the current analysis.

These previous efforts examined the effects that jetties would have on existing hydrodynamic processes. If such a river control structure were built along the shore to block river water from moving along the shore past the Station, this water would be directed offshore, where it would then be directed toward the intake from the end of the structure. Therefore, the Station intake would draw primarily the same water into the Station cooling system as it presently does, only that water would travel around the jetties to get to the intake.

Furthermore, with regard to density gradients, available site-specific data indicate that ichthyoplankton densities are highly variable in time and space. Ichthyoplankton densities may be higher or lower near the shore compared to the main river channel depending on fish species, life stage, time of year and time of day. Therefore, available data do not show a persistent and uniform gradient of fish eggs, larvae, and juveniles near the estuary shoreline, but rather a highly variable pattern. This finding is not unexpected since, in narrow and shallow, rapidly flowing estuaries such as the Delaware estuary, mixing is intense, and such gradients do not persist.

Finally, it is important to note the possibility that installation of jetties could, in fact, attract fish. Further, impingeable fish moving along shore could be directed offshore, but if actively following the shoreline may swim around the jetties, and back to the vicinity of the intake structure. In either case, fish attracted to the jetties would be exposed to the CWIS for longer periods of time.

PSEG's examination of operational issues that would be expected to arise from the use of jetties indicates the following:

- Jetties would cause a local accumulation of sediment adjacent to (outside) the structures, possibly clogging the Service Water Intake for Salem. Such sedimentation would increase the cost and risks of dredging to maintain the intake basin to depths allowing passage of sufficient volumes of cooling water to the Station.

- A structure on the upriver side of the intake would interfere with the discharge of the once-through cooling water, probably re-entraining the discharged water during the ebb tidal phase, thereby increasing entrainment losses and certainly reducing the effectiveness of the intake water to cool the Station.

- Environmental permitting of such structures would be difficult for the above reasons.

- A jetty would have to be constructed on top of the circulating water system discharge tunnels. These existing tunnels were not designed to support the weight of a jetty.

As quoted above, ESSA suggests that jetties might allow the integration of behavioral systems and diversion technologies. ESSA's comments regarding integrated behavioral systems are addressed by the discussion in Section V.E.1.a above. With regard to integrating "simple" diversion technologies at the end of a jetty, PSEG firmly believes, for all of the reasons outlined previously, that incorporating such technologies at a facility the size of Salem is far from simple.

In summary, a review of available information does not support the concept of a density gradient of fish eggs, larvae, and juvenile fish in the near-shore area. Even if such a gradient did exist, the hydrodynamic processes of the estuary are such that the installation of jetties at the Station would merely direct near-shore waters to the new point of withdrawal further offshore. Finally, potentially serious operational issues would arise relative to sedimentation, recirculation of the thermal discharge (with associated increases in organism recirculation and power penalties) and impacts of the jetties on structural integrity of the cooling water discharge tunnels. In the absence of any clear environmental benefits resulting from the installation of jetties, there appears to be no justification for PSEG to consider the jetty concept further, particularly in light of their anticipated high installation costs.

2. ESSA Report § 3.4.2: Further Options for Fish Protection

ESSA states that the intent of its recommendations regarding fish protection is "to reduce fish impingement, without incurring costs that are wholly disproportionate to the benefits" (ESSA Report, page 49). PSEG fully agrees with this goal. ESSA also states that "[i]f test results show no significant decreases in impingement losses and mortality rates with these proposed options, then more costly alternatives may have to be considered, e.g., flow reduction options, or revising the timing of the station's re-fueling outages." (Id.) In fact, these options already were considered in PSEG's Application, and their costs were determined to be wholly disproportionate to their benefits. PSEG thus believes, consistent with ESSA's stated standard for evaluating additional fish protection options, that these options are not BTA for Salem.

VI. RESPONSE TO ESSA'S SECTION 4: COST-BENEFIT ANALYSIS

Section 4 of the ESSA Report provides a review of the cost-benefit analysis in the Application. After careful review of ESSA's comments, PSEG concludes that the ESSA recommendations for additional documentation and analyses are not justified because they would not add to an understanding of the likely costs and benefits of fish protection alternatives at Salem. PSEG also concludes that the ESSA critique does not fundamentally challenge, or even take issue with, the data, methods and conclusions of the PSEG Salem cost-benefit assessment.

The organization of this response is based on the organization of comments provided by ESSA in their review. The first section addresses the summary and recommendations. The second section addresses concerns regarding the economic costs of fish protection alternatives. The third section addresses concerns regarding the economic benefits of fish protection alternatives.

A. ESSA Report: Summary and Recommendations

Section 4 of the ESSA Report begins with an overview of ESSA's review of the cost-benefit analysis in the Salem Application. The ESSA review includes several recommendations that the existing cost-benefit analysis be supplemented by "more complete information," and that additional analyses be undertaken if the documentation does not support the approach taken in the cost-benefit analysis. Many of ESSA's specific recommendations reflect the "primary" ESSA recommendation summarized in the ESSA Report's Executive Summary:

> The primary recommendation is that the methods, assumptions and justification of assumptions used in the analysis be more fully explained and documented to improve comprehension of what was done. (ESSA Report, page viii.)

PSEG concludes that the ESSA recommendations for additional documentation and analyses are not justified and would not add to an understanding of the likely costs and benefits of fish protection alternatives at Salem. The major bases for this conclusion are the following:

- Although the ESSA Report is dated June 14, 2000, there is no evidence that the authors took into account their extensive discussions with PSEG and its consultants before that date regarding the procedures that were used in the cost-benefit analysis. ESSA has not incorporated any of the detailed written comments that were provided by PSEG prior to June 14, 2000. Written comments addressing initial ESSA issues were provided in the May 2000 Report filed with NJDEP on May 17, 2000. The written comments followed two in-person meetings and several conference calls to explain the methods used in the cost-benefit analysis. Virtually all of the comments in the ESSA critique were addressed in these extensive discussions and documentation. In the case of ESSA's most relevant concern — that the costs and benefits represent private rather than social costs — PSEG and its consultants provided extensive discussion and explanation of the calculation of the actual social costs at in-person meetings, during conference calls, and in the May 2000 Report.

- Most of the critiques, particularly of the benefits analysis, having an "academic" flavor, are not specifically linked to actual applied cost-benefit assessments or to guidelines that have been developed by the USEPA or other agencies for such assessments. The extensive list of references provided at the end of the ESSA Report cost-benefit review section, for example, includes virtually no references to USEPA guidelines or actual cost-benefit analyses for Section 316(b) studies.

- The ESSA Report makes little effort to weigh the significance of its various comments, particularly those in the benefit section. To its credit, in the case of costs, ESSA does suggest that its concerns would not affect the overall conclusions of the cost-benefit assessment (ESSA Report, page 52). No such useful perspective is found in the benefit assessment.

- The cost-benefit study in the Application includes extensive documentation of the objectives of the evaluation, the data and methods used, and the results and conclusions reached after performing the analyses. This documentation was supplemented by materials given to NJDEP and ESSA after the Application was submitted. Section IX, which was 45 pages long (including 8 tables and 19 figures), was accompanied by over 110 pages of appendices that provided background information and detailed descriptions of the data and methodologies used.

- In some cases, ESSA appears to have overlooked available explanations of the methodologies. For example, in the Summary of Concerns, ESSA notes that "[i]t is unclear what criteria were used in [the] selection process" to choose recreational demand studies (ESSA Report, page 67). The selection criteria are clearly outlined in the Application (See Application Appendix F, Attachment F-14).

- Some of the statements in the ESSA cost-benefit section are not well supported by specifics, and thus it is not possible to respond directly. For example, ESSA's comment that the documentation and written explanations are "inconsistent in some areas" (ESSA Report, page 52) is not explained when it is stated and does not appear to be supported elsewhere in the section.

- ESSA provides no evidence that any of its comments would affect the conclusion that the costs of additional fish protection at Salem far exceed the fish protection benefits.

In sum, the additional documentation or analyses recommended by ESSA would not add to an understanding of the likely costs and benefits of fish protection alternatives at Salem. Such documentation would not affect the overall conclusion of the Salem cost-benefit analysis, that the costs of additional fish protection alternatives greatly exceed the benefits realized if those alterations were to be installed.

The following two subsections provide brief discussions of ESSA's comments or recommendations in the overview section. Following ESSA's organization, the first subsection addresses issues raised with respect to the costs of fish protection. The second subsection addresses issues raised with respect to the benefits of fish protection.

1. Costs of Fish Protection

ESSA's summary raises the following issues with respect to estimates of the costs of fish protection in PSEG's Application:

- *Power costs.* ESSA states that "[t]he costs from lost power revenues may be overstated because it appears that the power system's ability to adjust to gradual changes in generating capacity was not considered in the analysis" (ESSA Report, page 52). The power costs in PSEG's Application are not overstated. In fact, empirical analyses provided in supplemental materials indicate that actual marginal costs (as reflected in observed market prices) are higher than the cost estimates used in the PSEG Application (PSEG July 2000; see Attachment II.A to these Comments). Thus, energy costs are not overstated. This supplemental analysis used a revised methodology for estimating energy costs that better reflects actual market conditions and addresses any concerns regarding system adjustments. Section B.1 below provides further discussion of this issue.

- *Cost estimates.* The ESSA Report states that "[c]osts were estimated from the perspective of the power utility, using the appropriate discount rate and power costs for that purpose" (ESSA Report, page 52). Materials in the Application and the May 2000 Report make it clear that the costs and benefits in the Salem cost-benefit assessment are measured from a societal perspective, not an individual or firm perspective. Sections B.6 and C.2.a below further discuss this issue, providing a detailed discussion of the estimation of power costs. ESSA recommends that "[a]ssumptions and methods used for cost estimates should be more carefully documented, and recalculations made where necessary, to assure that costs are estimated for the societal, and not the firm, level." (ESSA Report, page 53.) As described throughout this section of the PSEG Response, PSEG's Application and supplemental materials provide detailed information on data and methodologies used in estimating the social costs of fish protection. No further documentation or analyses are necessary or useful.

- *Discount rate.* The ESSA Report suggests that PSEG's Application should have used "higher social discount rate that reflects the consumers' costs of borrowing" (ESSA Report, page 52). The discount rates used in PSEG's Application are consistent with USEPA and Office of Management and Budget ("OMB") guidelines. ESSA's proposal to use higher discount rates would increase cost-benefit ratios, since up-front capital costs would be weighted more heavily compared to benefits, which are roughly constant over time. Section B.6.c below discusses these issues in further detail.

- *Least cost systems*. ESSA proposes that "optimized systems" that combine alternatives should have been examined, although ESSA concedes that "it is unlikely that the costs of an optimized package of the alternatives examined in the [a]pplication could be reduced by the factor of four or five which would be necessary to achieve a benefit/cost ratio greater than one from the perspective of society" (ESSA Report, page 52). As explained in Section B.5 of this response, combinations of alternatives likely would not be more beneficial from a cost-benefit perspective. Costs generally would be the sum of the individual costs, while benefits generally would be less than the sum of benefits; thus, net benefits would be lower for combined alternatives than for any individual alternative. Thus, ESSA's claim that a "package" of alternatives would reduce the cost-benefit ratio does not appear to be supported by available information. ESSA is correct, however, both in its judgment that fish protection alternatives with cost-benefit ratios greater than one would not be justified from a social perspective, and in its overall determination that combinations of alternatives would not affect the general conclusion in the Application that none of the alternatives is justified from a social cost-benefit perspective.

2. Benefits of Fish Protection

ESSA's summary and recommendations raise the following concerns with respect to estimates of the benefits of fish protection in PSEG's Application:

- *Documentation*. ESSA states that "documentation and written explanations are incomplete, inconsistent in some areas, and generally do not provide a clear description of methods, methodology, procedures and assumptions used" (ESSA Report, page 52). ESSA notes that documentation should be "sufficient to provide clients with enough confidence in the results to be able to support their use in a public policy context, and sufficient to allow for a thorough third party review of methods, data and assumptions" (ESSA Report, page 52). The ESSA Report states that the documentation is "insufficient for these purposes" (ESSA Report, page 52) and ESSA recommends that NJDEP "[i]nvite the authors of the CBA to provide more complete documentation to support assumptions made and to describe the implications of assumptions in the context of the policy decision" (ESSA Report, page 53). As summarized above in Section VI.A. and discussed in detail below in Sections VI.C.2.a.(3) and VI.C.6.a, the Application includes extensive documentation of the methods, methodology, procedures and assumptions used to develop estimates of the costs and benefits of fish protection alternatives. None of the few specific concerns about documentation included in the ESSA Report are justified. Indeed, as detailed in Section VI.C.6.a below, one of ESSA's "examples" of lack of clarity in the Application is contradicted by another section in the ESSA Report showing that the criteria used was in fact clear to ESSA. No additional documentation for the cost-benefit analysis is warranted.

- *Treatment of uncertainty.* The ESSA Report states that "[t]he analysis characterizes the point estimates of net benefits and cost-benefit ratios as deterministic. There is no acknowledgement or discussion of inherent uncertainty regarding biological and technical data used... nor of uncertainty introduced by the economic methods and data used." (ESSA Report, page 52.) As discussed in Section C.2.a below, PSEG's Application addresses uncertainty through sensitivity analyses of alternate discount rates and qualitative evaluation of factors and cost-benefit categories not considered in the analysis. ESSA's recommendation for further discussion of "sources and effects of uncertainty" is not warranted.

- *Non-fishing benefits*. ESSA states that the assumption that there are no non-fishing related environmental benefits is "not explicitly discussed, or justified." (ESSA Report, page 52.) As discussed in Section C.4.b below, the Application and supplemental materials provide a thorough discussion of the benefits categories considered in the cost-benefit analysis. Commercial and recreational fishing benefit categories are appropriate benefits categories at Salem; non-fishing benefits are not relevant at Salem since the health of the estuary ecosystem is not in jeopardy.

- *Benefits from Additional Fishing Days*. The ESSA Report states that the evaluation of recreational benefits assumes "that the increase in fish biomass would not result in additional fishing days" (ESSA Report, page 52). To the contrary, the estimated recreational fishing gains from fish protection include both increases in catch per trip and increases in the number of trips, although the results do not disaggregate these two categories. Section C.4.c. below addresses this issue. ESSA recommends that if this "omission" in not sufficiently justified, "the analysis should incorporate this into the benefits estimates." (ESSA Report, page 53.) Since the benefit of additional fishing days is included in the recreational benefits estimates, no further analysis is necessary.

- *Projections of Recreational Values*. The ESSA Report states that "[t]he analysis implicitly presumes that demand will be constant over the appropriate time horizon, but this is neither explicitly stated nor justified." (ESSA Report, page 52-53.) PSEG's Application assumes that recreational values remain constant in real terms (i.e., constant after adjusting for inflation) over the period of analysis. As discussed in Section C.4.a below, this assumption is reasonable. No further analysis is justified.

B. ESSA Report § 4.1: Economic Costs of Fish Protection Measures

This section responds to the various comments related to costs in Section 4.1 of the ESSA Report.

1. ESSA Report § 4.1.1: Costs of Reduced or Revised Generation

The ESSA Report states that:

> The analysis should fully consider how the regional system, with revised maintenance schedules, new stations, imports and exports, and load responses to changes in power prices might adjust in the long term to predictable changes in output from Salem. . . . The difference between the two computer runs probably suggests the loss of revenue to the utility, but it probably overstates the long run electricity costs seen by consumers in the PJM system. (ESSA Report, page 54.)

The costs from lost power are not overstated. The costs due to lost power from fish protection alternatives contained in the Application are estimated using results of a production cost model, PROMOD. The PROMOD model is a highly detailed representation of the PJM generation and transmission system. The model runs utilized in the PSEG Application are based on PROMOD runs used in PSEG's 1997 Energy Master Plan, which underwent substantial regulatory review.[1] The model has been used in a wide variety of contexts, as suggested by supplemental material provided to NJDEP and ESSA on January 11, 2000 (PSEG January).

Developments in the PJM market since the Application was filed indicate that the results in the Application have understated, not overstated, the costs of lost energy at Salem due to fish protection alternatives. Market prices in both real-time and forward energy markets suggest that the marginal cost of replacing lost Salem energy, as reflected in these market prices, is generally higher than estimated by PROMOD. Supplemental material including figures comparing estimated market prices from PROMOD with forward market prices was provided by PSEG via a letter to NJDEP dated July 28, 2000 (hereafter, "July 2000 Supplemental Material"). Figure 1 through Figure 6 of this supplemental material show that actual forward market prices are significantly higher than forecast marginal costs in PROMOD. Thus, social costs in the Application are not overstated.

The results provided in the July 2000 Supplemental Material utilize an updated methodology for estimating energy costs. The new methodology reflects changes in the competitive wholesale power market in PJM that occurred between the time the cost-benefit analysis in the Application was developed and the supplemental materials were provided. The updated methodology is based on forward prices (i.e., the price for guaranteed delivery of electricity at a future date) in PJM, rather than PROMOD results. The market price reflects the marginal cost of replacing lost energy at Salem. This updated approach was used to better reflect the actual observed prices for energy in PJM. Actual market prices provide good estimates of marginal costs, since prices in competitive wholesale markets reflect the costs of marginal

[1] See State of New Jersey, Board of Public Utilities, In the Matter of the Energy Master Plan Phase II Proceeding to Investigate the Future Structure of the Electric Power Industry, Docket No. EX94120585Y, EO97070462.

generating units. The real resource costs of replacing Salem energy would be equal to these marginal costs, minus the costs saved from reduction in Salem output. This methodology addresses all of the supply factors mentioned by ESSA, including maintenance schedules, capacity additions, and imports and exports. Demand responses to price changes are anticipated to be limited, and consequently were not quantified. Because the updated methodology addresses ESSA's comments, there is no need to perform any adjustments to the energy cost estimates found in the Application or in PSEG's supplemental filings.

2. ESSA Report § 4.1.2: Cooling Water System Modifications and Operation Cost Estimates

This section of the ESSA Report discusses cost estimates for cooling water system modifications and operation costs. ESSA concludes that:

> The documentation, methodology, and estimates presented in the Application seem reasonable considering the major revisions that would be required for a modified cooling water circulation system. (ESSA Report, pages 54-55.)

PSEG agrees with ESSA's conclusion regarding the validity of PSEG's cooling water system modification cost estimates.

3. ESSA Report § 4.1.3: Construction Costs for Additional Screens

This section of ESSA's review discusses construction costs for additional screens. The ESSA Report states that:

> However the construction is done it will be costly - the estimates, which are in the $20 to $30 million range, seem high but they could be realistic. (ESSA Report, page 55.)

ESSA provides neither support nor any particular reason for its concern that costs "seem high," and does not identify any concerns with particular cost components or methodologies used to develop these estimates. In contrast, PSEG's Application provides detailed documentation for the screen construction costs. PSEG continues to believe that the screen construction cost estimates are accurate.

4. ESSA Report § 4.1.4: Construction Costs for Lights and Air Bubbler

ESSA raises the concern that operating costs for the lights and air bubble curtain may be higher than anticipated:

> The estimated present value of operating costs for the strobe lights and air bubbler [sic] curtain are about the same as the construction costs. This proportion is probably reasonable, although operation costs could be much higher if, for example, an extreme event destroys part of the installation. (ESSA Report, page 55.)

These comments, by suggesting that costs may be higher than estimated by PSEG in the case of unforeseen events, support PSEG's position that cost estimates in the Application are underestimates. This is consistent with other conservative assumptions made in the Application that lead to underestimation of costs.

5. ESSA Report § 4.1.5: Optimum Alternatives

The ESSA Report states that:

> The applicant has defined some alternative technologies to replace or to improve the current intake, but it is not clear whether these alternatives represent least-cost systems that will achieve specifically defined objectives to reduce entrainment and impingement mortality. (ESSA Report, page 55.)

ESSA suggests that combinations of alternatives - i.e., least-cost alternatives - would have higher net benefits (i.e., benefits minus costs) than the alternatives considered by themselves. However, because the benefits of a combination of alternatives are generally lower than the sum of the benefits taken individually, while the costs are likely to be additive, a combination of two or more fish protection alternatives is likely to have smaller net benefits than the individual alternatives, rather than higher.

Consider a "least cost system" that would combine two alternatives, e.g., sound deterrent and screen modifications. The cost of this "optimized" alternative generally would be equal to the sum of the costs of the two alternatives. The "optimized" technology would require incurring capital costs, operating and maintenance costs, and replacement power costs roughly equal to the sum of the alternatives.[2] In contrast, the benefits of a hybrid technology generally would be lower than the sum of the benefits of each individual alternative. The fish protection gains from screen modifications, for example, would be lower if a sound deterrent system were in place to reduce the number of organisms that came in contact with the screen. Thus the benefits for this hybrid alternative would be lower than the sum of benefits for the two components.

In sum, evaluation of the type of "least cost systems" analysis suggested by ESSA - in which combinations of alternatives would be evaluated - is not warranted given the results for the individual alternatives. The cost-benefit ratios for combinations of technologies would generally be higher, rather than lower as ESSA suggests.

6. ESSA Report § 4.1.6: Cost-Benefit Assessment

This section of the ESSA Report raises two questions:

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[2] There are some exceptions; the costs of a mix of two flow-control alternatives, for example, would not be equal to their sum if the periods in which the alternatives reduced the flow were to overlap, since summing the costs might double-count power losses.

1. What perspective was used to estimate costs?

2. Was the discount rate used appropriate for a social cost analysis ?

These issues are addressed separately below.

a. Perspective for Cost Estimates

The first question relates to the perspective from which costs and benefits should be estimated; ESSA proposes that costs and benefits could be estimated "for the utility in terms of lost revenue," "for the power users in terms of long run effects on electricity rates," or both (ESSA Report, page 55). In fact, cost and benefit estimates should not be estimated from either of the two perspectives; costs and benefits should be estimated from the perspective of society as a whole. Other portions of the ESSA Report agree with this point, and, indeed, emphasize a concern that costs presented in the Application may represent only private costs. For example, an earlier section of the Report states that "[a]ll costs and benefits should be at the societal level." (ESSA Report, page 53.) The ESSA Report provides no explanation for this apparent inconsistency regarding the proper perspective for developing cost and benefit estimates.

In fact, the cost methodology used and documented in the Application is consistent with widely-accepted social cost methodology (See USEPA 2000, Office of Management and Budget 1996, Stokey and Zeckhauser 1978, and Nas 1996). This point is fully addressed in the supplemental materials and explanations provided by PSEG to ESSA during the Application review process. (See, e.g., May 2000 Report.) This section reiterates these explanations of why costs should be estimated from a social perspective and why the costs used in the Salem cost-benefit assessment corresponds to social costs.

The costs included in cost-benefit assessments should reflect costs to society as a whole, rather than transfers from one group to another. USEPA cost-benefit guidelines define social cost as follows:

> The total social cost is the sum of the opportunity costs incurred by society because of a new regulatory policy; the opportunity costs are the value of the goods and services lost by society resulting from the use of resources to comply with and implement the regulation, and the reduction in output. (USEPA 2000, page 113.)

This definition is consistent with guidelines from the Office of Management and Budget (1996) and standard economic theory as described in economic texts on cost-benefit analysis (e.g., Stokey and Zeckhauser 1978 and Nas 1996).

USEPA guidelines describe five basic components of total social costs (USEPA 2000, pages 113-4):

- Real-resource compliance costs (including unpriced resources); [3]
- Government regulatory costs;
- Social welfare losses (i.e., deadweight welfare losses resulting from changes in prices to consumers; [4]
- Transitional costs; [5] and
- Indirect costs (e.g., affects on product quality, productivity, and innovation).

The most significant component of the total costs for regulatory requirements typically is the value of the real-source compliance costs. The USEPA Cost-Benefit Guidelines, for example, state:

> The largest fraction of direct social costs arises from the real-resource costs due to the new regulation. These new compliance costs arise from the installation, operation, and maintenance of new capital equipment, or are a result of changes in the production process that raise the price of producing the good. (USEPA 2000, page 119.)

The costs in the PSEG cost-benefit assessment are consistent with the USEPA guidelines and represent the social costs of fish protection alternatives. The following are the three major components of the cost of fish protection alternatives evaluated in this study:

1. Capital costs. Capital costs are the one-time costs of construction and installation of fish protection equipment. Capital costs are real resource costs.

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[3] Resource costs are costs associated with the use of valuable resources, such as materials, equipment, and labor. With respect to environmental compliance, EPA guidelines define these real-resource costs as "the principal component of total social costs and are associated with: (1) purchasing, installing, and operating new pollution control equipment, (2) changing the production process by using different inputs or different mixtures or inputs, or (3) capturing the waste products and selling or reusing them." (USEPA 2000, page 113.)

[4] "These are the losses in consumer and producer surpluses associated with the rise in price (or decreases in output) of goods and services that occurs as a result of an environmental policy." (USEPA 2000, page 114.)

[5] "These include the value of resources that are displaced because of regulation-induced reductions in production, and the private real-resource costs of reallocating those resources." (USEPA 2000, page 114.)

2. Operating and Maintenance (O&M) Costs. Operating and maintenance (O&M) costs are changes in the operation and maintenance costs of Salem due to fish protection alternatives. O&M costs are real resource costs.

3. Costs Associated with Power Impacts. Implementation of fish protection would result in impacts to power generation at Salem. The impacts would result in social costs due to increases in fuel and operations and maintenance costs within the PJM system as a result of the power impacts.

These cost categories correspond to the real-resource compliance costs of the proposed action. These estimates do not include governmental regulatory costs, social welfare losses, transitional costs, and indirect costs, since these costs were judged not to be significant for the fish protection alternatives at Salem. To the degree that these non-included costs are important, the social costs estimates in the Application may understate the actual social costs of fish protection.

b. Discount Rate

The second question raised by ESSA in this section relates to the discount rates used in the cost-benefit analysis. The discount rates in the Application are consistent with EPA and OMB methodological guidelines. PSEG's base case analysis assumes a real discount rate equal to PSEG's after tax cost of capital adjusted for inflation, which was 6.19 percent. Sensitivity analyses were performed assuming discount rates of 3 percent and 9 percent. The following are guidelines provided by the Office of Management and Budget (OMB) and USEPA regarding discount rates:

1. OMB. OMB recommends using a discount rate of 7 percent (OMB 1996).

2. USEPA. USEPA recommends using a discount rate of 2 to 3 percent as well as the OMB value of 7 percent.

PSEG's analysis is consistent with these guidelines. The values used by PSEG are roughly consistent with the set of values recommended by USEPA and OMB. The value of 6.19 percent used in the cost-benefit analysis is similar to OMB's rate of 7 percent. The lower value (3 percent) is equivalent to USEPA's other recommended value (2 to 3 percent).

The conclusions of the cost-benefit analysis are valid notwithstanding changes in the discount rate. ESSA suggests that if a higher consumer discount rate were used, "the ratio for cooling towers may be close to the ratio for strobe lights and a bubble curtain." (ESSA Report, page 56.) F-IX Table 14 in the Application shows that the cost-benefit ratios increase for most alternatives when a higher discount rate is used. Cost-benefit ratios increase because most alternatives involve significant up-front capital costs that lead to a long-run reduction in fish losses. Increasing the discount rate puts greater weight on these early costs as compared to more distant benefits. Thus, it is inaccurate to say that increasing the discount rate would make cooling towers relatively more desirable from an economic perspective.

C. ESSA Report § 4.2: Fisheries Economic Benefits

1. ESSA Report § 4.2.1: Introduction

In the introduction to this section, ESSA identifies the following four "areas of concern" that are addressed in its review: the soundness of methodology, the suitability of data used in the analysis, the validity of assumptions and inferences drawn, and the level of integration with other study components (ESSA Report, page 56). (Note that although ESSA identifies "five items" explicitly considered, only four sub-headings are provided.) The following sections address each of these subjects.

2. ESSA Report § 4.2.2: Soundness of Methodology

ESSA considers three issues with respect to the soundness of the methodologies used in PSEG's Application, including the cost-benefit analysis, benefits transfer, and the meta-analysis.

a. ESSA Report § 4.2.2.1: Cost-Benefit Analysis

With regard to the cost-benefit analysis, ESSA identifies three issues related to the soundness of the methodologies used. These include the accuracy of methods, treatment of uncertainty, and documentation of costs.

(1) Accuracy of Methods

ESSA does not raise any comments on the methodological choices or implementation of those methodologies in the cost-benefit analysis. Instead, the ESSA review focuses on documentation of the relative accuracy of the components of cost and benefits. The ESSA Report states, for example, that:

> It is generally accepted that variability in the accuracy of standard methods to quantify non-market values is greater than in methods for calculating values that are directly measured via the marketplace. (ESSA Report, page 56.)

The ESSA Report also states that:

> The relative differences in uncertainty and accuracy may be important information for a decision-maker, and should be acknowledged in the Application. (ESSA Report, page 57.)

ESSA's characterization of methods to deal with uncertainty appears overly simplistic and might be misleading. To discuss the relative accuracy of alternative methodological approaches in general terms is not helpful. The relative accuracies of cost and benefit estimates depend on many factors specific to the analysis, including data quality, degree of disaggregation, institutional factors in markets, and methodology. When costs and benefits are forecast into the future, many additional factors affect the accuracy of different components of the cost and benefit estimates. The valuation methodology is only one factor among many affecting the relative accuracy of cost and benefit estimates. Generalizations about the relative accuracy of individual cost and benefit components based on only one factor - valuation methodology - may be inaccurate or misrepresentative.

Moreover, while ESSA states that it is "generally accepted" (ESSA Report, page 56) that non-market estimates are less reliable than market based estimates, the only support for this statement is a partial quote from a single study. Omitted portions of this quote, however, show that the study qualified its statement regarding estimation of ecosystem benefits by saying that "except ... where people use ecosystems (for example, for commercial harvesting of fish or for recreation), economists will not be able to contribute comparable welfare measures on the benefit side of the equation." (Freeman 1993, page 485.) While ESSA uses the partial quote to suggest that economists cannot develop benefits estimates that are of comparable accuracy to cost estimates, the full quote, in fact, indicates the opposite: that some benefit categories can be estimated with accuracy comparable to costs. The full quote suggests that economists can develop estimates of recreational and commercial benefits, such as those estimated for Salem, that are of comparable accuracy to cost estimates.

(2) Treatment of Uncertainty

ESSA raises concerns regarding the treatment of uncertainty in the Application. For example, the ESSA Report states that:

> The CBA does not explicitly acknowledge inherent uncertainties around the point estimates for net benefits and cost-benefit ratios that arise from the uncertainty in the technical data and accuracy of the economic methodology. The analysis presents mean values as deterministic, and makes no attempt to describe the significance of this omission. (ESSA Report, page 57.)

ESSA's concerns that the Application ignores uncertainty are unwarranted. PSEG addresses the effects of key uncertainties in both quantitative and qualitative fashions. Thus, it is inaccurate to characterize the estimates as "deterministic." Moreover, the discussion in the Application is sufficient to provide decision-makers with an understanding of the factors not quantified in the cost-benefit estimates and their likely effects on the cost-benefit results. Further analyses would not be helpful for several reasons.

First, the Application performs quantitative analyses of the cost-benefit analysis under alternative discount rates. Sensitivity analysis with alternative discount rates is consistent with various government guidelines, including the recent USEPA guidelines that recommend using values that are virtually the same as in PSEG's sensitivity analyses .

Second, the Application considers the qualitative effect of omitted factors and other effects on the analysis. Appendix F, Section IX.F summarizes many of these factors that are addressed in greater detail in other parts of Section IX and its appendices. (Application

Appendix F, Section IX.F.) The uncertainties addressed throughout the analysis include the following:

- Natural biological compensation reduces the effects of Salem on the population of adult fish. The effect reduces the quantity of equivalent adult fish and thus the benefits of all fish protection alternatives. (See Application Appendix F, Section IX, page 6.)

- Lags in adult fish production are not included. The effect would reduce the present value of equivalent adult fish because the benefits would occur in later years. (See Application Appendix F, Section IX, page 16.)

- Value per pound for some non-RIS species would be less than the value that was used, i.e., the average value for the RIS. The value of all the individual non-RIS fish was not estimated because data are not available to determine the quantities of non-RIS by species. However, these species are generally of lower commercial value and lower recreational interest. Consequently, it is likely that the non-RIS species are overvalued. (See Application Appendix F, Section IX, page 14.)

- Increased costs to commercial fishermen to obtain the commercial fishing benefits might compensate for some or even all of the commercial fishing benefits. The commercial valuation methodology assumes that the value of commercial fish is equal to the wholesale price. (See Application Appendix F, Attachment F-13, page 2.)

- Recent declines in commercial fish prices, particularly striped bass prices, suggest that the actual prices will be lower than the values used in this study. These historical declines could indicate that the future commercial value of fish, particularly striped bass, will decline over time. Adjusting for this decline would reduce the benefits. Such an adjustment was not made in the estimation of commercial fish benefits. (See Application Appendix F, Section IX, page 16.)

- The analysis ignores other costs and benefits associated with intake alternatives. The Application identified a number of costs (e.g. field tests, disposal of hazardous materials, developing prototype test facilities, and permitting costs) that would or might be incurred if the alternative were implemented. (See Application Appendix F, Attachment F-16.) These costs were not quantified, although they were discussed in qualitative terms.

The ESSA Report suggests that additional quantitative evaluation of uncertainty could be performed. The Report states that, "[g]iven more information about the underlying probability distributions, the CBA could have used standard practices for dealing with uncertainty." (ESSA Report, page 57.) This comment is consistent with ESSA's earlier recommendation that "if possible, sensitivity analyses should be conducted." (ESSA Report, page 53.) Both of these comments recognize that limitations in data can make quantitative analysis of uncertainty infeasible and unreliable.

ESSA cites a report by Kopp et al. (1997) that briefly describes an approach to performing uncertainty analysis. The report states that proper uncertainty analysis "involves characterizing uncertainties in input data, equation parameters, and other features of the analysis with probability distributions." (Kopp et al. 1997.) Kopp et al. go on to state that:

> In practice, the full representation of uncertainties is often ignored in favor of more *ad hoc* approaches, such as the representation of output variables by their expected values and others by 'low', 'middle' and 'high' values (say, the values representing the 95% confidence interval around some expected value). These results are then paired with their corresponding values from the next stage of the analysis. The result is a set of 'low', 'middle' and 'high' values for the final outputs (say, the benefits of a waste cleanup) that do not correspond to any particular confidence interval, and thus can be very misleading. (Kopp et al. 1997.)

The authors of the Kopp report conclude that performing *ad hoc* approaches to uncertainty analysis can be potentially misleading. Indeed, their recommendation suggests that *ad hoc* approaches to uncertainty analysis can do more harm than good in helping policy-makers understand results and develop appropriate conclusions. The cited report therefore does not support ESSA's recommendation for further uncertainty analyses.

Additional analyses of uncertainties affecting the costs and benefits of fish protection would not be helpful. There is inadequate information to quantify probability distributions for the many variables affecting the cost and benefit estimates. A variable's distribution quantifies the probability that the variable takes on certain values. Without some information on the distribution, quantitative analysis of uncertainty can be misleading.

It would be difficult, if not impossible, to develop distributions for most of the variables used to evaluate the benefits and costs of fish protection at Salem. Data on the effectiveness of fish protection alternatives, for example, is based on information from a limited set of existing studies. While the mid-point of this range provides a good estimate of the expected level of effectiveness, there is no information on the full distribution. An analysis based on the high and low values from this range of reported values may be very misleading since the likelihood that actual effectiveness will be equal to these high and low values are unknown. Thus, the Application is consistent with the recommendation of Kopp et al. that potentially misleading *ad hoc* approaches not be used in cost-benefit analyses.

In sum, ESSA's comments regarding the treatment of uncertainty are unwarranted. The Application provides detailed discussions of the factors affecting the cost and benefit estimates. Additional quantitative analysis of uncertainty in the various parameters is not called for.

(3) Scope of Costs

The ESSA Report questions whether costs and benefits are estimated at the "firm, system, or societal level" (ESSA Report, page 58). With regard to benefits, ESSA finds that "[t]he scope for benefits is clearly defined in the report to be at the societal level." (ESSA Report, page 59.) With regard to costs, however, the ESSA Report states that:

> The documentation is not complete enough to determine whether costs are consistently measured at firm, system, or societal level[s]. (ESSA Report, page 58.)

ESSA's concern is unwarranted. As discussed above in Section B.6, the cost estimates in the Application reflect social costs. This point is fully addressed in the supplemental materials and explanations provided by PSEG to ESSA during the Application review process. (See, e.g., May 2000 Report.) These materials clearly state that the power costs estimates, which are the focus of ESSA's concern, represent social costs.

The energy cost estimates in the Application reflect the social cost of lost energy, and not lost revenues to PSEG. These cost estimates are based on the real resource costs resulting from lost energy. The social cost of the lost energy at Salem is the *net* of the costs of replacement energy and the cost savings at Salem:

1. Costs of Replacement Energy. The energy lost at Salem due to a given fish protection alternative would be replaced by increased generation at other units. This increased generation would result in increases in fuel and other variable costs of production at the other units.[6] These costs represent increases in resource costs to society. The costs are estimated using modeling (PROMOD) that determines the least-cost means of replacing lost energy in the PJM system. Supplemental analyses estimate energy costs using a revised methodology based on prices in forward energy markets that reflect the marginal cost of replacing lost energy. (PSEG August 2000.)

2. Cost Savings at Salem. The *reduced* energy produced at Salem means that fewer costs would be incurred at Salem for fuel and variable operations and maintenance costs. For each kilowatt-hour of reduced energy at Salem, these fuel and variable operations and maintenance costs would not be incurred, and thus the resources would be available for other uses. These constitute resource cost savings.

Since both elements reflect changes in real-resource costs to society, the net costs represent social costs.

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[6] Note that energy generation results in emissions that also produce social costs. In the Application, the costs associated with CO_2, NO_X, and SO_2 were estimated separately from energy costs. In supplemental analyses (PSEG July 2000, PSEG August 2000), some of these costs (SO_2 and NO_X) are included in energy costs and some (CO_2) are estimated separately.

As noted in the Application, the methodology used to estimate the social cost of reductions in Salem generation capacity is based upon assessing the market value of capacity, which reflects the least-cost means of providing replacement capacity. For the PJM market, the least-cost means of producing peaking capacity is the construction of natural gas combustion turbine (CT) units. (See Application Appendix F, Section IX, and Attachment F-16.) As a result, the estimates of the market value of capacity are based on the capital costs of constructing CT units. Since the capital costs reflect real-resource costs to society, the capacity costs represent social costs.

ESSA provides two examples to support the proposition that costs are not sufficiently documented in the Application. However, neither of these examples supports ESSA's statements regarding insufficient documentation. ESSA's first example relates to the estimates of capacity costs. ESSA comments that:

> Including costs to the firm of purchasing capacity from another firm in the system, in order to comply with capacity guidelines, is a cost only to the firm. To the system as a whole, this transaction amounts to a transfer between firms. The only legitimate cost should be the net additional cost to the final consumers in the market, should the reduction in capacity lead to any real cost. The penalty itself is set up as an incentive to prevent the risks of 'shortage' (brown outs, black outs) in a peak use situation. Should the fish protection alternatives at Salem increase the probability of such an event, then the appropriate cost is the expected value of the increased risk to consumers, due to the fish protection alternatives. This measure of the social cost of decreased capacity would be strictly lower than using the cost of procuring capacity to avoid the penalties levied on the firm as a proxy. (ESSA Report, page 58.)

This statement reflects an apparent misunderstanding by ESSA regarding the method used in the Application to calculate the value of lost capacity at Salem. The quoted paragraph confuses two possible methods: (1) payment of penalties to PJM if capacity obligations are not met; and (2) purchase of capacity from others. The Application clearly states that the capacity cost estimates are based upon the second method, i.e., purchase of capacity from others at the market rate. (Application, Appendix F, Attachment F-9, page 2.) ESSA's concern may arise from references in Attachment 9 to Appendix F to monetary penalties that electric utilities in the PJM pay if they fall below capacity requirements. Capacity Deficiency Rates (CDRs) are penalties assessed on a generator that does meet its designated capacity obligation. Such monetary penalties do not necessarily represent the social costs of reductions in capacity. The references in the Application to PJM monetary penalties were intended only as background information.

In addition, ESSA's statement is troubling in its suggestion that the cost of purchasing capacity from others "is a cost only to the firm" rather than a social cost because "[t]o the system as a whole, this transaction amounts to a transfer between firms" (ESSA Report, page 58). The market price of capacity represents the value, at the margin, of additional capacity as well as the resource cost, at the margin, of providing additional capacity. As with all competitive market transactions, the purchase and sale involves a transfer from the buyer to the seller, i.e., payment at the market price. But this competitive market price reflects the social value of the commodity that is being purchased and sold.

The following analogy illustrates the fundamental misperception underlying ESSA's statements that capacity costs are not social costs. Suppose that PSEG were to lose a vehicle in the course of one of its operations. The cost of replacing that vehicle would be the social cost of PSEG's operation and certainly not a "transfer" from society's standpoint, even though of course there is a transfer of funds from PSEG to the vehicle dealer/manufacturer. The market price of the vehicle reflects that value to PSEG of the vehicle to its operations, as well as the resource costs of providing the vehicle. Similarly, the market price of capacity represents the value to PSEG and its customers of the capacity, as well as the resource costs of providing it. Under ESSA's suggested approach, the vehicle loss is only a cost if it leads to an increase in consumer rates. This view clearly is inconsistent with the perspective that costs should be estimated from a social perspective.

ESSA's discussion of costs includes other apparent misunderstandings as well. For example, ESSA comments that "the social cost of decreased capacity would be strictly lower than using the cost of procuring capacity to avoid the penalties levied on the firm as a proxy." (ESSA Report, page 58.) Although this comment is somewhat confusing, it appears that ESSA is claiming that the true social cost of capacity is strictly lower than the cost of procuring capacity. However, once again ESSA's concern is misplaced. If capacity is traded in a market, as noted above, we would expect, at the margin, that the social cost of decreased capacity would be equal to the cost of procuring capacity. But in some cases the social cost of decreased capacity could be substantially greater than the cost of procuring capacity. If there are supply constraints in the short-term, the social cost of decreasing capacity could be substantially *greater* than the cost of procuring capacity.

Consider recent experience in California as an example. Shortages of generation capacity and increases in demand — among other factors — led to sharp increases in energy prices, rolling brownouts, and other risks (e.g., blackouts and industrial disruption) during 2000 and the first part of 2001. The social costs of these interruptions appear to outweigh the cost of additional generation capacity. Thus, it would not be accurate in this example to state that the true social cost of capacity is "strictly lower" than the cost of procuring capacity.

ESSA's second example of insufficient documentation relates to the PROMOD model used in estimating energy costs. ESSA states that:

> The reference in the Application documentation to PROMOD does not clearly state the purpose of the simulation software, nor justify its use in this capacity (Attachment F-9, page 5). At the very least, documentation should be provided that demonstrates that PROMOD projections are reliable for regional-level cost estimates. (ESSA Report, page 59.)

However, contrary to ESSA's suggestion, extensive documentation regarding PROMOD has been provided in the Application and supplemental materials. PROMOD is a production cost model that estimates the least-cost means of meeting electricity demand given the cost of electricity generation (fuel and variable operation and maintenance costs), operation constraints (e.g., scheduled maintenance outages), and transmission system constraints. Cost estimates are based only on the production costs of energy, which include fuel and variable operation and maintenance costs.

The Application stated that:

> The value of lost energy is obtained by using the results from PROMOD, a computer model that simulates the future operation of the PJM system and calculates production costs. PROMOD is a detailed, industry-standard computer simulation model licensed from Energy Management Associates of Atlanta, Georgia and used by PSE&G and most members of PJM. Runs are consistent with PSE&G's Energy Master Plan (See Response to Staff Request, S-PS-SC-11 in Application).
>
> The value of lost energy for each alternative is based on forecasts of monthly energy costs. These monthly forecasts are generated using two simulation runs. The first assumes normal operating conditions of the PJM energy market. (Note that normal Salem refueling outages are not included in this simulation.) The second simulation is the alternative case that assumes one of the Salem units would be removed from service while still meeting the same level of demand (For a unit removed from service, the model simulates no electric energy production and no fuel or variable O&M costs). Subtracting the total PJM production costs for the two cases yields monthly lost energy values for one of the Salem units. We refer to this estimate as the PJM system value of a Salem unit. A PJM system cost per MWh ($/MWh) can be calculated by dividing the PJM system cost impact by the unit's expected energy output (in MWh) from the first run when both Salem units are available. (Application Appendix F, Attachment F-9, page 4).

The Response to Staff Request, S-PS-SC-11, which was provided in the Application, provides four pages of description and 14 exhibits providing data used in the analysis. PSEG's Energy Master Plan has been publicly approved by the New Jersey Board of Public Utilities after significant public scrutiny by many intervening parties. The document is publicly available.

PSEG also has provided substantial additional information on the PROMOD IV model to NJDEP and ESSA. These materials include:

1. PROMOD IV Technical Description;

2. PROMOD IV Dispatching Methodologies;

3. PROMOD IV 2-page brochure and Application sheets;

4. NewEnergy Associates Corporate Overview and Demonstration CD; and

5. PSE&G Production Cost Analysis to Estimate Energy Revenues (Response to Staff Request S-PS-SC-11 (S-2)).

As noted, the latter material was also provided as part of the Application. These materials together provide significant detail on PROMOD. The ESSA Report does not appear to reflect consideration of any of this information.

b. ESSA Report § 4.2.2.2: Benefits Transfer

The ESSA Report provides a general discussion of alternative approaches for valuing non-market goods, the use of benefits transfer for estimating non-market goods, and the general approach to benefits transfer. The discussion first notes the widespread use of benefits transfer to value non-market goods in cost-benefit analysis.

ESSA then raises some issues with respect to the benefits transfer methodology. ESSA's comments generally appear to reflect academic concerns regarding the methodologies used to perform benefits transfer, and in some cases appear to lack substantiation. For example, ESSA states that "virtually all economists who practice non-market valuation agree that primary valuation studies are superior in terms of theoretical consistency and empirical accuracy" (ESSA Report, page 59). ESSA also states that "the quality and accuracy of a benefit transfer is necessarily inferior to estimates produced from a primary valuation study of the policy site" (ESSA Report, page 60). Neither of these statements is supported by additional explanation or by any cited reference. Moreover, some of the issues about benefit transfer raised in the references that are cited in the ESSA Report appear to relate to a simple benefit transfer approach — in which a benefit value from one study is used directly in another — that is very different from the benefit transfer method used in the Salem cost-benefit analysis. For example, ESSA quotes one report as asserting that "*conventional benefits transfers are very unreliable!*" (ESSA Report, page 60) (italics and exclamation mark in original). But this quote seems to refer to the simple (or "conventional") benefit transfer approach, rather than the meta-analysis technique that was used in the Application.

Contrary to ESSA's comments, guidelines for performing cost-benefit analyses suggest that benefits transfer is an appropriate approach to estimating the value of non-market benefits. USEPA guidelines, for example, provide an extensive discussion of benefits transfer and its appropriate use in cost-benefit analyses. The USEPA guidelines state that:

> The advantages to benefit transfer are clear. Original studies are time consuming and expensive; benefit transfer can reduce both the time and financial resources needed to develop benefit estimates... Additionally, while the quality of primary research is

> unknown in advance, the analyst performing benefit transfer is able to gauge the quality of existing studies prior to conducting the transfer exercise. (USEPA 2000, page 86.)

Despite its concerns, ESSA does not suggest that benefits transfer should not have been performed and does not propose an alternative approach. (Note that the discussion mentions that a primary valuation study *could* have been performed, but never suggests that one *should* have been performed.) ESSA apparently does not take issue with the choice to use a benefit transfer approach to estimate recreational fishing benefits.

The ESSA Report also makes statements regarding the specific benefits transfer approach- meta-analysis - used in PSEG's application. ESSA comments that:

> [T]he preferred approaches [methodology], in terms of accuracy, would have been to transfer a benefits function that incorporates variables to account for study site and policy site social, demographic, and economic differences. (ESSA Report, page 62.)

However, ESSA provides no citations to support this statement. In fact, USEPA economic guidelines suggest no tradeoff in accuracy or preference for the benefit function approach compared to meta-analysis. The USEPA guidelines provide the following discussion of benefits transfer methods:

> There are four types of benefit transfer studies; point estimate, benefit function, meta-analysis, and Baysian techniques. The point estimation approach involves taking the mean value (or range of values) from the study case and applying it directly to the policy case. As it is rare that a policy case and study case will be identical, this approach is not generally recommended. . . . The benefit function transfer approach is more refined but also more complex. . . . The most rigorous benefit transfer exercise uses meta-analysis. Meta-analysis is a statistical method of combining a number of valuation estimates that allows the analyst to systematically explore variation in existing value estimates across studies. . . . An alternative to the meta-analysis approach is the Baysian approach. These techniques provide a systematic way of incorporating study case information with policy case information. (USEPA 2000, page 87.)

These guidelines indicate that meta-analysis is the "most rigorous benefit transfer exercise." Thus, ESSA's statement that the benefit function approach is "the preferred approaches [methodology], in terms of accuracy" compared to the meta-analysis approach is inconsistent with USEPA Guidelines.

In addition, ESSA makes other statements that seem to compliment PSEG's approach. ESSA comments that, "[t]o the credit of the CBA, the benefits transfer did attempt to modify the values using a random utility approach and meta-analysis." (ESSA Report, page 62.) Also, after commenting that the lack of studies on which to base a transfer is "a noted shortcoming" of the benefits transfer, ESSA goes on to acknowledge that if "a large number of studies had been included in the meta-analysis, then it is more likely that the differences in demand and populations would have introduced more error, because they would have been from primary data sites with very different population characteristics" (ESSA Report, page 62). Thus, PSEG concludes that the Application's approach to calculating benefits is fully supported by available regulatory guidance. Moreover, despite some of its comments, it appears that ESSA does not fundamentally challenge that approach.

c. ESSA Report § 4.2.2.3: Meta-analysis

This section of the ESSA Report reviews the meta-analysis used to value the recreational benefits of fish protection alternatives. Although ESSA raises several issues regarding meta-analyses, most of these, they acknowledge, "arise whenever *any* benefits transfer is to be performed" (ESSA Report, page 63). Moreover, many of the comments appear to be generalized, rather than based upon the specific application of the methodology in the Salem cost-benefit study. For example, ESSA states that "meta-analysis does not correct for data derived from studies that are based on different underlying phenomenon and conceptual models." (ESSA Report, pages 62-63.) As discussed below, the studies used in the Salem meta-analysis were chosen to reflect the situation and conceptual model applicable to fish protection alternatives at Salem.

The meta-analysis in PSEG's application utilizes a methodology that is consistent with the relevant EPA Cost-Benefit Guidelines. These guidelines provide recommendations for choosing studies, including steps for identifying existing, relevant studies and for reviewing the studies for quality and applicability. These recommendations include:

> *Identify existing, relevant studies.* Conducting a literature search identifies existing, relevant studies. This literature search should, ideally, include searches of published literature, reviews of survey articles, examination of databases, and consultation with researchers to identify government publications, unpublished research, works in progress, and other 'gray literature.'
>
> *Review available studies for quality and applicability.* . . . [T]he analyst should review and assess the studies identified in the literature review for their quality and applicability to the policy case. . . . Assessing studies for applicability involves determining whether available studies are comparable to the policy case. (USEPA 2000, page 86.)

PSEG's analysis conforms to these guidelines relative to selecting the studies used in the meta-analysis presented in Appendix F to the Application. An extensive literature review was undertaken to identify all empirical studies of recreational fishing values, including studies from the "gray literature." The criteria to select the specific studies for the meta-analysis included two main factors:

1. *Studies had to be relevant to the resource being valued.* The studies had to meet the following criteria: East Coast, marine environment, and bank and private boat fishing. These criteria identify studies that provide values relevant to the types of benefits that would be generated by fish protection alternatives at Salem, i.e., increases in marine recreational fishing catch along the East Coast.

2. *Studies had to be scientifically sound.* Studies must employ scientifically sound methodological approaches and be implemented in a scientifically sound manner. The three critical components in such an assessment are sampling protocols, response rates, and estimation techniques.

Only studies meeting these two basic criteria were included in the meta-analysis.

The studies used in the meta-analysis clearly reflect the resource conditions, geographic area, and type of recreational experience relevant to recreational benefits generated by fish protection at Salem. The meta-analysis has chosen studies to ensure that the goods, user conditions, and user populations are similar across studies and appropriate to Salem. The meta-analysis then accounts for differences in the relationship between marginal or incremental values, the incremental increase in catch, and the baseline level of catch through statistical modeling. Thus, the meta-analysis accounts for the most important factors necessary to ensure that recreational values used in the Application are appropriate to conditions at Salem.

ESSA reiterates its suggestion for additional information and again seems to imply that the meta-analysis provides less accurate estimates of recreational benefits than other methods, although ESSA fails to specify a preferred alternative. ESSA states,

> The shortcoming in this CBA is the lack of acknowledgement of the decisions and assumptions made concerning the use of these methods, and the effects of these choices on the accuracy of the benefits estimates. It is likely that the accuracy around recreational benefit measures is much less than that of the commercial fishing benefits and the costs of adopting fish protection strategies. These concerns should be carefully described in the context relevant to the decision-makers' problem. (ESSA Report, page 63.)

As with its general discussion of benefit transfer methods, ESSA's recommendation for additional information does not suggest a specific alternative method or provide any basis for statements regarding the relative accuracy of cost and benefit estimates. PSEG believes that its description of the meta-analysis method is complete, that the method is fully supportable, and that ESSA does not provide a clear or convincing rationale for additional information.

3. ESSA Report § 4.2.3: Suitability of Data Used in Analysis

a. Benefits Based on Secondary Sources

ESSA suggests that documentation of the rationale for using secondary sources for benefits transfer should be provided. The ESSA Report states that:

> It may be justifiable that secondary data are used for a benefits transfer using a meta-analysis with as few as 6 study sites — but written documentation should not simply assert that these choices are optimal for this study without describing the nature of the trade-offs, and justifying them. (ESSA Report, page 63.)

The recreational benefits of fish protection at Salem would occur over a very broad geographic range. Development of an accurate primary valuation study would necessitate implementing a recreational valuation survey over a geographic range covering many East Coast states. Such a study is not likely to provide more timely and reliable estimates than the meta-analysis, and, indeed, ESSA does not recommend that such a study be done. Thus, PSEG continues to believe that its approach to calculating fishing benefits is appropriate.

b. Suitability of Energy Cost Estimates

ESSA again raises concerns regarding the documentation of the PROMOD model:

> The model is not described in the documentation for the CBA, nor are the input data. Since the documentation is limited, it is impossible to determine whether the costs of energy supplied by alternative generation (other than Salem) make sense. At the very least, the documentation should provide complete justification for the use of the PROMOD simulation results. (ESSA Report, page 63.)

As discussed in Section C.2.a.(3) of this response, PSEG has provided detailed and extensive documentation of the PROMOD model in the Application and supplemental materials. Further, the model runs used in the analysis were based on the PSEG Energy Master Plan, which has undergone significant regulatory review. Further documentation of the PROMOD model is unnecessary.

c. Scope of Cost Estimates

This section of the ESSA Report again raises the issue of whether costs reflect social costs or costs to the firm. As discussed in detail in Sections B.6 and C.2.a.(3) of this response, the cost estimates in the Application do reflect social costs.

4. ESSA Report § 4.2.4: Validity of Assumptions and Inferences Drawn

The ESSA Report includes several comments regarding the "validity of assumptions and inferences drawn" in the benefits estimates. The following sections discuss these comments.

a. Future Demand for Recreational Fishing

ESSA questions whether future demand for recreational fishing is appropriately estimated in the Application. This comment essentially reiterates ESSA's comments made in the Summary section that:

> The Application includes no discussion of assumptions made about future projections in the demand for recreational fishing. The analysis implicitly presumes that demand will be constant over the appropriate time horizon, but this is neither explicitly stated nor justified. (ESSA Report, pages 52-53.)

PSEG's assumption that marginal recreational values are constant over time is reasonable given available information. To PSEG's knowledge, there are no empirical studies that have examined the change in marginal values for individual anglers over time, and indeed ESSA does not cite any studies.

There are many factors that affect the demand for recreational fishing, and thus the marginal value per pound. These factors include the costs of recreational fishing (e.g., travel costs, license costs, gear costs, and the opportunity cost of time), the relative preference for various recreational activities, income, and changes in resource conditions at substitute sites (see, e.g., Lesser, Dodds and Zerbe 1997). Forecasts of future marginal values would require the development of a model incorporating all of these disparate factors and development of forecasts for each of these parameters. ESSA does not indicate that such an empirical effort has been developed for the fisheries that are relevant in this case.

ESSA comments that these marginal values are likely to increase over time. ESSA's comment is based on an anecdotal discussion of factors that may affect future recreational values:

> Given the trend toward an aging population with more leisure time and money than in previous years, much of the recreational resource literature predicts an increase in the demand for resource-based leisure activities, such as fishing. One would thus expect to see an increase in marginal values for recreational fishing over time. (ESSA Report, page 64.)

ESSA provides no data or citations to support this statement. Data from the US Fish and Wildlife Service (USFWS), in fact, suggests that the participation of older populations in fishing is declining. Between 1985 and 1996, recreational fishing in the Northeast by those aged 55 to 64 declined by 18 percent, and by those aged 65 and older by 12 percent (USFWS 1999). These data raise serious doubts about the validity of the anecdotal observations made by ESSA.

PSEG concludes that additional analyses of future recreational values is not warranted. The assumption of a constant value per pound over time is reasonable given existing information.

b. Inclusion of Relevant Non-Fishing Benefits

ESSA comments that the Application does not consider all relevant benefits categories. For example, ESSA states that:

> An additional category of economic benefits not considered by the Application document is the potential benefits from non-user values, such as existence values, and the benefits of avoiding environmental risk and uncertainty from unanticipated and long term impacts of entrainment and impingement. (ESSA Report, page 64.)

PSEG's cost-benefit assessment considers the relevant benefit categories. The 1983 USEPA Cost-Benefit Guidelines directly address the issue of estimating benefits from regulatory requirements that affect ecosystems. (The most recent EPA Guidelines do not provide specific recommendations for estimating benefits to ecosystems under different environmental conditions.) The 1983 guidelines state that:

> As long as neither the primary productivity of the ecosystem nor the total population of the affected species is jeopardized by the change in water quality, component pricing [i.e., pricing of individual ecosystem components] can be used to measure the changes in service flows from the resource. (Appendix A, page 39.)

The 1983 USEPA Cost-Benefit Guidelines identify two components of ecosystem benefits in cases in which the ecosystem is not in jeopardy:

1. *Benefits from Changes in Commercial Species.* Regulatory requirements leading to changes in the stock of species used commercially (e.g., commercial fishery stocks) can lead to changes in yields or total production. Under these circumstances, the guidelines state that "[In] the special case of output changes that do not affect market prices, the appropriate measure of producer's surplus is simply the expected change in output multiplied by market price per unit." (USEPA 1983, Appendix A, page 30.)

2. *Benefits from Changes in Recreational Species.* Regulatory requirements leading to changes in the stock of species used recreationally (e.g.,

> recreational fishery stocks) can lead to changes in recreational benefits. Under these circumstances, the guidelines suggest using methods that capture individuals' willingness-to-pay for recreational services. (USEPA 1983, Appendix A, page 30.)

Although these guidelines mention the possibility of other values for species that do not have recreational or commercial value, no specific valuation methods are identified. PSEG developed values for the forage species based upon the recreational and commercial values of the additional predator species that would be made available. The Application describes the methodology for converting gains in these forage species to gains in species with recreational and commercial value (Application Appendix F, Section III.B).

The ESSA Report mentions non-use values that might be included, such as "existence values, and the benefits of avoiding environmental risk and uncertainty from unanticipated and long term impacts of entrainment and impingement" (ESSA Report, page 64). ESSA, however, provides no reasons why these values would be relevant for the fish protection alternatives considered in the cost-benefit assessment in the Application.

ESSA also states that the discussion of other costs and benefits in the Application is inadequate:

> The level of discussion and justification for conclusions about non-market valued use and non-use benefits and costs provided in Appendix F, Attachment 16 is not acceptable. The discussion is vague and not well-balanced. (ESSA Report, page 64.)

ESSA provides no specifics to support this claim, such as confusion regarding the effects described in Appendix F, Attachment 16. PSEG believes that the discussions in the Application are sufficient to convey a clear understanding of the nature of the environmental costs and benefits that are not quantified in the cost-benefit analysis. (See Application Appendix F, Attachment F-16; Application Appendix F, Section VIII.)

Thus, contrary to ESSA's statement that "the Application's assertion that all benefits have been included . . . should be better supported," (ESSA Report, page 65), PSEG firmly believes that the Application properly considers all relevant benefits categories. The benefits estimates calculated therefore are valid, reliable and accurate.

c. Benefits from Additional Fishing Trips

ESSA suggests that some fishing benefits are excluded from the benefits analysis. The ESSA Report states that:

> The analysis assumes that the only benefit to the recreational fishery is due to a marginal increase in the numbers of pounds of fish caught per recreational fishing day by recreational fishers already in the fishery. No increase in benefits due to a net increase

> in the number of recreational fishing days for the fishery, either by additional days per existing fisher or by the net increase in individuals in the recreational fishery. (ESSA Report, page 65.)

ESSA's concern that fishing benefits are understated is unwarranted. The methodology that PSEG uses to estimate recreational fishing benefits includes gains from increased fishing trips as well as additional fish per trip (Application Appendix F, Attachment F-14, page 4). Thus, benefits estimates in the Application do not omit the benefits of increases in recreational fishing days from its analysis.

The methodology for estimating the benefits of fish protection has two basic steps. The first step involves estimating the gains to the recreational and commercial fisheries (in pounds) from fish protection. These estimates include all gains to these fisheries, including gains due to increases in catch per trip and gains from additional trips. Thus, the benefit values in the Application do consider fish gains from increased trips but do not separate out the effects of increased trips from increased catch per trip (Application Appendix F, Attachment F-14, page 4).

The second step values these fish gains. The methodology to value fish gains assumes that all gains result in marginal increases in catch per trip. This approach is a reasonable approach and, as noted above, does not omit recreational benefits. Recreational benefits based on marginal increases in catch and marginal increases in the number of trips are likely to be roughly equivalent. The Application describes in detail why the value of additional catch per trip (i.e., the marginal catch) declines as the number of fish caught per trip increases (Application Appendix F, Attachment F-14, page 4). Similarly, the value of an additional (or marginal) fishing trip would decline as the number of trips increases. Thus, the marginal fishing trip will have a lower value than the average fishing trip.

The ESSA Report states that:

> [t]he significance of this [omission] is that an additional fishing day, or the first fish caught by an additional recreational fisher who would not otherwise be in the fishery, would be valued substantially greater than a marginal increase in catch for existing fishing days." (ESSA Report, page 65.)

This statement ignores both the "travel" costs of recreational fishing trips (including the opportunity cost of time) and the fact that recreational anglers incorporate an expectation of how successful they will be (i.e., how many fish they will catch, or catch-and-release) into their decision about whether or not to take an additional trip. A simple example will illustrate this point. A recreational angler considers whether or not to take a trip in the coming year. Based on her expectation that she would catch eight fish, her value for the trip would be $50. Her travel costs are $52, though, so she plans to take no trips in the coming year. With the implementation of fish protection alternatives, however, her expected catch increases to nine fish, and the total value of her trip increases to $53. Since her expected gain from the trip is greater than the cost, she decides to take a trip, with an expected gain of $1 (i.e., $53-$52). In contrast, the marginal value per catch is $3 (i.e., $53 minus $50). This example also shows that, contrary to ESSA's statement, the marginal value for additional catch (in this case, $3) can be greater than the marginal value for an additional trip (in this case, $1).

The methodology for estimating recreational benefits does not omit benefits of additional recreational fishing days. Consequently, the methodology used to value additional recreational catch will not understate recreational benefits. No further analysis therefore is necessary.

d. Calculations with Benefit Transfers

The ESSA Report states that:

> The conversions from value per fishing trip to a marginal per pound value as a result of increased fish biomass include some significant assumptions concerning how the secondary studies benefits measures can be used. (ESSA Report, page 65.)

The point of ESSA's statement is somewhat unclear. This statement appears to be based on the belief that the marginal (and incremental) values used in the meta-analysis were derived from data on the total value per trip. (There is no other obvious meaning for "conversion from value per fishing trip to a marginal per pound value.") The meta-analysis uses estimates of the incremental or marginal value that are reported directly from the studies used in the meta-analysis; these values are not based on estimates of the total value per trip. Assuming that PSEG correctly interprets ESSA's statement, the concern expressed appears to reflect a misunderstanding of the meta-analysis methodology. No further documentation is necessary.

e. Use of Penalties in Estimating Costs

ESSA suggests that capacity costs are based on "penalties," again implying that energy capacity cost estimates are not based on social costs. The ESSA Report states that:

> A cost component appears to include a "penalty" that would be levied against any one firm that failed to meet its 'capacity' obligations as defined by PJM. (ESSA Report, page 65.)

As noted earlier in Section C.2.a.(3) of this response, ESSA's concern regarding "penalties" may arise from references in the Application to monetary penalties that electric utilities in the PJM pay if they fall below capacity requirements. (See Application Appendix F, Attachment F-9, page 2.) The references to PJM monetary penalties were intended only as background information. As Section C.2.a.(3) describes, capacity cost estimates in the Application are not based on "penalties" and do reflect social costs. No further documentation or analyses are warranted.

f. Estimation of Costs and Benefits

ESSA states that it is "difficult to support" PSEG's assertion that costs provided in the Application are underestimates and benefits are overestimates (ESSA Report, page 66). ESSA provides the following four reasons for questioning PSEG's assertion:

(a) there are concerns about whether the costs are perhaps overstated, as explained above;

(b) there are unresolved questions about the accuracy of the benefits estimates used for recreational fishing;

(c) the projections for the future benefits of the fishery do not include any changes in the demand, relative to the dates of the studies used in estimating current demand; and

(d) any non-recreational non-market benefits are not included. (ESSA Report, page 66.)

Earlier sections of this response, however, have shown why none of these concerns with the cost and benefit values in the Application is warranted:

1. Costs are not overstated, as discussed in Section B.1. of this response.

2. Benefits estimates are not understated. As noted in Sections C.4.b. and C.4.c. of this Response, all relevant benefit categories and components are included.

3. Future benefits assume that recreational values are constant in real terms. As discussed in Section C.4.a. of this response, this assumption is reasonable.

4. As outlined in Section C.4.b. of this response, PSEG's Application includes all relevant benefit categories. No relevant benefits categories have been omitted.

ESSA has thus provided no persuasive arguments to revise the conclusion in the Application that the costs are underestimates and the benefits are overestimates.

5. ESSA Report § 4.2.4: Level of Integration with Other Study Components[7]

This section of the ESSA Report reviews the level of integration with other components of the study. The issue of "discussion of uncertainty and the sensitivity of the analysis to particular sources of uncertainty" is again raised (ESSA Report, page 66). As detailed in Section C.2.a.(2) above, no further treatment of uncertainty is warranted beyond the extensive discussions already provided in the Application.

[7] The ESSA Report contains two sections numbered 4.2.4; this Response retains ESSA's numerical headings and titles.

The cost-benefit analysis in the Application is extensively integrated with other study components. Estimates of the benefits of fish protection are based on:

- Quantitative data on impingement and entrainment under current operations for each species and life-stage (presented in Appendix L, tabs 6 through 9);
- Quantitative biological data on growth and mortality associated with each species and life-stage (presented in Appendix L, tab 18); and
- Quantitative technical data on the effectiveness of different fish protection alternatives on individual life-stages (see Application, Appendix F, Section VIII).

In addition, the cost-benefit analysis included qualitative information on factors not included in the analysis. This information includes cost factors related to implementation of alternatives and biological factors not accounted for in the benefits estimates. No further documentation or analyses are necessary.

6. ESSA Report § 4.2.5: Summary of Concerns and Expansion of Recommendations

ESSA concludes its review with five "summary recommendations" that build on its earlier comments (ESSA Report, page 67). ESSA also provides further elaboration of these concerns.

a. Written Documentation

ESSA recommends that the report should be "rewritten to describe clearly and completely all methods, assumptions and justification for assumptions" (ESSA Report, page 67). As described throughout this response, PSEG provided complete documentation of methods, data, assumptions, and justifications for these decisions. No further documentation or discussion is warranted.

ESSA supplements its earlier discussions regarding documentation with "more examples of confusion in the written documentation" (ESSA Report, page 67). For example, ESSA states that "the text [in the cost-benefit analysis] continues by declaring that random utility models are a type of non-market valuation method, while contingent valuation is another. This is incorrect." (ESSA Report, page 67.) ESSA provides no citation for this purported statement of the cost-benefit study. It appears that ESSA is referring to the following discussion in the Application:

> Researchers have developed methods to use information from multiple sites to infer the value of greater catch rate and other measures of the quality of the fishing experience. The most widely used methods are the random utility model (RUM) and the travel cost model with multiple sites. (Application Appendix J, Section IX, Attachment 14, page 4.)

This discussion in Attachment 14 simply notes the two major types of methods that have been used to value recreational fishing. Thus, ESSA's statement mischaracterizes the Application.

ESSA's second example of confusion is the following:

> The text states that hundreds of studies were reviewed in order to select the final six on which the meta-analysis of recreational benefits was based. It is unclear what criteria were used in this selection process and how there criteria were justified. (ESSA Report, page 67.)

Attachment 14 of Appendix F, however, states the criteria used in selecting studies for inclusion in the meta-analysis. (See Application Appendix F, Attachment F-14.) Detailed discussion of these criteria is provided in Section A.3 of this response. In addition, earlier portions of the ESSA Report appear to recognize these criteria. For example, ESSA states that "[t]his reviewer was not able to find appreciably more studies that would have been useful" and that "these six [studies] where [sic] of populations and fishing experiences that were relatively close in physical proximity to the policy site" (ESSA Report, page 62) in the meta-analysis. These statements appear to indicate a clear understanding of the criteria used in selecting studies for the meta-analysis. ESSA's concern that it is "unclear what criteria were used in the selection process" seems misplaced. No further documentation of the methodology for selecting studies for the meta-analysis is necessary.

b. Benefits of Additional Fishing Days

ESSA states that the benefits of recreational fishing days have been omitted from benefits estimates and should be incorporated into the analysis. As described in detail in Section C.4.c. of this Response, the recreational benefits in PSEG's Application include benefits associated with increased recreational fishing days. Consequently, no additional analysis is necessary.

c. Future Recreational Values

ESSA recommends that "benefits estimates should be recalculated to incorporate the appropriate projections" of recreational benefits. (ESSA Report, page 67.) As discussed in Section C.4.a. of this Response, recreational benefits are based on the appropriate and reasonable assumption that recreational values are constant in real terms. No further analysis is necessary.

d. Treatment of Uncertainty in the Analysis

With respect to the treatment of uncertainty in the analysis, ESSA recommends that:

> An explicit description of the sources and effects of uncertainty should be included, and if possible, sensitivity analysis should be conducted to demonstrate the effects of risk and uncertainty on the resulting cost and benefits measures. (ESSA Report, page 67.)

As discussed in Sections C.2.a.(2) of this report, no further documentation of the effects and sources of uncertainty is warranted, nor are additional quantitative analyses of the effects of uncertainty needed. The cost-benefit analysis quantified uncertainty where feasible, performing sensitivity analyses for alternate discount rates. The Application provides a clear discussion of non-quantified factors affecting the costs and benefits of fish protection alternatives. Thus, no further documentation is warranted.

ESSA also expresses concern regarding statements in the cost-benefit analysis related to omitted costs and benefits. ESSA comments that "[r]epeated statements that assert that benefits are always overestimated while costs are underestimated are difficult to support in a rigorous manner." (ESSA Report, pages 67-68.) This comment does not reference specific elements of the Application and thus it is not clear precisely to which statements the comment refers. The Application lists factors that understate costs and overstate benefits. (Application Appendix F, Section IX.F.1, page 16). The Application's cost-benefit study notes that including information on these omitted factors would "reinforce the conclusion that none of the fish protection alternatives has benefits that exceed its costs" (Application Appendix F, page IX-16). ESSA does not provide any basis for questioning this statement. Omitted factors are further addressed in Section IV.C.2.a(2) above. As detailed in that section, PSEG firmly believes that the Application appropriately considers uncertainty issues, and that the statements made in the Application are fully supported.

e. Estimation of Costs and Benefits Estimated at the Societal Level

ESSA recommends that additional documentation of the assumptions and methods used for cost estimation would assure that these estimates are from the societal level, and not the level of the firm. As discussed in Sections B.6 and C.2.a.(3), documentation provided in the Application and in supplemental materials made available to ESSA clearly states that these costs are estimated from a societal, and not a firm, level. No further documentation is needed. ESSA's recommendation that "recalculations" be "made where necessary" is unwarranted, since the cost estimates accurately reflect the social costs of fish protection (ESSA Report, page 67).

ESSA's final section includes a recommendation "to place these benefits and costs estimates in a larger context" (ESSA Report, page 69). This section includes a statement that appears to contradict the societal perspective recommended earlier. The last sentence states that:

> Since the proper perspective of the CBA is to measure costs in terms of net change in consumer rates, this approach is consistent with the CBA policy context. (ESSA Report, page 69.)

Throughout its comments, ESSA raises concerns regarding the proper scope of costs, noting repeatedly that costs must be measured at the societal, and not firm or system, level. These comments are made in numerous sections of the Report. This final sentence, however, completely contradicts these statements, suggesting that costs should be measured from the consumer's perspective and not the perspective of society as a whole. PSEG agrees with the view expressed in most of the ESSA comments that costs and benefits should be measured from a societal perspective and does not agree with the apparently inconsistent ESSA statement in the final sentence.

In sum, after review of ESSA's comments, PSEG concludes that the ESSA recommendations for additional documentation and analyses are not justified and would not add to understanding of the likely costs and benefits of fish protection alternatives at Salem. PSEG also concludes that the ESSA Report does not fundamentally challenge, or take issue with, the data, methods and conclusions of the Salem cost-benefit assessment.

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VII. RESPONSE TO ESSA'S SECTION 5: IMPACT ASSESSMENT

A. Summary and Recommendations

1. Summary

a. Indicators of Adverse Environmental Impact

In its summary, ESSA argues that PSEG's benchmarks ("assessment endpoints," in ESSA's terminology) of Adverse Environmental Impact ("AEI") are insufficient for an adequate assessment of AEI:

> Each of the three assessment endpoints chosen in the PSE&G Application (i.e., historical trends, long term sustainability, fish community structure) are confounded by changes in other stressors (i.e., water quality, changes in harvest). Inferences made on these assessment endpoints are therefore dependent on historical and future assumptions regarding other stressors. By contrast, assessment endpoints such as fish killed by entrainment and impingement and foregone production, are related directly to the impacts of the power station intakes, are less confounded by other factors, and require fewer assumptions about unknown parameters. Based on a review of current guidelines and standards of ecological risk assessment (EPA's 1998 Risk Assessment Guidelines), the three assessment endpoints included in the PSE&G Application are *necessary*, but clearly are not *sufficient* for an adequate assessment of Adverse Impact. (ESSA Report, page 75)

This comment suggests that ESSA has misunderstood PSEG's approach to using multiple benchmarks of impact to address AEI. As is clearly stated in the 1999 Application (Appendix F, Section VII.D), PSEG's conclusions with respect to AEI are based on the combined weight of evidence of *all three* benchmarks, as interpreted by fishery experts, rather than on any single benchmark. While it is true that all observational data concerning the status of populations and communities are subject to confounding environmental influences of the types cited by ESSA, the use of multiple lines of evidence, each based on different data sets, assumptions, and models, to overcome these confounding influences is a common practice in ecological risk assessment and is specifically endorsed in USEPA's Guidelines for Ecological Risk Assessment (USEPA 1998).

The alternative benchmarks proposed by ESSA are based on estimates of Station losses and "foregone production" derived by extrapolating Station losses using an overly simplified and highly conservative production model. These benchmarks are inconsistent with PSEG's criteria for benchmark selection, with the Guidelines for Ecological Risk Assessment, and with relevant regulatory precedents.

b. Production and Catch Foregone

ESSA states that PSEG's methods for calculating estimates of production foregone and catch foregone (which are used as inputs in PSEG's assessment of benefits associated with technology alternatives) are flawed because they omit some components of production foregone and use inputs that contain uncertainty:

> While the overall approach and implementation described in Attachment F4 and associated materials is reasonable, this analysis can be criticized from four main perspectives:
>
> 1) It focuses solely on the foregone catch of commercially or recreationally important fish and does not consider the value of fish lost to the ecosystem and other non-market values;
>
> 2) It does not include the total loss of food to predators in the production foregone calculations for bay anchovy by ignoring the biomass of organisms killed at the station;
>
> 3) It does not consider the contribution of RIS juveniles other than bay anchovy to RIS predators ... (ESSA Report, page 75).

PSEG's estimates of pounds lost to the fishery (referred to as catch foregone by ESSA) were used as inputs to PSEG's assessment of benefits associated with technology alternatives. The estimates were not intended to be impact assessment endpoints, as ESSA apparently erroneously presumed (see foregoing discussion on Indicators of Adverse Impact). For the intended purpose, i.e., input to a benefits assessment, PSEG's focus on commercial and recreational harvests is entirely appropriate. As discussed in Section VI, above, PSEG's focus on commercial and recreational harvests is an accepted and appropriate approach for conducting cost-benefit assessments.

PSEG rejects ESSA's view that PSEG should include estimates of "fish lost to the ecosystem," bay anchovy "biomass killed at the station," and the "contribution of RIS juveniles other than bay anchovy to RIS predators" using the methods advocated by ESSA. Including estimates of these quantities would not produce a valid estimate of "total biomass lost to the ecosystem," as ESSA claims. ESSA's method for estimating "total biomass lost to the ecosystem" is not scientifically valid because it ignores fundamental properties of ecosystems in favor of algebraically tractable but biased oversimplifications.

As discussed below in Section VII.C., fish production within the Estuary is ultimately determined by primary production. The Station does not remove biomass from the ecosystem, and does not alter the productive capacity of the ecosystem. Rather than being removed from the ecosystem, entrained and impinged fish are returned to the Estuary where they are available for consumption by other organisms. If not consumed, they decompose and the nutrients released become available for new primary production. Moreover, the prey organisms that would have been consumed by the entrained or impinged fish are available for consumption by the survivors. Because of reduced competition and increased prey availability, the survivors grow more rapidly and suffer lower rates of natural mortality. Ultimately, a large fraction of the prey biomass lost due to the deaths of entrained and impinged fish may be recovered due to a compensatory increase in the prey biomass provided by the survivors.

While the degree to which compensatory processes offset the direct effects of such losses at the Station is unknown, the processes themselves are well documented in Appendix I of the 1999 Application. It is possible that the only biomass actually lost to the ecosystem is the biomass of the entrained and impinged organisms at the time of death ("biomass killed" in ESSA's terminology). Even this loss may simply be a transfer of biomass from the pelagic food web to the benthic food web, with no net loss in ecosystem productivity. ESSA's method (Section 5.2.3.1 of the ESSA Report) of estimating "total biomass lost to the ecosystem" does not account for any of these fundamental ecosystem properties, and therefore estimates derived from its method are biologically meaningless.

Based on its estimates of "total biomass lost to the ecosystem" ESSA claims that PSEG's estimates of production foregone and catch foregone are biased low:

> ...the actual total biomass of fish lost to the ecosystem (including fisheries, station losses, and losses of food to predators, summed over all species) is at least 2.2 times greater than that listed in the Application. (ESSA Report, page 75.)

In addition to the scientific flaws in ESSA's estimates of "total biomass lost to the ecosystem" ESSA's claim that "the actual total biomass of fish lost to the ecosystem ... is at least 2.2 times greater than that listed in the Application" seriously misrepresents information presented in the Application. PSEG did not present estimates of "total biomass of fish lost to the ecosystem" in the Application, and did not imply that its estimates of pounds lost to the fishery could be construed as such.

ESSA also criticizes PSEG's production and catch foregone estimates because inputs to the estimates contain uncertainties:

> The input data and parameters contain some significant uncertainties due to a basic lack of information on some of these stocks and also to uncertainties in the estimates of station mortality. As a result, significant uncertainties about the final loss estimates should be considered. (ESSA Report, page 75.)

PSEG is well aware that inputs to its estimates of pounds lost to the fishery contain uncertainty, as do all inputs that are based on field data. In recognition of these uncertainties, PSEG deliberately chose methods for estimating pounds lost to the fishery that would err on the side of producing overestimates so that estimates of benefits associated with technology alternatives would be overstated and not understated. Because PSEG's methods for estimating pounds lost to the fishery do not account for the effects of compensatory mortality and growth, and the effects of alternative energy pathways within the estuarine food web, the estimates are likely biased high.

ESSA also repeats here the position expressed in Section 2.0 of its Report regarding trends in RIS abundance and the implication of those trends to estimates of natural mortality rates used in the Application:

> [W]e believe that natural mortality rates were overestimated for at least the 7 RIS species that are increasing (i.e., due to the equilibrium assumption used in life cycle balancing), and therefore the actual total biomass of fish lost to the ecosystem should increase further than the 2.2-fold amount discussed above. (ESSA Report, page 75.)

As discussed in Section IV.D.3, above, ESSA's presumption that increases in abundance of recruits implies increases in age-0 survival is not correct, and is not consistent with results from recent stock assessments conducted by the NMFS and ASMFC. For example, during the recent period of increases in weakfish and striped bass recruitment, age-0 survival of these stocks have decreased (ASMFC 1999 and NMFS 2000), not increased as ESSA erroneously states. The increases in recruitment have been due to increases in spawning stock size, the increases in spawning stock size have been due to reduced fishing mortality, and the decrease in age-0 survival has been due to compensatory mortality in response to the increased production of eggs. ESSA's hypothesis regarding the relationship between age-0 survival and trends in recruitment is not consistent with basic fish population dynamics or with relevant data and information from resource management agencies.

c. Balanced Indigenous Community (BIC)

ESSA states that PSEG's analysis of the BIC benchmarks has three major limitations. PSEG finds that ESSA's comments on the BIC analysis frequently misstate the objectives and results of the BIC analysis, and sometimes misconstrue the published scientific literature or the requirements of the applicable regulatory guidance.

The first limitation of PSEG's BIC analysis, according to ESSA, is that:

> [T]he fish community is not adequately characterized by the indices developed for the Permit Application. These indices are of undocumented but generally low sensitivity to power stations and other stresses, of unknown ecological significance, and based on data from a small geographical subset of the range occupied by the community. Thus it is not possible to determine the actual impact of the Salem station on a Balanced Indigenous Fish Community using the data and analyses presented. (ESSA Report, pages 75-76.)

Contrary to ESSA's statement, however, the two community indicators used by PSEG, which are species richness and species density, are well-documented in the scientific literature and are recognized in a paper cited by ESSA as being sensitive indicators of environmental stress. Although PSEG's quantitative analysis of fish community data was limited to the Near-Field Region, this region is 20 miles long, extending roughly ten miles upstream and downstream of the Station, and represents an ecological zone (the freshwater/saltwater mixing zone) that is distinctly different from the high-salinity Delaware Bay and the freshwater Delaware River. If Station operations were adversely affecting fish community composition in the Delaware Estuary, those effects should be observable in the region most directly affected by the Station, i.e., in the Near-Field Region. Moreover, PSEG's conclusion that the Salem Station is not adversely affecting the fish community present in the Near-Field Region is consistent with the conclusion of O'Herron (1994), who found that the fish community present in the Delaware River upstream from the Station changed very little between the 1970s and the 1990s.

The second limitation in PSEG's BIC analysis, according to ESSA, is that:

> ... it is unrealistic to assume that a few key statistics for one component (fish) are sufficient to detect changes in a highly variable system. The assumption that "no observed change" means "no negative effect" is also unwarranted, given this natural variability, high levels of measurement error, changes in sampling methods, and the potential masking of negative impacts of the station by improvements in water quality and changes in fisheries management. (ESSA Report, page 76.)

ESSA's second criticism of the BIC analysis, which relates to the variable nature of the estuarine environment, implies that PSEG's conclusions were unrealistically based on the failure to detect statistically significant changes in a few simple statistics, and that negative impacts of the Station may have been masked by natural variability, high levels of measurement error, changes in sampling methods, improvements in water quality and changes in fisheries management. PSEG's analysis of species presence/absence data and species turn-over show, however, that the species richness of the Near-Field region has been nearly invariant from year to year over the past 30 years and that the number of species collected per sample has actually *increased* over that period (contrary to the decrease that would be expected if Station operations were adversely affecting the fish community).

Indeed, PSEG specifically investigated the effects of confounding environmental influences using an "impact hypothesis" approach. PSEG found that changes in the relative abundance of predator and prey fish species in the Estuary over the past 20 years were consistent with the expected effects of water-quality improvements and reduced fishing mortality, but inconsistent with the expected effects of depletion of vulnerable populations by the Station. ESSA did not provide any specific comments on this component of PSEG's analysis.

The third limitation of PSEG's BIC analysis, according to ESSA, is that:

> ... in focusing on a balanced indigenous fish community, the PSE&G Application does not consider other components of the ecosystem such as shellfish, plankton and benthos, as well as other indicators of ecosystem function and structure. (ESSA Report, page 76.)

ESSA implies here that PSEG failed to perform an adequate assessment because the BIC analysis does not evaluate impacts on other components of the ecosystem, or on other (unspecified) indicators of ecosystem structure and function. While shellfish were not included in the BIC analysis, a representative and commercially important shellfish species (blue crab) is addressed in other components of the 316(b) Demonstration. Plankton and benthos were not addressed because, as is stated in USEPA's 1977 draft guidance on 316(b) determinations, these species are not vulnerable to adverse impacts related to entrainment and impingement.

d. Trends Analyses and Retrospective Assessment

(1) Trends Analyses

> ESSA summarizes its review of the trends analyses presented in Appendix J of the Application by stating that "we conclude that the Appendix J analyses should be considered *exploratory* in nature only and that conclusions based on them are premature and overstated." (ESSA Report, page 76.)

This assertion by ESSA ignores the stated purpose of PSEG's trends analyses. The conclusion that PSEG drew from the trends analyses was that the data show no evidence of a continuing decline in the abundance of most juvenile finfish RIS (PSEG's second benchmark of adverse environmental impact). In fact, the data provide positive evidence of increases in the abundance of seven of nine juvenile finfish RIS. Further, ESSA's assertion ignores relevant conclusions drawn by other researchers who have examined the same data.. For example, ESSA fails to note that Weisberg et al. (1996) concluded:

> Abundance of juvenile striped bass and American shad, two important game species in the river ... both increased more than 1,000-fold during the last decade.

And the Delaware Estuary Program (Santoro, 1998) concluded:

> A number of fisheries have shown a resurgence in recent years. ... Increases have been noted in the abundance of American shad, weakfish, striped bass, Atlantic croaker, Atlantic silversides, bay anchovy, black drum, hogchoker, northern kingfish and striped anchovy.

Furthermore, ESSA's own report contains several statements that support PSEG's conclusion and are contrary to ESSA's own conclusion:

> The trends analysis presented in Appendix J of the Application indicates that *most fish populations in the Delaware River are expanding* ... (ESSA Report, page 6, emphasis added).
>
> ... we believe that natural mortality rates were overestimated for at least *the 7 RIS species that are increasing* ... (ESSA Report, page 75, emphasis added.)
>
> *If a stock were actually increasing (as is the case for 7 of 9 RIS)* then the adjusted "M" values required to keep the population at equilibrium will be higher than the actual M operating in the population. (ESSA Report, page 99, emphasis added.)

PSEG finds it difficult to reconcile ESSA's characterization, in one section of its review, of PSEG's analyses as "exploratory" and PSEG's conclusions as "premature and overstated," with its embracing of those conclusions in other sections of its review.

Further, ESSA states that:

> Changes in relative abundance indices over time are confounded with changes in other factors (i.e., changes in water quality, harvest rates) that may mask the effects of the station. This makes it impossible to draw conclusions about the impact of Salem on the RIS finfish and blue crab populations using the trend analyses. (ESSA Report, page 76.)

This statement suggests that the trends analyses were intended to determine the effects of entrainment and impingement on fish stocks. However, elsewhere ESSA acknowledges and correctly states the objective of the trends analyses: "It is to assess the trends in Age 0 RIS fish." (ESSA Report, page 110.)

As clearly stated in the Application, the trends analyses were used only to characterize empirical trends in abundance of age-0 RIS fish for the period of record. The results from these analyses were never intended to be, and are not, interpreted in a vacuum. Interpretations of the results from the trends analyses are discussed in Appendix F and Appendix H of the Application. In Appendix F, the results from the trends analyses are interpreted in the context of alternative impact hypotheses as part of the BIC assessment. In Appendix H, the trends analyses is only one of many types of information on the historical condition of the RIS stocks that are reviewed as part of a cumulative assessment.

ESSA states further that:

> We also cannot conclude that increasing trend in relative abundance means no power station impact due to the confounding influences of changes in fishing mortality (F) and water quality. This confounding raises the question about whether the trend data

> on relative abundance are useful for addressing the impact of Salem on RIS finfish species. (ESSA Report, page 76.)

If by this statement ESSA means that it is not possible to quantify what the magnitude of trends would have been in the absence of Station operations, PSEG agrees. However, that was never the purpose of the trends analyses. As discussed above and in the Application, the trends analyses are simply one part of an integrated and holistic approach to the assessment of adverse environmental impact. Within the context of this approach, the trends analyses do provide a useful means for addressing the impact of Salem.

ESSA also criticizes PSEG's trends analyses by alleging that other researchers working with the same datasets used by PSEG would come to different conclusions due to their use of different methods:

> Differences in the average CPH calculated for Appendix J and those calculated by other researchers using the same data are disturbing. In some instances, these differences can lead to different conclusions. (ESSA Report, page 76.)

As discussed in Section VIIE.1.d below, the differences ESSA found most "disturbing" apparently were due to ESSA's errors in transcribing data from a 1996 paper by Weisberg, et al. PSEG is not aware of any material inconsistencies between its conclusions regarding trends in abundance of RIS and conclusions drawn by other researchers.

ESSA also suggests that PSEG did not present any diagnostic information that would help a reader of Appendix J identify influential data points:

> ... an important caveat is that a similar result (e.g., positive significant slopes) for different surveys can occur for different reasons that may not be related to a true increase in abundance. It is therefore important to document the diagnostic procedures used to assess each result and to account for different processes that might underlie results for different surveys. For example, a few large data values can affect the magnitude of the regression slope. We feel that these assumptions are not adequately addressed in Appendix J. It is misleading to present summary results of trend analysis in tables without referencing supportive details. (ESSA Report, page 76.)

As discussed in Section VII.E.1.d, below, the diagnostic plots in Appendix J are more than adequate for identifying influential data points. One diagnostic plot accompanies each test for trend (i.e., one per species and sampling program), and each diagnostic plot depicts each annual index of abundance and the approximate 95% confidence interval for each annual index value. Large data values that might have affected the magnitude of the regression slopes are easily identified from these plots. Thus, contrary to ESSA's statement, those plots provide the "supportive details" that identify "large data values [that] can affect the magnitude of the regression slope."

In its summary, ESSA also alleges that PSEG did not address the assumptions underlying its trends analyses:

> Numerous assumptions are made about the relationship of the average catch-per-haul (CPH) indices to the populations. The validity of these assumptions is not addressed in Appendix J. (ESSA Report, page 76.)

Although not stated clearly in ESSA's summary, this criticism appears to be a reference to the assumptions discussed in Section 5.4.1.2 of ESSA's report, in which case the assumptions in question address the statistical population of interest and the relationship between relative abundance and absolute abundance. As discussed in Section VII.E.1.b, PSEG's Application does present summary graphics, including maps, that define the statistical populations of interest (although the technical jargon "statistical population" is not used).

In its summary, ESSA also offers two comments apparently addressed at the trends analyses that PSEG is unable to determine any basis for. Regarding adult stock size, ESSA states:

> ... we cannot conclude that spawning stock biomass (SSB) shows the same trend as Age-0 relative abundance because no supporting evidence is provided. (ESSA Report, page 76.)

Nowhere in the Application does PSEG claim that the results from the trends analyses can be used to make inferences about trends in SSB. PSEG does not understand the basis for ESSA's implication that PSEG did make such a claim.

Similarly, regarding the interpretation of statistically insignificant results, ESSA states:

> We also note that a declining trend that is not statistically significant does not mean it is ecologically unimportant. Statistical significance and ecological significance are not necessarily equal. (ESSA Report, page 76.)

PSEG is unable to determine the relevance of this comment to PSEG's Application. First, of all of the tests for trends that are presented in Appendix J, the only ones that are not statistically significant are *upward* trends; none are declines. Second, nowhere in the Application does PSEG claim an equivalence between ecological significance and statistical significance. As discussed in Section VII.E.e PSEG conducted tests for statistical significance to screen out unreliable results, not to gain insight into the reasons for observed trends.

(2) Retrospective Assessment

ESSA acknowledges the breadth of information included in Appendix H of the Application:

> Appendix H.II is a laudable effort at synthesizing a great deal of information from many separate sections of the Permit Application. (ESSA Report, page 77.)

However, ESSA's other comments and criticisms regarding the Retrospective Assessment, suggest that ESSA did not fully understand the implications of a synthesis of such a breadth of information.

PSEG recognized that a thorough assessment of the cumulative effects of the operation of Salem would require consideration of a vast amount of disparate data and information on the affected RIS populations. PSEG also recognized that considerable uncertainty would exist within this information and data (as is always the case with data and information on aquatic populations). It was also clear to PSEG that no single formula or procedure was available that could be used to analyze all relevant information and data in a holistic manner that would lead to unambiguous answers. Finally, the assessment of cumulative effects (of which the Retrospective Assessment is a part) could not be simply a descriptive discourse on the data and information, but had to provide scientifically defensible conclusions regarding Station effects.

For these reasons, PSEG engaged stock assessment scientists, with decades of experience conducting stock assessments for resource agencies, to assemble and interpret the relevant information and data. The conclusions presented in Appendix H are based on the professional judgement of these scientists.

ESSA's comments and criticisms on Appendix H suggest that ESSA believes it would have been possible to conduct the Retrospective Assessment using some kind of simple, uniform approach. For example, ESSA criticizes Appendix H because not all data are interpreted using a common approach, and ESSA had difficulty with some of the terminology:

> ... it is clear from the text that a common approach to using and interpreting the data used throughout the Application needs to be developed. Inconsistency in the use of terminology [and] poorly defined terms ... detract from the rigor of this section and raises skepticism about the results. (ESSA Report, page 77.)

One example of ESSA's difficulty with terminology apparently is the use of the word "abundance," which means different things in different sections of the Application. ESSA's difficulty, however, is inherent in the nature of stock assessment analyses. Since each species is different, stock assessment experts must take these differences into account when assessing "abundance" for each stock. Moreover, each resource agency responsible for managing fish stocks does things differently, which makes applying a common approach to all species in all situations a practical impossibility.

ESSA also criticizes the Retrospective Assessment for including conclusions based on the professional judgement of stock assessment experts:

> … a tendency to draw conclusions that are not supported by the information presented … raises skepticism about the results. In particular, there is a tendency to draw subjective and unsupported conclusions about the importance of Salem's impact in RIS finfish species. (ESSA Report, page 77.)

As noted above, the conclusions presented in Appendix H are based on the professional judgement of experienced stock assessment scientists. The technical foundation for each conclusion was discussed as part of the Retrospective Assessment, or by reference to other parts of the Application. The interpretation of the technical foundation was also discussed as part of the Retrospective Assessment and was based on the professional judgement of the stock assessment experts. ESSA appears to be seeking some kind of simple, uniform algorithm through which each input can be tracked to a conclusion. PSEG acknowledges that, owing to the complexity of the topic, the conclusions in the Retrospective Assessment are not, and could not be, based on any such simple uniform algorithm.

e. Prospective Stock Jeopardy Analysis

ESSA's review of the stock jeopardy benchmark focuses on three components of PSEG's approach:

- the use of meta-analysis to quantify compensation in RIS species,
- the use of the Equilibrium Spawner-Recruit Analysis (ESRA) to quantify the long-term impacts of the Station on RIS species,
- the use of the Spawning Stock Biomass per Recruit (SSBPR) model as an alternative indicator of long-term Station impacts on RIS species, and
- the validity of PSEG's argument that Station mortality is analogous to fishing mortality.

With regard to the meta-analysis, ESSA states that:

> The limitations of the meta-analysis approach are largely related to four problems:
>
> 1) biases due to measurement errors in the spawner and recruit data;
>
> 2) inherent difficulties in the interpretation of spawner and recruit data;
>
> 3) time series biases due to auto-correlative properties of underlying processes; and

4) lack of similarity of species chosen to represent RIS species." (ESSA Report, page 77.)

The above issues are important from a theoretical perspective. However; ESSA appears to ignore the extensive efforts PSEG made to ensure that compensation was not overestimated. These efforts included using the most conservative of the available models to quantify compensation and to calculate station impacts, using the most conservative of three available approaches to estimate the prior distributions for the meta-analysis, eliminating outlier data sets that reflected unusually strong compensation compared to other data sets used in the meta-analysis, and verifying the compensation estimates where possible, using independent data sets.

In response to ESSA's comments, however, PSEG performed additional sensitivity studies to investigate the potential influence of measurement errors and time series biases on estimates of compensation derived from meta-analysis. These studies show that measurement errors could bias the estimates of compensation by at most 1%. Time series bias could result in overestimation of compensation in some RIS by as much as 10%, but could result in underestimation of compensation in other RIS. For both types of error, the potential biases are more than offset by the conservative assumptions made by PSEG in performing the meta-analysis documented in the 1999 application.

With regard to the ESRA model, ESSA states that:

> The simple models chosen by the authors for the Equilibrium Spawner-Recruit Analysis (ESRA) are both their strength and weakness. The models are easy for us to understand and easy for us to find fault with. Because of the simple nature of the models, and the strong assumption of equilibrium in the analysis, we view the results mainly as a guide to the levels of population impact. The guide is somewhat prejudiced because of biases with measurements of compensation employed in the models and overly exact because of the restricted range of sensitivity studies presented. The levels of bias and narrow range of alternative hypotheses about life history parameters in the model prevent us from drawing any conclusions about the relevance of the results to probable future station impacts. However, the bias in compensation and bias in conditional mortality rates imply that the station impacts based on ESRA are likely lower bounds to probable impacts. (ESSA Report, page 77.)

PSEG agrees with ESSA that equilibrium-based fish population models provide general guides concerning the probable effects of changes in mortality rates due to power plants or fishing. The ESRA model was intended to project impacts of typical rates of Station-related mortality on long-term average population size and fishery yield. Similar models are routinely used by fisheries scientists for similar purposes, e.g., to estimate MSY and F_{msy} for managed populations. PSEG does *not* agree, however, that the models used in the Application are "prejudiced" because of biases in the measurements of compensation and conditional mortality rates. As noted above, PSEG took great care to ensure that the estimates of compensation derived from meta-analysis are underestimated rather than overestimated. Sensitivity analyses performed in response to ESSA's comments confirm PSEG's conclusion that compensation was not overestimated in the Application. Moreover, there is no basis for ESSA's statement that the ESRA results are biased because of the use of biased CMR estimates. Examination of the natural mortality rates used in the CMR calculations (see Section IV.D) shows that there is no bias.

With regard to PSEG's use of the SSBPR model, ESSA states that:

> Spawning Stock Biomass per Recruit (SSBPR) provides a useful tool to establish the lower bound to population level impacts from power station mortality. The technique is a "lower bound" method because it contains the assumption that recruitment levels are unaffected by changes in future spawning levels. Biases in station mortality rates, described in earlier sections, and the narrow range of alternative hypotheses about life history parameters limit the immediate usefulness of the results. (ESSA Report, page 77.)

PSEG agrees that the SSBPR approach provides a useful tool for evaluating Station impacts. However, it is inaccurate to characterize the SSBPR approach as a "lower bound" method. As used in fisheries management, the SSBPR model is *not* a tool for establishing lower bounds on long-term impacts, and the model does not assume that recruitment levels are unaffected by changes in future spawning levels. As documented by Mace and Sissenwine (1993) and by Goodyear (1993), the SSBPR approach makes no assumptions at all concerning the relationship between spawning stock and subsequent recruitment, except that if the spawning stock is reduced to a low enough level, recruitment will decline. The National Research Council (1998) recognized the SSBPR approach as an acceptable approach for defining *conservative* "biological reference points" for regulating fishing mortality, i.e., for limiting fishing mortality rates to levels that do not threaten future recruitment. As demonstrated elsewhere in this Response, the Station mortality rates and life history parameters used as inputs to the SSBPR analysis are not biased.

With regard to PSEG's use of fisheries management concepts in impact assessment, ESSA states that the analogy between fishing and power plants is "inconsistent with Section 316(b) of the Clean Water Act," (ESSA Report, page 77), but that if the analogy is applied anyway, then Station operations should be restricted whenever fisheries managers conclude that an exploited RIS population is being overfished. Moreover, ESSA suggests that striped bass, weakfish, and spot are currently being overfished, indicating a possible need for immediate reduction in Station mortality:

> Fisheries Management Councils meet three or more times each year and they constantly evaluate the status and need for management regulations on particular fisheries. If the Salem Nuclear Power Station were viewed as another fishery then one could ask, "what station management mechanisms are in place to alter station operations should a fish population drop below optimum abundance?"

> The results presented in the Application suggest weakfish, striped bass, and spot are RIS species that are certainly below 50% spawning stock biomass (SSB). If one used the Schaefer model threshold of 50%, then fisheries management actions would need to be taken to reduce exploitation of these stocks. Even with a lower target threshold of, say, 35% SSB then there is a substantial probability that those species would be below the 35% threshold. As discussed in the our review of meta-analysis, it is likely that compensation has been over-estimated for the RIS species which would increase the likelihood that several of the species are below reasonable target thresholds and perhaps below the limit threshold of 20%. On the other hand, a control rule to reduce exploitation below the target threshold was not applied in the ESRA analysis; if it were then that should offset some of the decline due to overestimates of compensation. A difficulty in application of such a control rule to ESRA would be in deciding what part of the reduction in fishing mortality will be accounted for by reducing Salem station operations.
>
> The National Marine Fisheries Service (NMFS) National Standard Guidelines discuss incorporation of risk aversion into catch limits. There are numerous reasons to believe the ESRA analysis is more uncertain than indicated by results in the Application. As a consequence, limit and target thresholds and exploitation rates for RIS species may need to be more precautionary than those normally applied to extensively studied populations, such as those associated with large scale commercial fisheries. (ESSA Report, pages 77-78.)

ESSA's contentions here are inconsistent with applicable regulatory precedents, and fisheries management methods. As discussed elsewhere in this Response, the 1977 draft guidance on 316(b) demonstrations (USEPA 1977) and the Seabrook decision clearly state that assessments of AEI should focus on population-level impacts. Fisheries scientists have developed widely accepted approaches for quantifying impacts of fishing on fish populations. These approaches are directly applicable to assessing impacts of entrainment and impingement, because the impact of killing any particular fish, or removing a particular fraction of the future spawning stock of a population, is the same regardless of whether the mortality is caused by a power plant or by fishermen.

The fact that the scientific principles underlying fisheries management are applicable to assessing impacts of power plants does not mean, however, that power plant mortality should be managed in the same way that fisheries are managed. Fisheries management focuses on managing fishermen because fishing mortality has direct, immediate, and obvious impacts on exploited populations. The Station, in contrast, has been operating for nearly a quarter century without having any observable impact on these populations. There is no need for station operations to be altered in any way in respect to changes in stock characteristics.

Finally, there is no basis for ESSA's use of the ESRA model results to argue that striped bass, weakfish, and spot populations are possibly being overfished, indicating a need for reducing both fishing mortality and station mortality. The Atlantic coastal weakfish and striped bass populations are both fully recovered from over exploitation that occurred in past decades (NMFS 2000, ASMFC 1999). Target fishing rates and spawning stock biomass levels for both stocks are established using strongly-compensatory Shepherd spawner-recruit models. Much lower compensation is included in the ESRA models for these species. The ESRA analysis for spot assumed a range of fishing mortality rates between 0 and 0.6, because no stock assessment exists for this species. The actual rate of fishing mortality on spot is unknown. However, the Delaware Estuary is at the northern end of the range of this species and it is very unlikely that Station mortality could be adversely affecting the coastal spot population. It would be inappropriate to attempt to use the ESRA model to define a "control rule" for reducing mortality imposed on these species, or for allocating restrictions on mortality between fishing effort and Station operations.

Similarly, because the ESRA is not being used to establish target fishing rates for any of the RIS species, there is no need to adjust limits, target thresholds, or exploitation rates to account for uncertainties present in the ESRA analysis.

f. Data and Use of Data

In this brief section, ESSA acknowledges that the many concerns ESSA raises throughout its Report regarding the data collection programs and the use of data generated in those programs in PSEG's Application may in fact be invalid. "In some cases, our concerns may reflect size and complexity of the Permit Application - the appropriate explanation or caveat may exist, but we could not find it." (ESSA Report, page 78.) As the detailed responses developed here in PSEG's Response to ESSA's Report indicate, in fact, more often than not ESSA's concerns are addressed appropriately in the Application.

In ESSA's summary of its review of the data PSEG used in the Application and PSEG's use of those data, it acknowledged the comprehensive nature of the Application and the extensive details provided in the Application:

> Throughout our review, we have been aware that a great deal of effort has gone into the preparation of a comprehensive document. Our detailed criticisms in this and other sections of the review are possible due to the detailed information provided in Appendix F, Attachments 1 and 2. (ESSA Report, page 78.)

ESSA then referred to undefined concerns it had regarding data PSEG used and PSEG's use of those data, but implied that the cause for some of ESSA's concerns was a lack of understanding on ESSA's part that could have been eliminated if documentation presented in the Application had been more clear:

> The examples discussed in the sections above illustrate a number of concerns we have about the data collection programs and the use of data generated in these programs in the PSE&G Permit Application. In some cases, our concerns may reflect size and complexity of the Permit Application - the appropriate explanation or caveat may exist, but we could not find it. (ESSA Report, page 78.)

PSEG agrees that the Application presented a very comprehensive assessment of the Station's effects on aquatic biota, and that the assessment required a substantial breadth of supporting information and data which was documented in Appendix F (and Appendices C, G, H, I, J, and L). PSEG acknowledges that, in places, the documentation in the Application of the data PSEG used, and PSEG's use of those data could have been clearer.

2. Recommendations

a. Indicators of Adverse Environmental Impact

ESSA recommends the following as changes that should be made in a revised Permit Application:

> Additional assessment endpoints should be presented in the Permit Application as indicators of adverse environmental impact, including biomass entrained and impinged and production foregone. Information on these indicators is already present in either the Application or this review (see Section 5.2, page 85). Further analysis of existing data on changes in lower trophic levels should also be included; more intensive monitoring may be required in the future to detect impacts on these indicators. (ESSA Report, page 78.)

For reasons discussed in Section VII.B.2 of this Response, ESSA's recommendations are inappropriate. Estimates of biomass of a species entrained and impinged are simply expressions of Station losses in different units (kg rather than numbers) and are meaningless unless related to some measure of population or ecosystem structure or function. ESSA's proposed measure of production foregone is based on an overly simplified and excessively conservative model of energy transfer in estuarine ecosystems and consequently greatly overstates the actual impact of Station operations. Analysis of data on changes in lower trophic levels (e.g., benthos or plankton) would be irrelevant to NJDEP's permit decision because, as explicitly recognized in EPA's draft guidance on 316(b) determinations, these trophic groups are not vulnerable to adverse impacts from entrainment or impingement.

b. Production and Catch Foregone

ESSA makes eight recommendations regarding production and catch foregone. Seven of them address information in the Application (recommendations #1-7), and one addresses future work (recommendation #8).

ESSA's Recommendation #1

> The biomass lost to the ecosystem should be calculated either using a slightly modified version of the production foregone model for all RIS or the spreadsheet approach. (ESSA Report, page 78.)

PSEG strongly disagrees with this recommendation. As noted above and discussed in Sections VII.B and VII.C, ESSA's method for estimating biomass lost to the ecosystem produces results that are biologically meaningless. Therefore, computing estimates using the methods described in Section 5.2.3 of ESSA's report (using either a modified version of the production foregone model or ESSA's spreadsheet) would not serve any useful purpose.

ESSA's Recommendation #2

> Estimates of the biomass lost to the ecosystem should be used in an expanded cost-benefit analysis. (ESSA Report, page 78.)

PSEG also strongly disagrees with this recommendation because ESSA's method for estimating biomass lost to the ecosystem is not scientifically valid. Inclusion of all components of biomass lost to the ecosystem (using ESSA's method) with appropriate accounting for trophic transfer efficiencies and exploitation rates likely would not materially affect the results of the cost-benefit analyses. As noted above and discussed in Sections VII.B and VII.C, ESSA's method for estimating biomass lost to the ecosystem does not consider important ecosystem properties including compensatory mortality and growth, and alternative energy pathways, and therefore produces severe overestimates of biomass lost. Accordingly, any analyses based on ESSA's methods would severely overstate actual losses to the ecosystem.

Furthermore, before estimates of biomass lost to the ecosystem could be used in cost-benefit analysis, the estimates would have to be translated into equivalent units of commercial and recreational harvest so that a dollar value could be attributed to the losses. Translating biomass lost to the ecosystem requires consideration of trophic transfer efficiencies, apportionment of prey biomass among predator species and fishery exploitation rates (see Section VII.B.5). If these factors are taken into account, the inclusion of ESSA's components of total biomass lost (which are biased high) in the assessment of benefits would not materially affect the results of the cost-benefit analyses (see Section VII.B.5).

ESSA's Recommendation #3

> The contribution of RIS other than bay anchovy to the forage available for commercially and recreationally important species should be examined. This has the potential to significantly increase the estimates of lost revenue in the fishery. (ESSA Report, page 78.)

ESSA's contention that including "the contribution of RIS other than bay anchovy to the forage available for commercially and recreationally important species" has the potential "to significantly increase the estimates of lost revenue in the fishery" is incorrect. As described in Section VII.B.5, inclusion of this component from ESSA's method of estimating biomass lost to the ecosystem would not materially affect the results of the cost-benefits assessment. Inclusion of this component would not "significantly increase" estimates of pounds lost to the fishery (and hence revenue) because the forage biomass must be converted into predator biomass before it is available to the fishery. That transfer from forage to predator biomass results in a loss of roughly 90% of the biomass (i.e., assuming a 10% trophic transfer efficiency). Also, the forage biomass must be allocated among a range of predator species, some of which are not recreationally or commercially important. Therefore, only a small fraction of the contribution of RIS to forage actually would become biomass of the recreationally and commercially important species, and only a fraction of that biomass would be harvested.

Thus, PSEG disagrees with this recommendation since including estimates of the contribution of RIS to forage for commercially and recreationally important species (even if those estimates were based on ESSA's scientifically invalid methods) likely would not materially affect the results of the cost-benefit analyses, PSEG rejects this recommendation by ESSA.

ESSA's Recommendation #4

> A more detailed analysis of the levels of uncertainty in the production and catch foregone estimate needs to be considered. In the absence of this analysis it must be recognized that estimates for catch and production foregone that are two or more times those shown in Attachment F4 can readily be obtained within the range of uncertainty of parameters for early life stage survivals, weights, adult mortalities, fishing mortalities and station mortality. In some cases, for example white perch, the upper bound of feasible catch reductions may be much higher. A species by species analysis would help to refine these bounds. (ESSA Report, page 78.)

PSEG is troubled by the lack of balance ESSA shows in this recommendation, where ESSA characterizes what it believes is the potential upper bound of uncertainty in catch and production foregone estimates, but does not provide a balanced characterization of the lower bound. Had it done so, ESSA would have indicated to NJDEP that the true catch and production foregone numbers could be less than one-half the estimates presented in the Application. As discussed in Section VII.B.2.d other paces in its Report, ESSA acknowledges the possibility that PSEG may have severely overestimated catch and production foregone. For example, in ESSA's discussion of data uncertainties, ESSA states:

> The effect of using the Appendix G6 survival parameters for striped bass is to reduce catch foregone by 35%. (ESSA Report, page 99.)
>
> ... we reran some of the base case analyses with the values from the literature prior to the life cycle balancing process. For weakfish the catch foregone was decreased by 50% ... (ESSA Report, page 99.)

Yet ESSA's recommendation here inexplicably does not provide a reference the potential lower bound, which has the unfortunate effect of suggesting that PSEG's estimates are biased low.

ESSA, no doubt, is well aware of the scientific difference between bias and uncertainty. Bias refers to a potential error that is known to produce either an over-estimate or an underestimate of a parameter value, where the direction of the error is known. Uncertainty refers to a potential error with no known directional bias, i.e., it could produce an over-estimate or an under-estimate, and the direction of the error is not known. By characterizing only the upper bound of uncertainty in this recommendation, ESSA unfortunately creates the impression that the uncertainties that is inherent in aquatic analyses such as in PSEG's Application in fact contain bias. This, is false: the analyses are not biased.

<u>ESSA's Recommendation #5</u>

> The estimates used for the survival rates of Age-0 blueback herring in the Appendix F4 analysis should be reviewed given the different values used in Appendix G6. (ESSA Report, page 79.)

PSEG has reviewed the survival rate estimates for age-0 blueback herring and found no inconsistencies. ESSA's recommendation is based on erroneous assumptions. ESSA mistakenly assumed that the annual survival rates for blueback herring presented in Attachment G6, Table 6 reflect natural mortality only. In fact, they include both natural mortality and fishing mortality. Moreover, ESSA erred in its calculation of a daily mortality rate for age 0 blueback herring (presented in Table 5.14 of its review) from the value presented in Attachment G6. As discussed in Section VII.B.4.d, below, ESSA's conclusion that:

> For blueback herring the different values chosen for Age-0 survival are critical. This difference has a large effect, increasing both catch and production foregone of blueback herring by 14 times. (ESSA Report, page 99.)

was erroneous and resulted from a misinterpretation of PSEG's analyses.

<u>ESSA's Recommendation #6</u>

> The base case entrainment and impingement mortality estimates should be compared against the historical averages to ensure consistency. (ESSA Report, page 79.)

PSEG has compared the Base Case and historical entrainment and impingement loss estimates and found no inconsistencies. ESSA evidently did not consider the effects of improved impingement survival for white perch on the modified intake screens, and did not consider the effects of inter-annual variability in the vulnerability of weakfish and white perch eggs to entrainment. (<u>See</u> Section V.B.3.c) Because white perch spawn upriver of the Station, and weakfish generally spawn down-river of the Station, entrainment losses of eggs are not observed in all years. The greatest annual loss estimates during the Base Case years (1991—1998) for weakfish and white perch eggs were for 1998. Since the Base Case scenario includes scheduled spring outages, and no spring outages occurred in 1998, the Base Case water withdrawals were less than the historical water withdrawals during some periods in the spring (when weakfish and white perch eggs are subject to entrainment). Therefore, the Base Case loss estimates for weakfish and white perch eggs were appropriately lower than the estimates for historical conditions.

ESSA's Recommendation #7

> Projected increases in RIS abundance should be included in the estimates of catch and production foregone. (ESSA Report, page 79.)

Apparently, this recommendation is based on ESSA's belief that stocks that have exhibited increases in abundance in recent years will continue to increase in abundance in the future. It is surprising that ESSA (so concerned about uncertainties in PSEG's analyses) would recommend alternative analyses that require predicting the future, which surely must involve more uncertainty than simply characterizing the past.

PSEG did not present any quantitative projections of RIS abundance in the Application, and ESSA provided no estimates of projected increases in RIS abundance, nor did it provide any suggestions on how projected increases should be computed. In the absence of scientifically valid estimates of "projected increases in RIS abundance," PSEG must view this recommendation as a theoretical exercise that would serve no useful purpose in the context of the Application. For this reason, PSEG rejects this recommendation as proposed by ESSA.

ESSA's Recommendation #8

> The potential to customize intake protection strategies to minimize the impact of the station on catch foregone and the biomass lost to the ecosystem should be further investigated. (ESSA Report, page 79.)

PSEG strongly disagrees with this recommendation. ESSA's recommendation that PSEG investigate how to "minimize the impact of the station on catch foregone and the biomass lost to the ecosystem," with no reference to costs or to benefits associated with the biomass lost, is inconsistent with NJDEP's decision-making paradigm. NJDEP's decision paradigm is clearly stated in the Draft Permit Fact Sheet:

> Under Section 316(b), a permitting agency has the ultimate burden of persuasion that any BTA measure that it requires is "available" for a given facility, and that its *costs are not "wholly disproportionate"* to environmental benefits.

Thus, ESSA's recommendation is inappropriate in the context of the Department's review of PSEG's Section 316(b) Demonstration permit requirements.

Furthermore, as discussed above and in Sections VII.B and VII.C, below, ESSA's method for estimating "biomass lost to the ecosystem" is not scientifically credible.

c. Balanced Indigenous Community (BIC)

ESSA recommends that the current Permit Application be revised to include "a more rigorous sensitivity analysis," "more open discussion of the weaknesses in the data used," and a "much more cautious set of conclusions." (ESSA Report, page 79.) ESSA also recommends that, for the future, the "benchmarks" ("indicators," in PSEG's terminology) should be expanded to include "a more robust suite of indicators" that reflects "ecosystem well-being" and that is "consistent with the U.S. EPA's 1998 Guidelines on Ecological Risk Assessment." (ESSA Report, page 79.) ESSA recommends that the indicators should be developed in the context of other ongoing monitoring efforts, and should involve collaboration with other agencies. ESSA suggests, as an initial step, the development of an "explicit conceptual framework," and provides a list of twelve "considerations" that might be included in such a framework. Finally, ESSA recommends that the proposed monitoring program should be "tested and refined, with research and field studies that test indicators, calibrate methods, and determine the relative importance of different stressors."

ESSA's recommended program would be a remarkably ambitious undertaking and PSEG agrees that such a program would greatly improve the scientific basis for managing the ecological resources of the Delaware Estuary. However, the program proposed by ESSA far exceeds the scope appropriate for determining PSEG's compliance with NPDES Permit conditions. Although PSEG will conduct an expanded Biological Monitoring Program during the next permit period, the objectives of that program will be focused on measuring (1) the impacts of Station operations on vulnerable RIS populations, and (2) the success of PSEG's Estuary Enhancement Program.

d. Trends Analyses and Retrospective Assessment

(1) Trends Analyses

ESSA makes eight recommendations to improve the rigor of Appendix J, and two recommendations for future applications. ESSA's eight recommendations to improve Appendix J (found at ESSA Report, page 80) are:

1. expand the discussion of statistical methods to explicitly state the underlying statistical assumptions;

2. evaluate how well data and results meet these assumptions;

3. assess and discuss potential sources of bias in the data and indices as well as its implication for the interpretation of results;

4. assess the utility of each survey for indexing each RIS finfish species;

5. ensure that the preparation, use, and interpretation of data is externally consistent between PSE&G and the agencies that collect it;

6. acknowledge the severe confounding that is present in the time-series;

7. report retrospective statistical power for non-significant results; and

8. develop estimates of ecological effect size, or effects that are important to detect in trend analyses.

PSEG agrees that additional discussion about the first three recommendations would improve the rigor of Appendix J. However, as discussed in Section VII.E.1, below, PSEG's analyses do not violate key assumptions, and potential sources of bias did not adversely influence results of the trends analyses. Therefore, although these topics were not fully discussed in Appendix J, they did not compromise the results of the analyses.

ESSA's fourth recommendation that PSEG assess the utility of each survey for indexing each RIS was in fact addressed in the Application. The utility of each survey for indexing each RIS is discussed in detail on pages 6-11 of Appendix J. As fully explained there, PSEG gave careful consideration to inter-annual consistency in sampling techniques, the life histories of each of the RIS, and to the catch rates of each RIS in each region and month of each sampling program. Only after this background information was systematically assembled and reviewed were programs, and months and regions for each program, selected for the purpose of representing relative abundance of each of the RIS. As documented in Appendix J, not all programs were judged appropriate for all RIS.

Nevertheless, PSEG purposefully erred on the side of including additional information (i.e., data from additional sampling programs) on each RIS, rather than excluding information *a priori*. PSEG believed it was important not to ignore information that might have shed some light on the condition of the fish stocks. If the sampling variability of catches from a program for a particular RIS was too large to produce meaningful results, this fact was uncovered by the statistical analyses PSEG conducted on these data sets in connection with preparing the Application. Only statistically significant results were relied upon for drawing conclusions.

Regarding ESSA's fifth recommendation that PSEG should ensure that "the preparation, use, and interpretation of data is externally consistent between PSE&G and the agencies that collect it," PSEG agrees that this would improve the rigor of Appendix J. However, PSEG's data analysis methods were decided based on the recommendations of the fisheries experts who helped prepare the Application. Although PSEG's data analysis methods may have differed from those of the agencies that collect it, this does not compromise the results of PSEG's analyses. As discussed in Section VII.E.1, PSEG's conclusions are consistent with those of published studies that have used the same datasets.

Regarding ESSA's sixth recommendation that PSEG should acknowledge the severe confounding that is present in the time-series, PSEG rejects this recommendation because it is inconsistent with the objectives of the trends analyses. The trends analyses are not intended to determine the effects of entrainment and impingement on fish stocks, as is suggested by ESSA's recommendation. As clearly stated in the Application, particularly in the documentation for the trends analyses that is provided in the Application's Appendix J, the trends analyses were used simply to characterize empirical trends in abundance of age-0 RIS fish for the period of record.

Further, the results from the trends analyses were never intended to be, and were not, interpreted in a vacuum. Interpretations of the results from the trends analyses are discussed in Appendix F and Appendix H of the Application. In Appendix F, the results are interpreted in the context of alternative impact hypotheses as part of the BIC assessment. In Appendix H, the trends analyses are the source of one of the many types of information on the historical condition of the RIS stocks that were reviewed as part of a cumulative assessment.

PSEG disagrees with ESSA's seventh recommendation that retrospective statistical power for non-significant results should be reported. The purpose of the statistical tests performed as part of the trends analyses was to identify trends (increasing or decreasing) in the indices of abundance that could be explained simply by the magnitude of sampling error in the annual estimates of average CPH (i.e., the indices of abundance). Even if there is no underlying trend in abundance of a fish stock, the sampling error in average CPH estimates generally will produce non-zero estimates of slopes (or differences) in the average CPH estimates. The purpose of the statistical tests, as applied in the trends analyses, was to identify which trends in average CPH estimates could have been due to sampling error alone, even if there was no underlying trend in abundance. Those trends were labeled as being not statistically significant, and were ignored when the results from the trends analyses were interpreted because they were viewed as unreliable.

Finally, PSEG disagrees also with ESSA's eighth recommendation that PSEG should develop estimates of ecological effect size, or effects that are important to detect in trend analyses. Like others, this recommendation is based on ESSA's misconception regarding the objectives of the trends analyses. The trends analyses were not intended to separate the effects of Station operation from the effects of other anthropogentic activities (like fishing) on fish populations. As clearly stated in the Application, particularly in the documentation of the trends analyses provided in Appendix J, the trends analyses are used simply to characterize empirical trends in abundance of age-0 RIS fish for the period of record. Interpretations of the results from the trends analyses are discussed in Appendix F and Appendix H of the Application.

With regard to future Applications, ESSA makes two recommendations:

ESSA's Recommendation for Future Applications #1

> ... we recommend the development of methods to explore the link between Salem and fish abundance more directly. For example, look at the relationship between abundance in the nearfield region and the number of Age-0 fish that are entrained. (ESSA Report, page 80.)

PSEG disagrees with this recommendation. PSEG does not understand the purpose of studying "the relationship between abundance in the nearfield region and the number of Age-0 fish that are entrained." There is no question that the number of fish entrained is related to the abundance of fish in the nearfield region. For example, if no fish are in the nearfield region, none can be entrained. But PSEG does not understand how studying this relationship would provide information useful to the assessment of adverse impacts; nor why this study would be preferable to monitoring for trends in abundance; nor what is the link between the abundance of fish in the nearfield and the population of age-0 fish. PSEG finds this recommendation as proposed to be *ad hoc* and ill-conceived.

ESSA's Recommendation for Future Applications #2

> Work with other monitoring agencies to develop a common, consistent and coordinated approach to using and interpreting relative abundance indices. (ESSA Report, page 80.)

PSEG agrees with this recommendation. As noted in Section VII.A.2.f, below, PSEG has already begun developing monitoring collaborative efforts with resource management agencies monitoring aquatic biota in Delaware Estuary.

(2) Retrospective Assessment

ESSA indicates that a number of modifications could be made "to improve the rigor of Appendix H.II for the current Application and improve similar syntheses in future applications." (ESSA Report, page 80.)

For the current Application, ESSA recommends that:

> An effort should be made to quantitatively define important impacts to RIS finfish species. It is important to clearly define terms and make sure that their use is consistent with other sections of the Application. A consistent method for using and interpreting data and results taken from other analyses throughout the Permit Application needs to be developed. Ensure that ancillary data sources do not "double count" results and that caveats associated with the ancillary data make it through to Appendix H.II. This is especially important when using data from outside agencies. Keep arguments consistent between species-specific discussions. When raising alternative hypotheses, make them explicit and provide evidence both for and against. Make sure that the uncertainty in data and analytical results is carried through to Appendix H.II. Ensure that conclusions about the impact of the Salem station include the proper caveats. (ESSA Report, page 80.)

For future Applications, ESSA recommends:

> We also recommend that a rigorous process for the evaluation of alternative hypotheses about factors that can influence fish survival get started. This may require the modification and coordination of existing monitoring programs to collect new information. Ensure that a coordinated and consistent approach is taken to the preparation, application and interpretation of data and results within the context of the Permit Application analyses. (ESSA Report, page 80.)

These recommendations thus repeat recommendations and concerns that PSEG has addressed above and in detail in Section VII.E, below.

e. Prospective Stock Jeopardy Analysis

ESSA makes separate sets of recommendations for four aspects of the stock jeopardy analysis: meta-analysis and compensation, Equilibrium Spawner Recruit Analysis (ESRA), Spawning Stock Biomass Per Recruit (SSBPR), and application of fisheries management concepts to power station impacts. This section of the Response deals in turn with each set of recommendations.

(1) Meta-Analysis and Compensation

ESSA has five recommendations concerning meta-analysis and compensation. ESSA's first recommendation was that PSEG should indicate in the current Application the "exploratory nature" of the analysis (ESSA Report, page 80). PSEG strongly disagrees that its meta-analysis is "exploratory." All the data and methods used in the assessment have been subjected to rigorous peer review and published or accepted in respected scientific journals (Myers et al. 1995, Myers and Barrowman 1995, Myers and Barrowman 1996, Myers et al. 1999, Myers 1997, Myers and Mertz 1998, Myers et al. 1997, Myers et al. 2001a, Myers et al. 2001b, Hilborn and Liermann 1998, Liermann and Hilborn 1997, Punt and Hilborn 1997). As is shown in Section VII-F of this response, comparisons of compensation estimates derived from meta-analysis to independently derived stock-specific estimates consistently show that meta-analysis is conservative and does not overestimate compensation. No further research or documentation is needed to support the use of met-analysis in the Application.

ESSA's second and third recommendations concern sensitivity studies. ESSA recommends that, for the current Application, PSEG should perform "a sensitivy study that shows the affect [sic] on estimates of steepness of a simple analysis of a range of assumed levels of uncorrelated measurement errors on estimates of spawners" and also that PSEG should perform "a simulation study of autocorrelation errors, using a 'typical' example from each species domain" (ESSA Report, page 81). PSEG agrees that these sensitivity analyses are valuable and has performed them in response to ESSA's recommendations. The methods and results of these sensitivity analyses are documented in Appendices 2 and 4. The results confirm the opinions of PSEG's fisheries experts that the quantitative influence of uncertainties related to measurement errors and autocorrelation are small and are more than offset by the conservative assumptions adopted by PSEG in developing and applying the meta-analysis.

ESSA's fourth recommendation is that, for the long term, PSEG should replace the entire meta-analysis approach with a solid program of monitoring of RIS species and measurements of vital statistics. Implementing this recommendation would be beyond the scope of a monitoring program appropriate for determining compliance with NPDES Permit conditions. However, much of the recommended information is already being collected by the National Marine Fisheries Service and by state monitoring programs, and is being synthesized in stock assessments performed by the Atlantic States Marine Fisheries Commission's technical committees. Future assessments of Station impacts on striped bass and weakfish, if needed, will be based on spawner-recruit models developed by the ASMFC and used in management of the stocks. If similar stock assessment models become available for other RIS species, they will be used by PSEG.

ESSA's fifth recommendation is that PSEG should design an experimental approach for manipulating stock levels to generate contrast in RIS species abundance levels. According to ESSA, such an approach would enhance the detection of compensation. PSEG disagrees with ESSA. The proposed experimental approach would serve no useful purpose and could not conceivably be implemented either by PSEG or by state and federal resource management agencies. In PSEG's view, the suggestion that PSEG, NJDEP, or any other agency should deliberately reduce the abundance of any species to a low level in order to test hypotheses concerning responses of populations to Station impacts is absurd and should not be taken seriously.

(2) Equilibrium Spawner-Recruit Analysis (ESRA)

ESSA makes three recommendations concerning the ESRA model. All three of ESSA's recommendations relate to minor modifications of the model applications included in the 1999 Application, and would not alter the conclusions derived from the stock jeopardy analysis.

ESSA's first recommendation is that "To avoid the problem of timing of compensation, all power station mortality should be treated as post-compensatory in the current Application" (ESSA Report, page 81). This is in effect a recommendation to perform a "worst-case" analysis that is not supported by the available data on Station losses. As is clearly documented in the 1999 Application (Appendix L, Tabs 8 and 9), losses of fish at the Station are primarily losses of eggs yolk-sac larvae, and post yolk-sac larvae. As documented in Appendix I of the 1999 Application and in Appendix 2 to this Response, many compensatory mechanisms operate in all life stages of fish, including juveniles and adults. Density-dependent growth and mortality resulting from competition for limited food resources can only occur in actively feeding life stages, and so cannot occur in eggs and yolk-sac larvae. Hence a substantial fraction of Station mortality must be pre-compensatory. The ESRA analysis contains already a high degree of conservatism due to the conservative approach used to estimate compensation and the use of a conservative spawner-recruit model (see Section VII.F.1 of this response). There is no need to add additional conservative assumptions.

ESSA's second recommendation is that "Bias corrections to compensation and a wider range of uncertainty in compensation should be included in the current Application's analyses" (ESSA Report, page 81). Such bias corrections are unnecessary. As noted above, sensitivity analysis performed to support preparation of this Response (Appendices 1 and 3) show that any biases introduced by measurement errors and time-series autocorrelations (the two major potential sources of bias identified by ESSA) are small and are more than offset by the conservative assumptions made in PSEG's analysis.

ESSA's third recommendation is that "A sensitivity analysis showing consequences to a wide range of alternative levels of compensation, alternative life-history parameters, fishing mortality, power station mortality, and natural mortality should be provided in the current

Application." (ESSA Report, page 81.) PSEG believes that a more comprehensive sensitivity analysis involving a wider range of parameter values and assumptions than were addressed in the 1999 Application might be an interesting academic exercise but would not change the conclusions of the analysis. Uncertainties in estimates of compensation and in estimates of other key parameters (e.g., the contribution of the Delaware to coastal spot and weakfish stocks; natural mortality rates for spot, and the percentage of the local bay anchovy population residing within the Estuary) are addressed in the 1999 Application through Monte Carlo analysis. Given the limited objective of the ESRA analysis - which was to determine, given current scientific understanding of compensation and available data concerning the life histories of the affected species and the magnitude of Station losses, whether future Station operations could jeopardize the long-term sustainability of the stocks - there is little point to continued elaboration of the analysis to address additional sources of uncertainty.

(3) Spawner Stock Biomass Per Recruit (SSBPR)

ESSA's only recommendation concerning the SSBPR analysis is that PSEG should perform "a sensitivity analysis showing consequences to a wide range of alternative life-history parameters, fishing mortality, power station mortality, and natural mortality" (ESSA Response, page 81). While such an analysis would be relatively easy to perform, PSEG does not believe that it would provide significant additional insights into Station impacts.

(4) Application of Fisheries Management Concepts to Power Station Impacts

ESSA recommends that "impact reference limits" (presumably analogous to the biological reference points used in fisheries management) should be developed for the Station, and that plans for curtailing Station operations in response to declines in RIS abundance should be developed.

> Impact reference limits need to be developed for RIS species in the current Application. Those reference limits should account for the possibility of slow response time on the part of power station operations to offset unexpected declines in RIS species abundances, due either to unexpected environmental perturbations or to model mis-specification. The reference limits should be robust to the possibility of insufficient action by fisheries management agencies in the case of an unexpected decline. (ESSA Report, page 81.)

ESSA states further that:

> Station operation alternatives should be evaluated as a tool to increase response time in the current Application. Such alternatives include outages in response to low indices of abundance, timing of station maintenance operations to coincide with time periods where high risk species are most vulnerable to entrainment and/or impingement. (ESSA Report, page 81.)

These recommendations exceed the scope of ESSA's Scope of Work from the NJDEP and have no place in a technical review report. Establishment of approaches for managing fisheries and power plants are the responsibility of NJDEP, federal resource management agencies, and lawmakers. ESSA was not asked to review NJDEP's approach to determining the Station operating requirements that would be included in the Permit, or to recommend alternative requirements.

f. Data and Use of Data

In its recommendations regarding data used by PSEG in the Application, ESSA did not challenge the data used by PSEG, but suggested approaches for improving the quality of the Application:

> There are a number of possible improvements that would increase the scientific rigor of the present Permit Application and future applications:
>
> - be explicit about assumptions made during the collection, preparation, and use of monitoring data;
> - acknowledge the uncertainty of the data and provide the necessary estimates of this uncertainty (e.g., confidence intervals about parameter estimates);
> - perform sensitivity analyses to identify what sources of uncertainty (e.g., data, parameter, model uncertainty) have the greatest influence on the results of modeling; and
> - adjust strength of conclusions in the current Permit Application to reflect the level of uncertainty in the data and analytical results. (ESSA Report, page 81-82.)

PSEG agrees with ESSA that it is always possible to improve scientific rigor, and that providing additional discussions of assumptions, confidence intervals and supplemental analyses could contribute to scientific rigor. However, PSEG emphasizes that although the analyses could be made more rigorous (as is always the case), the analyses are not flawed and the conclusions based on the analyses are valid. ESSA's review of PSEG's data and data collection methods and its listing of potential improvements to scientific rigor are not a challenge to the results and conclusions presented in the Application.

PSEG disagrees with ESSA implication that PSEG overstated conclusions in the Permit Application. In recognition of the uncertainties inherent in data on aquatic biota, PSEG engaged stock assessment scientists, with decades of experience conducting stock assessments for resource agencies, to assemble and interpret the relevant information and data (see Section VII.A.2.d.(2), above). The conclusions in the Application that were referred to by ESSA are based on the professional judgement of these scientists. ESSA's position that PSEG overstated conclusions appears to be a reflection of ESSA's lack of experience and familiarity with the types of data utilized by PSEG's experts, and with accepted approaches for interpreting these types of data.

Regarding future data collection efforts, ESSA recommended the following:

- improve the spatial, temporal, and methodological consistency of monitoring to reduce uncertainty over time;
- quantitatively assess the implications of gear and method changes for the PSE&G data sets; and
- develop regional collaboration between agencies to coordinate the collection, use, and interpretation of data sets, including improved monitoring and analytical methods. It is particularly important that the utility of relative abundance data for indexing the baywide population of RIS species be thoroughly assessed with respect to bias and adequacy of sampling. Under current conditions, it is possible that bias has lead to underestimates of relative abundance for some species. For example, Appendix H.II of the Application suggests that the current surveys provide underestimates of Age-0 spot because they undersample their primary habitat (tidal creeks) (Appendix H.II, page 56). (ESSA Report, page 82)

PSEG believes its proposed Biological Monitoring Plan (BMP) addresses ESSA's recommendations regarding future sampling efforts. The proposed plan includes numerous improvements to the existing Biological Monitoring Work Plan (BMWP) that was established as a condition of the 1994 NJPDES Permit. Improvements include increased plant effects and baywide monitoring efforts to allow the NJDEP and PSEG to assess the Station's effects on biota. A comparison of sampling effort between the 1995-1999 BMWP with the proposed 5-year BMP illustrates the proposed increase in data collection:

Sampling Program	1995 – 1999 BMWP	Proposed 5-year BMP
Entrainment Sampling	1356	**6672**
Impingement Sampling	4680	**7800**
Ichthyoplankton Net Sampling	0	**1680**
Bottom Trawl Sampling	1400	**1740**
Pelagic Trawl Sampling	0	**1680**
Beach Seine Sampling	1200	**1200**

Consistent with ESSA's recommendations, the proposed changes to the BMWP were developed to expand spatial and temporal coverage of the sampling program and to increase sampling frequency, while maintaining continuity with the methods used in previous years. However, some habitats may remain unsampled (e.g., tributaries) which, as noted by ESSA, would result in underestimates of baywide abundance and therefore cause CMR estimates (that use the baywide abundance estimates as inputs) to be biased high.

PSEG agrees that quantitative assessments of implications of changes in sampling gears and sampling methods would be useful.

Regarding ESSA's recommendation to develop regional collaboration among agencies, PSEG agrees and already has begun the expansion and modifications of its programs to complement DNREC and NJDEP monitoring programs. PSEG's Juvenile Trawl program (which samples portions of Delaware Estuary not sampled by the DNREC Juvenile Trawl Program) was modified in 1995 to be consistent with gear deployment methods of the DNREC Juvenile Trawl program. Also in 1995, PSEG began a beach seine survey that uses the same gear as the NJDEP Beach Seine Survey, and that complements the geographic range of the NJDEP Beach Seine Survey, by sampling both shores of Delaware Bay from the C&D Canal to the mouth of the Bay (areas not sampled by the NJDEP Beach Seine Survey).

B. ESSA Report § 5.1: Indicators of Adverse Environmental Impact

In Sections 5.1 and 5.2 of its review, ESSA evaluates PSEG's indicators of Adverse Environmental Impact ("AEI") and proposes an alternative indicator. ESSA asserts that PSEG's indicators are necessary but insufficient for an adequate assessment of AEI. ESSA proposes an additional indicator that ESSA developed and termed "Biomass Lost to the Ecosystem" ("BLE") that ESSA believes is more directly related to Station effects and does not suffer from the alleged defects ESSA claims to have identified in PSEG's indicators. ESSA recommends that PSEG should be required to analyze the proposed BLE indicator as an additional indicator of AEI in the impact assessment. This section of PSEG's response details the flaws in ESSA's critique of PSEG's AEI indicators as well as the conceptual and scientific invalidity of ESSA's proposed BLE indicator.

1. Adequacy of the AEI Indicators

ESSA argues that PSEG misinterpreted USEPA's 1998 Guidelines for Ecological Risk Assessment ("ERA Guidelines") and characterizes PSEG's AEI indicators as "necessary but insufficient" for determining the impact of Salem on the Delaware Estuary. ESSA's conclusion is based on two points:

1. ESSA claims that the AEI indicators are only indirectly related to actual losses due to entrainment and impingement, and more direct endpoints should be used (ESSA Report, page 82);

2. ESSA claims that the AEI indicators are confounded by past and future changes in other factors, e.g., water quality and harvest rates that also affect the health of the Estuary's ecological resources (ESSA Report, page 82).

ESSA supports its arguments with a "conceptual model" of Station impacts and with its own interpretation of the ERA Guidelines. After reviewing ESSA's arguments, PSEG concludes that they reflect a misunderstanding of PSEG's approach to impact assessment, a misinterpretation of EPA's Guidelines, and insensitivity to relevant regulatory precedents. Each of these points is addressed below.

a. Analytical Basis of PSEG's AEI Indicators

A detailed description of the benchmarks, component indicators, and overall approach to determining whether the Station has had or will have an adverse environmental impact on the Delaware Estuary is presented in the Application. (See Application Appendix F, Section V). The three separate benchmarks of AEI in PSEG's Application are:

1. Absence of a balanced indigenous community of aquatic biota;

2. Observation of a continuing decline in abundance of aquatic species vulnerable to the Station; and

3. Indication from modeling that the Station is jeopardizing the sustainability of important fish stocks.

For reasons due to both science and legal and regulatory precedents, PSEG chose benchmarks that evaluate the Station's effects in terms of their implications for the health of fish populations and the ecosystem. In biological terms, the reproducing population is the smallest ecological unit that is persistent in time (Suter 1993). Salem's impact is imposed on small invertebrates, small fish, and early life stages of fish. These organisms experience very high natural mortality rates even in the absence of entrainment and impingement.

PSEG concluded that numeric loss estimates in and of themselves are virtually meaningless as indicators of AEI because (1) many of the organisms lost due to the Station would otherwise have succumbed to the concurrent risks of death from natural causes and (2) the numbers lost at the Station (although apparently numerically large) are small in comparison to the total abundance of that life stage and species. To determine whether entrainment and impingement losses at Salem have resulted in AEI, the consequences of the losses of individual organisms to populations and to the Delaware Estuary ecosystem as a whole must be addressed.

Basing benchmarks of AEI on population and ecosystem level effects is consistent with a broad range of regulatory and legal precedent. This precedent includes the USEPA's 1977 draft guidelines for Section 316(b) of the Clean Water Act, guidelines which EPA has recently reaffirmed the applicability of pending issuance of final regulations under Section 316(b) (Cook 2000 Memorandum); EPA's ERA Guidelines (EPA 1998); relevant judicial precedent (Seacoast Anti-Pollution League v. Costle, 597 F.2d 306. (1st Cir. 1979); and the approach of the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1801 et seq.).

The 1977 USEPA Draft Section 316(b) Guidance affirms that the population level is the appropriate end point to determine AEI by indicating that the concern is whether "the impact would endanger (jeopardize) the protection and propagation of a balanced population" (Draft Guidance, USEPA 1977, page 15). Similarly, in 1975 Draft BTA Guidelines, USEPA stated that:

> Adverse environmental impacts occur when the ecological function of the organism(s) of concern is impaired or reduced to a

> level which precludes maintenance of existing populations. (Draft BTA Guidelines, USEPA 1975, page 52.)

Defining AEI at the population level has also been upheld by the courts. In Seacoast Anti-Pollution League v. Costle, 597 F.2d 306, 310 (1st Cir. 1979), the court said that in assessing AEI, the key question was whether intake losses would "affect the ability [of fish species] to propagate and survive."

PSEG's three AEI benchmarks - fish community balance, fish population abundance, and fishery sustainability - are functionally equivalent to the "Assessment Endpoints," defined in the ERA Guidelines. According to the ERA Guidelines, assessment endpoints are "[e]xplicit expressions of the actual environmental value that is to be protected, operationally defined by an ecological entity and its attributes." Individual species (e.g., the Salem representative important species referred to as "RIS") and communities of species (e.g., the Delaware Estuary fish community) are identified in the ERA Guidelines as examples of appropriate "ecological entities" for defining assessment endpoints. And "attributes," according to the ERA Guidelines, are specific characteristics of entities of concern that are "important to protect and are potentially at risk."

Based on the cited regulatory precedents cited, it is clear that PSEG's three AEI benchmarks - fish community balance, fish population abundance, and fishery sustainability - are "important to protect and are potentially at risk" due to Station operations and, therefore, are valid "attributes." However, the benchmarks would be useless from an assessment perspective unless there were explicit definitions of the kinds and degrees of change in the identified attributes that should be considered "adverse" as well as specific methods for determining whether those definitions have been met. In the ERA Guidelines, the methods used to measure or estimate changes in an attribute (e.g., abundance of an ecologically or economically important species) in response to a stressor (e.g., entrainment and impingement) are termed "measures of effect," and they are combinations of data and models.

In PSEG's 316(b) Demonstration for Salem Station, the functional equivalents of the ERA's "measures of effect" are the various indicators developed for each benchmark. The Application evaluates the three benchmarks of fish community balance, fish population abundance, and fishery sustainability, respectively, in the Balanced Indigenous Community analysis, the trends analyses, and the stock jeopardy analyses. For each of these benchmarks, the Application documents one or more indicator-specific criteria of adversity (see Application Appendix F, Section VII), and for each indicator, the Application provides a specific method - a combination of data and models - for measuring the impact of the Station as well as a quantitative criterion for determining whether AEI has occurred or will occur.

For example, in the stock jeopardy analysis, PSEG uses reductions in spawning stock biomass ("SSB") and reductions in spawning stock biomass per recruit ("SSBPR") as indicators of AEI. These reductions are quantified using the Equilibrium Spawner Recruit Analysis (ESRA) model and the Spawning Stock Biomass per Recruit (SSBPR) model. Consistent with the standard established for assessing other stressors on fisheries under the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1801), AEI was assumed to occur if

Station operations were to cause SSB to fall below a level equal to 20% of the unfished SSB, or to cause SSBPR to fall below 30% of the unfished SSBPR.

PSEG deemed all three of the criteria discussed above - i.e., direct relationship to population or ecosystem health, existence of regulatory and scientific precedents, and feasibility of establishing criteria for interpreting the significance of impacts - essential for performing an adequate determination of AEI. As noted above and detailed in Appendix F of the Application, the benchmarks and indicators chosen by PSEG satisfy all of these criteria.

b. Consistency of PSEG's AEI Indicators with EPA's Ecological Risk Assessment Guidelines

ESSA claims that the ERA Guidelines support its arguments that PSEG's AEI indicators are inadequate and that additional indicators are needed. To support this claim, ESSA provides a conceptual model of Station impacts (ESSA Report, page 83, Figure 5.1) and a table identifying five statements in the ERA Guidelines that ESSA argues support ESSA's position (ESSA Report, pages 84-85, Table 5.1). Both the figure and the table contain inaccuracies and misleading material.

ESSA's Figure 5.1 (reproduced in this Response as Figure VII-1) purports to show that the indicators advocated by ESSA – that is, Station losses, impacts of the Station on foregone production as defined by ESSA, and impacts on benthic invertebrate communities – are more directly related to Station effects than are PSEG's indicators. According to ESSA, its proposed indicators are not confounded by other stressors and therefore more accurately reflect Station impacts.

ESSA's Figure 5.1 mischaracterizes PSEG's assessment approach and incorrectly depicts the impacts of entrainment and impingement on aquatic populations and communities. First, it characterizes PSEG's three benchmarks of AEI as "indicators." As noted above, each of the three benchmarks was addressed using multiple indicators to account for the natural variability and confounding factors discussed in ESSA's review. Second, ESSA's figure includes impacts of the Station discharge on the benthic invertebrate community. Discharge impacts are not a component of a Section 316(b) assessment; therefore, this impact pathway should not be included in the conceptual model. Third, ESSA's figure identifies "fish killed by entrainment and impingement," i.e., station losses, as an assessment endpoint analogous to PSEG's benchmarks. However, numbers of organisms killed do not satisfy EPA's definition of an assessment endpoint. The ERA Guidelines state clearly that:

> Assessment endpoints are explicit expressions of the environmental value to be protected, operationally defined by an ecological entity and its attributes. (ERA Guidelines, Section 3.3.)

An ecological entity, in EPA terminology, must be an actual component of the affected ecosystem that is potentially susceptible to the stressor being evaluated (in this case, cooling-water withdrawals). Examples of such entities, according to Section 3.3.2 of the ERA Guidelines, include species, functional groups of species, communities, ecosystems, and valued habitats. Thus, under the ERA Guidelines, station losses clearly are not ecological entities and cannot be assessment endpoints. In EPA's terminology, the losses are clearly a "measure of effect" and not an assessment endpoint (see ERA Guidelines, Section 3.5.1).

More importantly, ESSA's conceptual model errs in identifying foregone production of fish for predators as an intermediate step in the causal pathway linking cooling system impacts to PSEG's indicators. As reproduced in Figure VII-1, ESSA's Figure 5.1 shows that entrainment and impingement mortality reduce the production available to higher trophic levels (as measured by foregone production), which in turn affects population trends, stock jeopardy, and fish community composition. In fact, however, production available to predators is no more directly linked to Station mortality than are the population and community level AEI benchmarks developed by PSEG.

Figure VII-2 provides a conceptual model that portrays more accurately than ESSA's Figure 5.1 the causal pathways that link Station mortality to population, community, and ecosystem-level benchmarks. Station mortality directly affects populations and communities through the loss of individual members of those populations and communities. The question addressed in PSEG's Application is whether the magnitude of those losses is sufficient to adversely affect those populations and communities. Station mortality could, at least in principle, also affect predator production by reducing the availability of prey. The foregone production indicator advocated by ESSA is intended to measure this potential reduction. However, rather than being an intermediate step in the causal pathway linking Station mortality to population and community effects, production available to predators is, in reality, another independent benchmark of impact, subject to the same confounding influences (such as environmental conditions, management policies, etc.) that ESSA claims confound PSEG's indicators. The various flaws in this proposed benchmark that compromise its usefulness as a benchmark for AEI are detailed at length below in Section VII.B.2.

In addition to the misleading nature of the conceptual model in ESSA's Figure 5.1, the isolated statements taken out of context from the ERA Guidelines that are cited by ESSA in Table 5.1 (ESSA Report, pages 84-85) are misleading. When read in context, they do not support ESSA's position. Following is a discussion that highlights each ERA guideline quoted in ESSA's Table 5.1 and analyzes why it does not support ESSA's position as ESSA argues.

> ERA Guideline Cited in ESSA Table 5.1: Ecologically relevant endpoints may be identified at any level of organization (e.g., individual, population, community, ecosystem, landscape). (ESSA Report, page 84.)

The statement quoted refers to "assessment endpoints," which as noted earlier in this section are functionally equivalent to "benchmarks" as defined by PSEG. According to Table 5.1, the quoted statement supports ESSA's contention that numbers of fish killed can be valid assessment endpoints even though losses *per se* would represent an individual-level endpoint rather than a population, community, or landscape-level endpoint. However, regardless of level of organization, an assessment endpoint must still satisfy the definition of an assessment endpoint provided in the introduction to Section 3.3 of the ERA Guidelines, as elaborated in

> biodiversity of an ecosystem or its components. They may contribute to the food base (e.g., primary production, provide habitat (e.g., for food or reproduction), promote regeneration of critical resources (e.g., decomposition or nutrient cycling), or reflect the structure of the community, ecosystem, or landscape (e.g., species diversity or habitat mosaic). (ESSA Report, page 84.)

ESSA argues that this statement supports its proposed measure of production foregone, and its claim that PSEG did not consider all ecologically relevant endpoints. However, the ERA Guidelines do not state that *all* ecologically relevant endpoints must be considered in an assessment. The purpose of ecological risk assessment is to provide decisionmakers with the scientific information needed to support informed environmental decisions. As discussed in Sections 1 and 2 of the ERA Guidelines, the scope and complexity of a risk assessment, including the types of effects addressed and the complexity of scientific studies performed to assess those effects, are determined by management goals and objectives. PSEG's indicators are fully consistent with the goals and objectives of 316(b) studies, as embodied in EPA's 1977 draft 316(b) guidance.

> ERA Guideline Cited in ESSA Table 5.1: Sensitivity is directly related to the mode of action of the stressors. Sensitivity is also influenced by individual and community life history characteristics. (ESSA Report, page 84.)

ESSA quotes this statement to highlight the need to assess impacts on the benthic and zooplankton communities, and to support the use of foregone production as an assessment endpoint. The statement is taken out of context and does not support ESSA's inference. The relevant "mode of action" in this assessment is the entrainment or impingement of organisms by the Station's cooling water system. All of PSEG's benchmarks and indicators address impacts of entrainment and impingement. The quoted statement, and the section from which it was taken, direct risk assessors to select endpoints that are sensitive to the stressor(s) being evaluated. PSEG's benchmarks meet that test. The quoted statement says nothing about a need for additional indicators.

Moreover, in the sentence in the ERA Guidelines that *directly precedes* the sentences quoted by ESSA, the ERA Guidelines state that "Sensitivity refers to how readily an ecological entity is affected by a particular stressor." Benthic invertebrates reside in and on the surface of the sediment and are not highly vulnerable to entrainment. Zooplankton, because of their short generation times and high reproductive rates, are also relatively invulnerable to entrainment impacts. It is for these reasons that neither group of organisms is recommended for detailed study in EPA's 1977 draft 316(b) guidance (see USEPA 1977, page 16).

> ERA Guideline Cited in ESSA Table 5.1: Adverse ecological effects represent changes that are undesirable because they alter valued structural or functional attributes of the ecological entities under consideration. The risk assessor evaluates the degree of

> adversity, which is often a difficult task and is frequently based on the risk assessor's professional judgment. (ESSA Report, page 84.)

ESSA quotes this statement to argue that PSEG's assessment is inadequate because it does not provide "... any evaluation of the overall structural or functional impacts on the ecosystem in terms of food web relationships, energy flow, trophic structure, or other indicators." However, both the ERA quotation and the section of the ERA Guidelines from which it was extracted are irrelevant to ESSA's argument. Section 5.2.2 of the ERA Guidelines addresses criteria to be used by risk assessors in determining whether or not a predicted or measured change in an assessment endpoint should be considered "adverse." ESSA's argument addresses instead the scope of an assessment, i.e., which endpoints should be considered in the assessment. As noted in Section VII.B.1.c, the scope of PSEG's assessment is fully consistent with the recommendations provided in EPA's 1977 draft 316.b guidance.

> ERA Guideline Cited in ESSA Table 5.1: Natural ecosystem variation can make it very difficult to observe (detect) stressor-related perturbations. For example, natural fluctuations in marine fish populations are often large, with intra-and inter-annual variability in population levels covering several orders of magnitude. Furthermore, cyclic events of various periods (e.g., bird migration, tides) are very important in natural systems and may mask or delay stressor-related effects. Thus a lack of statistically significant effects in a field study does not automatically mean that adverse ecological effects are absent. Rather, risk assessors should then consider other lines of evidence in reaching their conclusions. (ESSA Report, page 85.)

ESSA uses this statement to support its argument that PSEG should have performed a power analysis of the trends in RIS abundance and fish community composition, and that confounding effects of improved water quality and reduced fish harvesting may mask Station impacts. In fact, the quoted guideline actually *supports* PSEG's assessment approach. EPA does not mention the need to perform power analyses. Instead, EPA recommends that assessors consider "other lines of evidence." This is exactly what PSEG did. The assessment as a whole develops three independent lines of evidence, based on the Balanced Indigenous Community, trends, and stock jeopardy benchmarks. Moreover, for each of these components of the assessment, multiple lines of evidence were evaluated. This use of multiple lines of evidence to overcome uncertainties associated with natural variability and confounding influences is fully consistent with the ERA Guidelines (see Section 5.1, "Risk Estimation," and Section 5.2.1, "Lines of Evidence").

> ERA Guideline Cited in ESSA Table 5.1: When exceedance of a previously established decision rule, such as a benchmark stressor level is used as evidence of adversity . . . the reasons why this is considered adverse should be clearly understood. In addition, any evaluation of adversity should examine all relevant criteria, since

> none are considered singularly determinative. (ESSA Report, page 85.)

ESSA uses this statement to argue that PSEG insufficiently justified the criteria for adversity used in the stock jeopardy analysis. However, the statement does not support ESSA's argument because PSEG actually followed EPA's recommendation. The reasons for considering extreme reductions in spawning stock biomass (SSB) and spawning stock biomass per recruit (SSBPR) to be adverse are thoroughly documented in the Application (Application Appendix F, Section VII and Appendix I) and in the documents cited in the Application (e.g., NRC 1998). Moreover, the Application used both the SSB and SSBPR indicators rather than relying on a single indicator. The specific values chosen as criteria for adversity have both scientific and regulatory precedents (i.e., the Magnuson-Stevens Act) that were well documented in Appendix F, Section VII.C.2 of the Application.

c. Consistency of PSEG's AEI Indicators with Relevant Regulatory Precedents

The Application discussed the regulatory precedents for PSEG's approach to AEI determination (Application Appendix F, Section V). The most important of these are the Seabrook decision [Seacoast Anti-Pollution League v. Costle, 597 F.2d 306 (1st Cir. 19790] and EPA's 1977 draft 316(b) guidance.

In the Seabrook decision, the court considered the key question to be whether the cooling water intake system would "affect the ability of [the fish species at issue] to propagate and survive." Seacoast Anti-Pollution League 597 F2d at 310. The court held that despite the fact that the cooling system would kill many individual fish through entrainment, there would be no adverse environmental impact because the "protection and propagation" of species of fish would continue to be assured. The court found that assessment of population-level impact was sufficient to demonstrate absence of AEI. The decision made no mention of a need to perform a comprehensive assessment of impacts of the cooling system on all components of the ecosystem.

EPA's 1977 draft 316(b) guidance also emphasizes population and community-level impacts (see USEPA 1977, Section V, pages 15-17). The magnitude of an adverse impact should, according to the guidance, be addressed with reference to absolute "damage" (equivalent terminology to "losses," as used in PSEG's Application), percentage damage ("% of fish or larvae in existing populations which will be impinged or entrained, respectively"), or "whether the impact would endanger (jeopardize) the protection and propagation of a balanced population of shellfish and fish in and on the body of water from which the cooling water is withdrawn (long term impact)."

Although the guidance states that indirect impacts such as loss of food organisms can be considered to be adverse impacts, the guidance also states that "It is not practicable to study all species that may be directly or indirectly harmed by intake structure operations." Instead, the guidance recommends that 5-15 species should be selected for detailed evaluation. The species selected should, according to the guidance, emphasize meroplanktonic organisms (e.g., opossum shrimp and scud), macroinvertebrates (e.g., blue crab), and fish (e.g., the nine finfish RIS addressed in PSEG's Application). Because of their short life cycles and high regeneration capacities, the ERA guidelines suggests that phytoplankton and zooplankton should be selected for analysis only if they have a "special or unique value." The 1977 guidance does *not* suggest that impacts on benthic communities should be addressed, or that estimates of production foregone to the ecosystem should be quantified.

PSEG selected 12 RIS for evaluation, from the three groups identified in the 1977 EPA guidance. (As documented in Appendix C of the Application, phytoplankton and zooplankton communities in the vicinity of the Station are typical of east coast estuaries and are not unique.) PSEG selected these species according to criteria consistent with the guidelines (see Application Appendix F, Section V.B.2), and quantified the impacts on these species in terms of absolute losses, per cent losses, and population jeopardy.

Hence, PSEG's approach is fully consistent both with the *Seabrook* decision and with EPA guidance, and is sufficient to satisfy these regulatory precedents. In contrast, ESSA's conclusion that PSEG's indicators are "*necessary* but not *sufficient* for an adequate assessment of Adverse Impact" is inconsistent with the relevant regulatory precedents.

2. Inadequacy of ESSA's Proposed BLE Indicator

Section 5.0 of ESSA's Report recommends that "biomass lost to the ecosystem" (BLE) should be used as an additional indicator of AEI and that "total biomass lost," defined as "biomass lost to the ecosystem" plus "catch foregone by fishermen" should also be used as inputs to future benefits in the cost-benefit analyses conducted by PSEG. Section 5.2.1. of the ESSA Report describes ESSA's proposed method for using entrainment and impingement loss estimates to calculate "biomass lost to the ecosystem" as a result of Station operations.

This lost biomass, which ESSA interprets as being the reduction in future food eaten by predators, is according to ESSA composed of "... the total reduction in future growth, measured in units of biomass, attributable to organisms killed as a result of entrainment and impingement at the Station" (referred to by ESSA as production foregone) and the biomass directly lost due to station mortality (i.e., the biomass of the entrained and impinged organisms at death). (ESSA Report, pages 86-87). The total biomass lost due to the Station, according to Figure 5-2 of the ESSA Report, is equal to the sum of the production foregone and the catch foregone by fishermen due to Station mortality (see Figure VII-2, reproduced from ESSA Report, page 87, Figure 5-2).

ESSA asserts that its proposed BLE indicator requires fewer assumptions than PSEG's approach (ESSA Reports, p.75), and that it is supported by the ERA guidelines (ESSA Reports, Table 5.1). In fact, however, the BLE indicator is inconsistent with the ERA Guidelines and also with PSE&G's benchmark selection criteria. Moreover, the indicator is based on an oversimplified conceptual model of aquatic ecosystem processes and is biologically meaningless.

a. Inconsistency of ESSA's Proposed Indicator with ERA Guidelines and PSEG's Benchmark Selection Criteria

ESSA characterizes its proposed BLE indicator as being a valid risk assessment endpoint, fully consistent with the ERA Guidelines. However, BLE fits neither the definition nor the criteria for endpoint selection defined in those guidelines. BLE does not describe an actual ecological entity such as a species, population, community, ecosystem, or habitat (ERA Guidelines, Section 3.3.2). BLE is, in EPA terminology, actually a measure of ecological effects and not an assessment endpoint.

Predator production, as a measurable (at least in principle) ecological function, could be a valid assessment endpoint or benchmark of AEI (see Figure VII-16). In that case, the BLE would be a measure of effects of Station operations on the amount of predator biomass provided per year. This inconsistency is more than a minor technicality. ESSA has claimed that BLE is unaffected by natural environmental variability and by other stressors, and therefore is a more direct indicator of Station effects than are PSEG's benchmarks and indicators. Predator production, in contrast, is subject to all of the confounding environmental factors that influence biomass and energy flow in ecosystems. Moreover, there are no measurements of total predator production for the Delaware Estuary, and therefore no way to use empirical data to measure station effects on predator production.

Even though predator production might fit the definition of an assessment endpoint provided in the ERA Guidelines, however, it is not clear that this endpoint would satisfy all three of EPA's endpoint selection criteria. Those three criteria are: (1) ecological relevance; (2) susceptibility to known or potential stressors; and (3) relevance to management goals. Predator production would satisfy the first two criteria, but may not satisfy the third. ESSA's indicator would include all predators that could potentially feed on fish entrained and impinged at the Station. There is no way to allocate the lost production among the various predators, some of which are undoubtedly relevant to management goals but others of which have no management relevance. Moreover, ESSA has not proposed, nor is PSEG aware of, any resource management principles or criteria that could be used to determine the magnitude of reduction in predator production that should be considered "adverse."

In the absence of such principles and benchmarks, predator production is a relatively useless assessment endpoint. And, as discussed above, BLE is a useless measure of effects. In addition, both ESSA's proposed BLE indicator and the predator production indicator are inconsistent with PSEG's approach to impact assessment because they do not satisfy PSEG's benchmark selection criteria.

As discussed in Section VII.D.1 of this response, PSEG's benchmarks were devised to satisfy the following three criteria:

1. A benchmark must be directly related to population or ecosystem health;
2. Regulatory and scientific precedents for the use of the benchmark must exist; and

3. It must be possible to establish objective criteria for interpreting the significance of measured or predicted impacts.

Neither BLE nor predator production satisfy the second and third criteria. PSEG also believes that it is questionable whether ESSA's proposed indicator can satisfy the first criterion, as detailed further below.

b. Inadequate Analytical Basis of ESSA's Proposed Indicator

ESSA's proposed BLE methodology is based on an overly simplistic conceptual model of the Delaware ecosystem that neglects many important biomass and energy transfer processes. As shown in Figures VII-4a and VII-4b, fish production within the Estuary is ultimately determined by primary production. Carbon is transformed into a biologically available form by green plants (including phytoplankton and marsh vegetation) or derived from the decay of organic matter (dead plants and other organic material derived from aquatic, marsh or terrestrial sources). Invertebrates such as opossum shrimp and scud consume plants and decaying organic material, and are consumed, in turn, by small fish, including forage species such as bay anchovy and early life stages of other species. These small fish constitute the prey biomass available for consumption by predators such as striped bass and weakfish.

Figure VII-4b depicts the biomass production process in the Estuary that is implied by ESSA's BLE approach. ESSA's approach assumes that entrainment and impingement remove fish that otherwise could have been eaten by predators. The entrained and impinged fish and all of their future growth, had they survived, are removed completely from the ecosystem. Primary production remains the same and the growth and survival rates of the surviving fish are unchanged, but the amount of prey biomass available to predators is reduced substantially.

A more realistic depiction of the Estuary's biomass production process is shown in Figure VII-5a. This figure more realistically shows that the prey organisms that would have been consumed by the entrained or impinged fish are available for consumption by the survivors. Because of reduced competition and increased prey availability, the survivors grow more rapidly and suffer lower rates of natural mortality. Ultimately, a large fraction of the prey biomass lost due to the deaths of entrained and impinged fish may be recovered due to a compensatory increase in the prey biomass provided by the survivors.

While the degree to which the compensatory processes depicted in Figure VII-5b offset the direct effects of losses at the Station is unknown, the processes themselves are well documented in Appendix I of the Application. It is possible that the only biomass actually lost to the ecosystem is the biomass of the entrained and impinged organisms at the time of death ("biomass killed" in ESSA's terminology). Even this loss may simply be a transfer of biomass from the pelagic food web to the benthic food web, with no net loss in ecosystem productivity.

Moreover, the Station does not remove biomass from the ecosystem, and does not alter the productive capacity of the ecosystem. Rather than being removed from the ecosystem, entrained and impinged fish are returned to the Estuary where they are available for consumption by predators and scavengers. If not consumed, they decompose and the nutrients released become available for new primary production. Because of the recycling of the organisms lost to entrainment and impingement, more invertebrate biomass is produced.

ESSA's proposed BLE indicator would ignore the significance of these relationships and properties of the ecosystem in assessing the impacts of entrainment and impingement at the Station. As a result of ignoring these biomass and energy transfer processes, ESSA's BLE indicator would produce estimates of loss that are biased high and are not credible estimates of actual biomass lost. Thus, both because it is scientifically invalid and inconsistent with both ERA Guidelines and PSEG's criteria for selecting benchmark indicators, ESSA's recommendation that PSEG include BLE as an indicator of AEI does not warrant further consideration.

C. ESSA Report § 5.2: Production and Catch Foregone

ESSA's discussion of production and catch foregone begins by providing ESSA's definitions of several components of ESSA's biomass lost measures, including catch foregone, biomass lost to the ecosystem (BLE), production foregone and total biomass lost. The relationships among these categories are depicted in Figure VII-2, which indicates that the components of BLE are production foregone and biomass lost at the plant, while total biomass lost refers to BLE plus catch foregone.

After reviewing ESSA's descriptions of these measures, PSEG concludes the following: ESSA's BLE calculation would produce estimates that are biased high since they do not account for the effects of density-dependent compensation or other fundamental ecosystem properties that provide alternative energy pathways within the ecosystem (see discussion above in Section VII.B.). Further, incorporating these biased estimates of BLE directly into the cost-benefit analyses of technology alternatives, as ESSA appears to recommend, would be scientifically invalid and result in cost-benefit ratios that are unreasonably low.

Directly incorporating the BLE estimates into the cost-benefit analyses would be invalid because it would essentially double count the value of BLE by the fraction of natural mortality that is due to predation by economically valuable species, the trophic transfer efficiency of biomass moving up through the food chain, and the fishery exploitation rate transfers among food levels. The only way to appropriately use the BLE estimates in the cost-benefit analyses would be by taking these factors into account to translate the component measures of BLE – production foregone and biomass impinged and entrained at the station -- into "equivalent catch foregone" measures. Such an approach, however, would still result in estimates biased high due to the failure to consider density-dependent compensation.

1. ESSA Report § 5.2.1: Background and Definitions

The methods ESSA recommends for estimating catch foregone and production foregone neglect compensatory processes that act to offset the direct effect of losses due to Station operation. The estimates of catch foregone and production foregone that PSEG used as inputs to its cost-benefit evaluations of technology alternatives also did not account for these processes. In selecting its methods for the cost-benefit analyses, PSEG recognized that the omission of compensatory processes would lead to overestimates of actual catch and production foregone, resulting in likely overestimates of benefits from the technology alternatives.

ESSA itself, in § 5.4 of its Report, argues for recognition of the role of density-dependent compensation in fish populations:

> ... there are circumstances under which increasing juvenile abundance may not be related to an increase in adult abundance or may not translate into more adults. For example, with *strong density-dependent survival* between Age-0 recruitment and spawners, ... a stable or increasing trend in juvenile abundance may mask a declining adult population.
>
> Evidence that situations like this can occur is provided by H Figure 10 of Appendix H.II. That figure shows an index of Recruits (Age-0) for weakfish increasing while spawning stock biomass (SSB) (Age-1 and older) continues to decrease from 1987 to 1991. Additionally, recent analyses show an increase in SSB with no changes in Age-0 abundance (Bruce Freeman, NJDEP, personal communication). (ESSA Report, page 110.)

In addition to density-dependent mortality being clearly exhibited in the weakfish stock, several recent studies on other major fish stocks (i.e., Hudson River striped bass stock, Atlantic coast striped bass stock, and Atlantic coast demersal fish stocks) provide strong evidence for the presence of compensatory mortality. These studies are briefly summarized in this section.

The Hudson River striped bass population has been studied intensively for over two decades by the Hudson River utility companies and the New York State Department of Environmental Conservation ("NYSDEC"). These studies were recently synthesized in a Draft Environmental Impact Statement ("DEIS") prepared to support renewal of the State Pollutant Discharge Elimination System Permits for the Indian Point, Bowline Point, and Roseton generating stations (Central Hudson Gas & Electric Corp, et al., 1999). The DEIS was submitted to NYSDEC in December 1999, subsequent to PSEG's submittal of its Renewal Application. The data summarized in the DEIS reflect 24 consecutive years of sampling, covering the entire Estuary from the Battery at the mouth of the River (River Mile 0) to the Federal Dam at Troy (River Mile 152), using methods that sample every life stage of striped bass from egg to adult. In addition to data collected by the utility companies, the DEIS synthesizes information obtained from several monitoring programs conducted by the NYSDEC.

These studies indicate that the abundance of the adult component of the Hudson River striped bass population has grown substantially since 1980, while the operation of three large power plants located in the principal nursery area utilized by early life stages of striped bass has continued. The large year classes produced since 1980 were not heavily fished, resulting in a large increase in the size of the spawning stock by the early 1990's. As the size of the spawning stock increased (due to controls on fishing mortality), the densities of striped bass early life stages in the Estuary also increased. However, the average abundance of juvenile striped bass, as reflected in the annual NYSDEC beach seine index, did not increase. This is because the relative productivity or index of pre-recruit survival (recruits, "r," divided by spawning stock biomass, "ssb," that produced it) decreases as the spawning stock biomass increases.

The lack of correlation between early life stage abundance and subsequent year-class strength was noted previously (Pace et al. 1993). Data for recent years, presented in the DEIS, confirm this pattern. The abundance of early life stages of striped bass in the Hudson River Estuary has continued to increase with spawning stock size, but juvenile abundance has not increased. Recruitment production is equal to the relative productivity multiplied by the spawning stock biomass. When recruitment remains stable as spawning stock biomass increases then the decrease in relative productivity just offsets the increase in spawning stock biomass. The increase in abundance of adults, eggs, and larvae, coupled with stable production of juveniles, provides strong evidence for density-dependent mortality of early life stages of striped bass in the Hudson River Estuary.

The above data were used to develop a stock-recruitment model of the Hudson River striped bass population (Appendix VI-4 of the DEIS). Analysis of the model indicated that reproductive success in striped bass is highly density-dependent or compensatory in nature. Density-dependent mortality is so strong that annual CMRs as high as 20% on fish less than Age-1 would result in only an approximate 1% reduction in average annual recruitment (assuming a fishing mortality rate of $F<0.5$, and a 28 inch size limit).

According to the ASMFC stock assessment for striped bass, the abundance of the east-coast stock of striped bass has increased since 1989 (ASMFC 1999, Figure VII-3a documented in Appendices J and H of the Application, the abundance of juvenile striped bass in Delaware River also increased over those years. During this period of increasing abundance, the first-year survival rate of striped bass has been decreasing. The decrease in first-year survival rate is indicated by a pronounced decline in the ratio of the number of recruits (i.e., Age-1 fish) to the spawning stock biomass (i.e., the total weight of spawning aged fish in the population). This decline in first year survival rate in response to the increase in spawning stock biomass (Figure IV-6) is characteristic of the presence of strong density dependent mortality.

The 30th Stock Assessment Review Committee ("SARC") report documents increases in the abundance of the stock of weakfish since the early 1990's (NMFS 2000, Figure VII-3b). The abundance of juvenile weakfish within the Delaware Estuary increased during that period also (see Appendices J and H of the Application). As was the case for striped bass, the first-year survival rate of weakfish (as measured by the ratio of the number of recruits to the spawning stock biomass) declined sharply while the spawning stock biomass increased (Figure IV-7). Again, this pattern is characteristic of the presence of strong density-dependent mortality. In the 30th SARC report, the authors stated that "the rapid rebuilding of the stock reflected high estimated compensatory reserve."

In July of 1999, the Stock Assessment Workshops Northern Demersal Working Group reviewed the relative productivity (r/ssb) for eleven groundfish stocks (NMFS 2000b). For all eleven stocks, the maximum value of r/ssb occurred at or below average ssb level of abundance. Similarly, for 8 out of 11 stocks, the minimum r/ssb value occurred at an above average ssb level. The working group concluded: "The apparent decline in r/ssb, as ssb increased in 10 out of 11 stocks, was consistent with the notion that compensation influenced relative productivity of these stocks." This recent report is consistent with other information, documented in Appendix I of the Application, demonstrating that density-dependent responses to increased mortality are commonly observed in fish populations and that the concept of compensation is now firmly entrenched in fisheries management practice.

2. ESSA Report § 5.2.2: General Comments on Catch and Production Foregone Analysis

In Section 5.2.2. of its report, ESSA presents an overview of the methods PSEG used to estimate catch and production foregone. ESSA concludes that the general approach and computer algorithms PSEG used for estimating catch foregone are appropriate:

> The equations for the catch foregone model and the implementation of these in the SAS code appear to have no problems. ...
>
> The entrainment and impingement values used in the analysis in Attachment F-4 ... were generated from estimates of the density of each RIS (by life stage and by day) ...
>
> [U]sing a daily calculation to estimate production foregone or the biomass lost to the ecosystem, while cumbersome, is likely to give the best results. (ESSA Report, page 88.)

However, with respect to production foregone, ESSA apparently did not understand the computer algorithms PSEG used. ESSA did not seek PSEG's assistance to clarify their confusion, but instead offers a critique of PSEG's method based on a misunderstanding of it:

> It appears that the daily nature of the calculations was not fully exploited, with monthly total entrainment and impingement values simply being distributed uniformly within a month. ... it appears that spawning dates were assigned to the first day of the month by default. This approach weakens the rationale for using such a complex analytical approach as opposed to the simpler spreadsheet / life stage based approach described below. (ESSA Report, page 88.)

In fact, PSEG used daily (not monthly) entrainment values as input to the production foregone calculations. Further, ESSA's criticism implies that PSEG's computation is faulty, when in fact it is only more complex than ESSA would prefer. ESSA's task was to determine whether the method used by PSEG produced reliable results, not whether an easier approach exists. Contrary to ESSA's implication, the PSEG and ESSA computational approaches for estimating production foregone, while involving different methods, do not result in materially different outcomes. As documented by ESSA, the production foregone estimate for bay anchovy (for the Base Case scenario) based on its method is within 2% of the estimate computed using PSEG's method (ESSA Report, page 98).

Similarly, because ESSA did not bother to seek clarification, it misrepresented another aspect of PSEG's method for estimating production foregone:

> From the information available it appears that the duration of the last life history stage in the first year of life is shortened as a function of the date of impingement and entrainment in an earlier life stage. It would make sense for the last life history stage in the first year to be shortened based on the date on which eggs were laid, but this does not seem to be the case. … This issue may be due to confusion caused by notation in the written document and between the various SAS files, or there may actually be a problem. (ESSA Report, page 88.)

ESSA apparently did not understand that the presence of an early life stage on a particular date provides information regarding the date when the eggs were laid. For example, if the egg stage lasts for 3 days and the yolk-sac larval stage lasts for 11 days, and a yolk-sac larvae is observed in an entrainment sample on July 14th, it indicates the fish was spawned in early July. In PSEG's method, this information was used to adjust the duration of the last life stage of the first year of life.

Section 5.2.2. of ESSA's Report notes that Attachment F-4 of the Application presents estimates of production foregone and not estimates of biomass lost to the ecosystem. ESSA further notes that biomass lost to the ecosystem may be twice the production foregone. This conclusion by ESSA, and PSEG's response are discussed below in Section VII.C.2.e.

3. ESSA Report § 5.2.3: Reconstructed Production and Catch Foregone Analysis

Section 5.2.3 of the ESSA Report documents ESSA's spreadsheet method for calculating production and catch foregone. To demonstrate that its alternative methods produced results similar to the results from PSEG's methods, ESSA presents a comparison of results from the spreadsheet method with estimates presented in the Application for Base Case catch foregone of weakfish and white perch, and for Base Case production foregone for bay anchovy. ESSA also discusses a comparison of life-stage-specific losses of weakfish, white perch and bay anchovy for the Base Case scenario with average (over years) life-stage-specific losses for these species for historical conditions. Finally, ESSA presents its own estimates of historical catch foregone and biomass lost to the ecosystem for the RIS, and compares ESSA's estimates of historical catch foregone and PSEG's estimates of catch foregone for the Base Case Scenario.

a. ESSA Report § 5.2.3.1: Method

In this section, ESSA describes its spreadsheet method for calculating catch and production foregone. According to the description of the spreadsheet method, neither the effects of density-dependent compensation nor the effects of alternative energy pathways in the ecosystem are taken into account. Therefore, (as previously discussed in Section VII.B. above), ESSA's method severely over-estimates total biomass lost to the ecosystem.

b. ESSA Report § 5.2.3.2: Base Case Input Data

As part of its development of the spreadsheet method for calculating catch and production foregone, ESSA compares average loss estimates for historical conditions for the periods 1978-1998 and 1991-1998 to average loss estimates for PSEG's Base Case condition for white perch, weakfish and bay anchovy. The Base Case scenario (see Application Appendix F, Attachment F-4) assumes the existing intake technology — i.e., the improved Fletcher-modified Restroph screen system and all 12 cooling water pumps operating at 175,000 gpm year-round except during scheduled refueling outages that occur every 18 months for each unit of Salem. The results of the comparison are summarized in tables containing ratios of the Base Case loss estimates (by life stage) to the corresponding average 1991-1998 loss estimates for historical conditions calculated by ESSA. ESSA concludes that:

> The variation in ratios can generally be explained by the effects of differences in timing of operation through the year; however, it is difficult to understand how values can be less than or close to 1 given the major shutdowns in 1996 and 1997. (ESSA Report, page 91.)

Based on entries in Tables 5.2 to 5.4 in ESSA's report, ESSA's reference to ratios "less than or close to 1" apparently are limited to white perch eggs (ratio=1.01), weakfish eggs (ratio=0.96), and adult white perch (ratios range from 0 to 0.36 for different age fish). The ratios for all other life stage of these three species range from 1.11 to 2.52 (see ESSA Report, pages 90-91, Tables 5.2 to 5.4).

PSEG does not understand why ESSA finds it "difficult to understand how" the ratio for white perch eggs can be 1.01 and the ratio for weakfish eggs can be 0.96. A simple review of the loss estimates in Appendix L of the Application provides the answer (Application Appendix L, Tab 10). Because White Perch spawn up-river of the station, and weakfish generally spawn down-river of the station, entrainment losses of eggs of these species are not observed in all years. For both white perch and weakfish, entrainment of eggs was only documented to have occurred in 3 of the 7 years, during 1996-1998. (Entrainment sampling was not conducted in the spring of 1997 because the station was not in operation). The loss estimates for white perch and weakfish eggs in 1996 were zero (see Table VII-6). Therefore, the scaled-up estimates of losses for the Base Case scenario for these years would have been zero also. Furthermore, the greatest annual loss estimates for weakfish and white perch eggs during 1991-1998 were for 1998. Since the Base Case scenario includes scheduled spring outages, and no outages occurred in 1998, the Base Case water withdrawals were less than the historical water withdrawals during some periods in the spring (when weakfish and white perch eggs are subject to entrainment). Therefore, the Base Case loss estimates for weakfish and white perch eggs are lower than the estimates for historical conditions.

The reason the ratio is less than 1 for white perch adults is that the losses of white perch adults are due to impingement. The historical loss estimates for impingement were based on the impingement mortality rates for the old intake screens for all years prior to 1996, and on the impingement mortality rates for the new intake screens for 1996 through 1998. For the Base Case scenario (which is intended to represent future conditions) impingement mortality rates for the new intake screens, of course, were used. As documented in the Application (see Application Appendix L, Tab 10 and Application Appendix F, Attachment F-4, Table 3), the estimated impingement mortality rate for adult white perch is much lower for the new intake screens than for the old intake screens. Therefore, the Base Case scenario losses for 1991-1995 are substantially lower than the corresponding historical losses (see Table VII.-7 for Age-1 white perch loss estimates). However, as expected, the Base Case scenario losses for 1996-1998 are higher than the corresponding historical losses (see Table VII-7).

c. ESSA Report § 5.2.3.3: Comparisons of Base Case Results

In Section 5.2.3.3, ESSA presents a comparison of the Base Case catch and production foregone estimates presented in the Application to estimates computed by ESSA using its spreadsheet method. The comparison is for weakfish and white perch catch foregone and bay anchovy production foregone. ESSA's estimates are within 1-2% of the estimates presented in the Application.

d. ESSA Report § 5.2.3.4: Analysis Results

In arguing for its spreadsheet method for calculating catch and production foregone, ESSA claims:

> One of the benefits of an analysis using a simple spreadsheet approach in calculating mortality foregone *[i.e., catch and production foregone]* is the production of additional information which can be useful in a management context. For example, it is possible to generate figures which show how much each of the life stages entrained or impinged contributes to foregone catch and natural mortality *[i.e., production foregone]*. One can then use this information to optimize intake protection strategies by concentrating on those life history stages which contribute the most to foregone catch and production. (ESSA Report, page 94, parentheticals added.)

The computational benefits ESSA alludes to are not specific to ESSA's spreadsheet method. Inputs for the type of graphs referred to could be produced by any valid method for calculating catch and production foregone. More importantly, ESSA's statement is inconsistent with the criteria used by NJDEP in its Section 316(b) permit decision-making. NJDEP's decision paradigm is clearly stated on page 69 of the Fact Sheet:

> Under Section 316(b), a permitting agency has the ultimate burden of persuasion that any BTA measure that it requires is "available"

> for a given facility, and that its *costs are not "wholly disproportionate"* to environmental benefits. (NJDEP Fact Sheet, page 69, emphasis added.)

ESSA's suggestion that PSEG should evaluate technology alternatives "by concentrating on those life history stages which contribute the most to foregone catch and production," with no reference to costs or to benefits associated with the foregone catch and production, is inconsistent with NJDEP's decision-making paradigm. ESSA's recommendation is inappropriate in the context of the Department's review of PSEG's Section 316(b) Demonstration permit requirements.

4. ESSA Report § 5.2.4: Sensitivity to Parameters and Input Data

Section 5.2.4 summarizes ESSA's sensitivity analyses of production and catch foregone to input parameters. As a result of its sensitivity analyses, ESSA concludes that the Base Case catch and production foregone estimates are sensitive to (1) the choice of years to include in the Base Case scenario, (2) estimates of weight at age, (3) estimates of early life stage mortality, (4) estimates of adult mortality, and (5) estimates of fishing mortality. ESSA also notes inconsistencies between natural mortality rate and weight-at-age estimates for striped bass and blueback herring from Application Exhibit G-6 and Attachment F-4.

a. ESSA Report § 5.2.4.1: Entrainment and Impingement Estimates

In this section of the ESSA Report, ESSA correctly notes that the loss estimates in the Application Appendix L exhibit considerable inter-annual variability. Based on this observation, ESSA notes that "[T]he choice of years to include in the estimation of base case entrainment plus impingement (E+I) is very important due to trends in the data." In particular, ESSA claims that if data from 1991-1998, rather than from 1978-1998, had been used to estimate base case losses for Atlantic croaker, the catch-foregone estimates would have increased by almost 70%. (It is interesting to note that ESSA did not choose to use spot for this example. If data from 1991-1998, rather than data from 1978-1998, had been used for spot, the Base Case estimates of catch foregone for this species would have dropped dramatically, due to the recent decline in spot abundance in the Estuary.) ESSA also claims that if data from 1978-1998, rather than data from 1991-1998, had been used to estimate base case losses for bay anchovy, the production foregone would have increased by 25%. Had ESSA chosen Atlantic Croaker or Striped Bass for this example, it would show that PSEG's choice of 1991-1998 rather than 1978-1998 caused the base case loss estimates to be greatly overstated. Losses of these species were close to zero in almost all years during the 1980's.

Unfortunately, one implication of ESSA's comments is that PSEG's choice of years to include in the loss estimates was arbitrary or determined by an attempt to minimize the magnitude of the resulting loss estimates. PSEG does not understand therefore why ESSA would make such comments without including an evaluation of whether PSEG's approach and rationale were valid. PSEG's approach and rationale for selecting the years to include in the

Base Case analyses basis for each species had a sound analytical basis, as clearly documented in Application Appendix F:

> Since the early 1980s, RIS populations in the Delaware River have generally been on the rise, and Delaware River water quality has improved. ... On the assumption that river conditions over the next decade will resemble those of the 1990s more than the 1980s or 1970s, baseline data for the modeling effort related to these species were generated using entrainment/impingement data from the period 1991-1998. . . .
>
> A different baseline period was used for two species: Atlantic croaker and spot. Since, based on conditions outside the Bay, abundance of these two species fluctuates considerably, the entire record of entrainment/impingement data (1978-1998) was used to develop the base-case loss estimates for theses species. (Application Appendix F, Attachment F-4, pages 3-4.)

b. ESSA Report § 5.2.4.2: Growth Curves

In Section 5.2.4.2, ESSA discusses the influence of growth curves and age-specific weight estimates on the production and catch foregone calculations. ESSA concludes that the growth curves used in Attachment F-4 of the Application are "irregular," and "represent an area of parameter uncertainty." According to ESSA, the interpolation method used to generate the growth curves "does not have a strong biological basis," and "results in unrealistic patterns of growth within a life stage." ESSA also highlights differences in age-specific weight estimates for striped bass and blueback herring that were used in Attachments F-4 and G-6. According to ESSA, if the striped bass weights from Attachment G6 had been used in PSEG's catch foregone calculations, the estimates would have been reduced by 11%. If the blueback herring weights from Attachment G-6 had been used in Attachment F-4, the catch foregone (and also ESSA's estimates of biomass lost to the ecosystem) would have been increased by 50%.

ESSA's comments on the growth curves attach far too much significance to the underlying equations and assumptions used to generate the curves. The growth rates of fish depend on temperature, prey availability, and a host of other environmental factors. The method used by PSEG provides weight-at-age estimates that are consistent with empirical data, which is all that is necessary. Fitting a different model to the same data would not appreciably change the results of the analysis.

The weight-at-age estimates for striped bass and blueback herring that were used in Attachment F-4 are documented in the Application (Application Appendix L, Tab 18). The values for striped bass were obtained from the striped bass stock assessment for 1998 (NMFS 1998), and represent average weight-at-age for striped bass in the commercial and recreational fisheries. Because the harvest of striped bass originating in the Delaware Estuary occurs primarily in the mixed coastal fishery, these are the most appropriate weight-at-age estimates for estimating the catch foregone by commercial and recreational fishermen.

The weight-at-age estimates for blueback herring that were used in Attachment F-4 were derived from age-length and length-weight relationships developed by PSEG (PSEG 1984) for the Delaware River blueback herring population that are documented in the Application, Attachment C-8. Although weight-at-age estimates derived from commercial catch data for blueback herring would have been more appropriate, no such estimates are available.

The striped bass estimates in attachment G-6, as documented in Table 5 of Application (Application Appendix G, Attachment G-6) were derived from a Delaware-specific length-weight regression and were intended to represent typical sizes and weights of striped bass at the end of each year of life, assumed to be May 15 of each year. For attachment G-6, the values for blueback herring were developed using a growth model and also represent weights at the end of each year of life.

The differences in weight-at-age estimates used in the two analyses reflect differences in objectives and assumptions, not parameter uncertainty. In any case, the quantitative effects of the differences are inconsequential. As noted by ESSA, using the striped bass parameters from Application Appendix G, Attachment G-6 in the catch foregone calculations results in an 11% reduction in the catch foregone estimate (ESSA Report, page 98). Using the blueback herring estimates from the Application (Application Appendix G, Attachment G-6) results in a 50% increase in catch foregone for this species; however, the magnitude of the Base Case estimate for this species is so low (1,046 lbs.) that a 50% increase would have no effect on the conclusions from the cost-benefit analysis.

c. ESSA Report § 5.2.4.3: Early Life Stage Natural Mortality

In Section 5.2.4.3, ESSA evaluates the influence of uncertainties in estimates of natural mortality rates on the resulting estimates of catch foregone. The evaluation includes (1) a comparison of the age-specific mortality rates for striped bass and blueback herring used in Attachment F-4 to the rates used in Attachment G-6, and (2) a comparison of early life stage mortality rates adjusted using the life-cycle balancing procedure (found in Application Appendix L, Tab 18) to the starting values for the rates, prior to adjustment. ESSA's evaluations of age-specific mortality rates for striped bass and blueback herring are erroneous and contradict conclusions presented in other sections of ESSA's review.

ESSA's evaluation of the age-specific mortality rates for striped bass is presented in Table 5.13 (ESSA Report, page 98). ESSA's evaluation reflects a confusion by ESSA regarding natural mortality and total mortality. In fact, PSEG used the same values in Attachments F-4 and G-6. The values for Age-1 striped bass presented in ESSA's Table 5.13 differ because of a rounding error by ESSA in converting the survival rate presented in Attachment G-6, Table 4 (0.335) to a daily rate. There is no difference between the values used in the two analyses. For age-2 and older striped bass, ESSA mistakenly assumed that the annual survival rates (S) in Attachment G-6, Table 4 reflected only natural mortality. In fact, the S values in this table reflect *total* mortality rates, i.e., both natural mortality and fishing mortality. They are identical to the values used in Attachment F-4 (see Application Appendix L, Tab 18, Table 9).

Similarly, ESSA's conclusion that using the natural mortality rates in Attachment G6 to calculate catch and production foregone for blueback herring would result in a 14 times increase compared to the values presented in Attachment F-4 is erroneous and resulted from a careless misinterpretation of PSEG's analyses. ESSA mistakenly assumed that the annual survival rates for blueback herring presented in Attachment G-6, Table 6 reflected natural mortality only. In fact, they included both natural mortality and fishing mortality. Moreover, ESSA errs in calculating a daily mortality rate for Age-0 blueback herring from the value presented in Attachment G-6. In Attachment G-6 the annual survival rate for Age-1 blueback herring was applied to Age-0 fish "during the period from outmigration to the first birthday." The duration of this period is approximately six months. In calculating a daily mortality rate, for Table 5.14 of its review, ESSA applied this rate over the entire 306-day duration of the juvenile life stage. The actual daily rate, correctly applied over a 180-day period rather than a 306-day period, is approximately 0.0017. This value is still about 10 times lower than the value used in Attachment F-4. However, the two estimates are not comparable. The value in F-4 was intended for application over the entire juvenile life stage. Most of the mortality to juvenile blueback herring probably occurs during the early part of the life stage, from July through September, when the fish are small and predators are active. Mortality should be much lower from October through May, when the juveniles are larger and predators are less active.

In Table 5-15 of its review, ESSA presents a comparison of the adjusted early life stage mortality rates to the unadjusted values (ESSA Report, page 99). The Table shows that in the great majority of cases the life cycle balancing procedure reduced the estimated mortality rates. Substituting the unadjusted values into the catch and production foregone calculation generally reduces the estimated effects of Station losses. This result supports PSEG's conclusion that life-cycle balancing did not introduce a downward bias into the loss and catch foregone estimates.

d. ESSA Report § 5.2.4.4: Adult Natural Mortality

ESSA questions the adult mortality rates for white perch that are used in the Application, without discussing PSEG's rationale for the rates, which is provided in the Application, and discussed in Section IV.C.3 of this Response (Application Appendix L, Tab 18). The data set used in the Application was the largest and most complete data set available for estimating age-specific mortality rates in white perch; Appendix L included a printout of the data used in the mortality rate calculations. This detailed documentation apparently was ignored by ESSA, dismissed with a statement that "there does not appear to be much justification for the values used in Attachment F-4, and substituting alternate values has a large effect."

ESSA goes on to suggest that a mortality rate of 20% per year, adopted from comments on the Application by C. Phillip Goodyear (Goodyear 1999), would be equally valid and would increase the catch foregone estimates to 160,000 pound per year, "a number comparable to the total Delaware and New Jersey landings for white perch." ESSA seems unaware that Goodyear's estimate was simply an assumption not supported by any data. The magnitude of the value calculated by ESSA - equal to the total reported landings of two states - should have suggested to ESSA that Goodyear's value was not credible. As noted in Section IV.C.3 of this Response, new data obtained from DDFW after the filing of the Application show that the

For forage species, the effects of natural and fishing mortality on equivalent catch foregone are elaborated in the hypothetical example depicted in Figure 7. For forage species, no fishery exists so that all biomass lost is biomass lost to the ecosystem. In this example, the production foregone that occurs after fish are lost to entrainment or impingement is 1000 pounds. The total weight of fish lost to entrainment and impingement is 1,000 pounds.

As was the case for Age-0 predator fish, much of the natural mortality of small forage fish (e.g., fish vulnerable to entrainment) is expected to be due to predation by non-economically valuable species. Therefore, in this example, it is assumed that 50% of the biomass lost directly to the Station (i.e., biomass of entrainment and impingement) would have been consumed by non-economically valuable species. Accordingly, 500 pounds of the biomass of entrainment and impingement would have been consumed by economically valuable species and 500 pounds is consumed by other species. Due to the 10% trophic transfer efficiency, this produces 50 pounds of economically valuable fish. Of these, half (25 pounds) would be harvested by the fishery (based on the assumptions described above for biomass lost of predator species).

For the biomass lost that occurs subsequent to the loss at the Station, only a fraction of the natural mortality is due to predation by economically valuable species. In this example, the conservative assumption is made that 90% of the natural mortality associated with biomass lost subsequent to loss at the Station is due to predation by economically valuable species. Accordingly, 900 pounds are consumed by economically valuable predators and support the production of 90 pounds of those predators. The 90 pounds of predators are at risk to the fishery, and assuming the fishing mortality rate is equal to the natural mortality rate, 45 pounds would be harvested by the fishery.

In this example, the direct biomass lost is 2,000 pounds (1,000 pounds biomass lost to entrainment and impingement, and 1,000 pounds of production foregone subsequent to entrainment and impingement). This biomass lost translates into an equivalent catch foregone of 70 pounds (25 pounds from biomass lost to entrainment and impingement, and 45 pounds from subsequent production foregone).

As in the case of the predator species, ESSA's focus is on direct biomass lost (Figure VII-13) rather than on equivalent catch foregone, which is the calculation needed for the Cost-Benefit assessment. Although the biomass lost in this example is 2,000 pounds, the equivalent catch foregone of 70 pounds is only 3.5% of that amount.

PSEG's method for estimating production foregone for the Cost-Benefit analysis in the Application also overestimates the catch foregone, but for a different reason. PSEG's method incorporated several conservative assumptions regarding the fraction of natural mortality that is due to predation by economically valuable species, and the fishery exploitation rate. All natural mortality production foregone was assumed to be due to predation by economically valuable predators. Furthermore, the exploitation rate on these predators was assumed to be 100%. Given these assumptions, the estimated catch foregone for this example would be 100 pounds, over 40% greater than the correct value (for this example) of 70 pounds.

Estimates of equivalent catch foregone that include all of the components of biomass lost to the ecosystem identified by ESSA are summarized for bay anchovy in Figure VII-15. These results show that the inclusion of omitted components would not materially affect the Cost-Benefit analyses. The conservative assumptions PSEG used for the bay anchovy production foregone analyses likely resulted in overestimates of catch foregone. Accounting for the exploitation rate (by using a weighted average rate from all predator RIS), and making the conservative assumption that 90% of natural mortality is due to predation by economically valuable species, would cause the catch foregone estimate for the base case scenario for bay anchovy to be 41% lower than the estimate presented in the Application — even after including the effects of biomass lost at the Station as suggested by ESSA.

b. ESSA's Conclusion Regarding Uncertainties in Estimates of Catch and Production Foregone

Regarding uncertainties in the estimates of catch and production foregone, ESSA concludes:

> [T]he input data and parameters contain some significant uncertainties due to a basic lack of information on some of these stocks and also to uncertainties in the estimates of station mortality; as a result, significant uncertainties about the final loss estimates should be considered. (ESSA Report, page 101.)

As a result, ESSA recommends that:

> [A] more detailed analysis of the levels of uncertainty in the production and catch foregone estimate needs to be considered. ... In the absence of this analysis it must be recognized that estimates for catch and production foregone that are two or more times those shown in Attachment F-4 can readily be obtained within the range of uncertainty of parameters for early life stage survivals, weights, adult mortalities, fishing mortalities, and station mortality. (ESSA Report, page 101.)

In this recommendation, ESSA only characterizes ESSA's view of the potential upper bound of uncertainty in catch and production foregone estimates and does not provide a characterization of the lower bound. A balanced characterization of the lower bound would have indicated to NJDEP that the true catch and production foregone was just as likely to be less than one-half the estimates presented in the Application. Indeed, as discussed above in Section VII.C.2.d, ESSA acknowledges that PSEG may have severely overestimated catch and production foregone. Yet, ESSA fails to mention this in its summary recommendations.

ESSA must be aware of the scientific difference between bias and uncertainty. Bias refers to a potential error that is known to produce either an over-estimate or an under-estimate of a parameter value where the direction of the error is known. Uncertainty refers to a potential error with no known directional bias, i.e., it could produce an over-estimate or an under-estimate.

The implication of ESSA's characterization of only the upper bound of uncertainty in its Summary and Recommendations section here is that the uncertainty in PSEG's catch and production foregone estimates is biased low. This implication, as detailed at length above, is false. PSEG notes that ESSA's analyses of uncertainty throughout the report display an unscientific tendency to imply bias in the uncertainties.

D. ESSA Report § 5.3: Balanced Indigenous Community Analysis

In Section 5.3 of its Report, ESSA provides a detailed critique of the benchmarks, data, and analytical methods used by PSEG in its Balanced Indigenous Community (BIC) analysis. ESSA's primary comments are that

1. the species presence/absence benchmark is "of limited value";
2. the pre-operational data are inadequate;
3. there are no "control post-operations" data;
4. PSEG should have measured impacts of the Station on benthic invertebrate communities;
5. PSEG should have addressed impacts of the Station on the entire Delaware Estuary ecosystem; and
6. PSEG's assessment of nuisance/non-indigenous species outbreaks is not sufficiently thorough. ESSA recommends that PSEG develop a comprehensive, Estuary-wide ecosystem monitoring program in conjunction with state and federal agencies to address the concerns raised by ESSA regarding the BIC analysis. (ESSA Report, pages 102-103.)

As detailed in this section, many of ESSA's concerns about the BIC analysis arise from the fact that ESSA misconstrued the purpose of the BIC analysis. In addition, the ESSA Report mischaracterizes and misrepresents important scientific literature related to community-level analyses. Each component of ESSA's review is briefly summarized and addressed below.

1. ESSA Report § 5.3.1: Selection of Benchmarks

ESSA states that the three indicators used by PSEG in the BIC analysis ". . . do not take into account the broader considerations of ecosystem structure and function, as outlined in the more recent U.S. EPA Ecorisk Guidelines [referred to as the "ERA Guidelines" in other sections of ESSA's review], as discussed in Section 5.1" (ESSA Report, page 102). ESSA further states that PSEG should have used "a broader range of appropriate measures of ecosystem response," and cites a paper by Rapport et al. (1985) as an example of advances in methodology that were not used in the Application (ESSA Report, page 102).

ESSA's claim that PSEG's indicators are inadequate because they do not address "broader considerations of ecosystem structure and function," (ESSA Report, page 102), is not supported by the documents cited in ESSA's review. EPA's Guidelines describe a *process* for designing and conducting ecological risk assessments that are consistent with goals, options, and decision criteria defined by environmental risk managers and stakeholders. The guidelines *do not* state that "broader considerations of ecosystem structure and function" must be part of every assessment. To the contrary, a major objective of the guidelines is to assist risk assessors in designing studies that focus on the information necessary to support the specific decision to be made. The information needed to support decisions regarding the impacts of cooling water intake systems is specified in USEPA's 1977 draft guidance on Section 316(b) assessments. The continued applicability of this guidance was recently reaffirmed by EPA (See Cook 2000 Memorandum.) The 1977 draft guidance does not direct applicants to study impacts of entrainment and impingement on ecosystem structure and function. Therefore, ESSA's advocacy of such studies is inconsistent with both the ERA Guidelines and EPA's Section 316(b) guidance. Moreover, the paper by Rapport et al. (1985) cited by ESSA describes a theoretical framework for investigating effects of stress on ecosystems, and does not include recommendations for designing site-specific studies such as those required for Salem 316(b) Demonstrations. The paper does not even discuss power plants as a source of stress to aquatic ecosystems. To the extent that the paper is even relevant to the Salem 316(b) Demonstration, it actually *supports* PSEG's analysis. Table 1 of Rapport et al. (1985) summarizes "symptoms of ecosystem distress" related to nine categories of stresses. One of these categories, "harvesting of renewable resources," is analogous to entrainment and impingement losses at the Station. According to the table, excessive harvesting would lead to reductions in species diversity (measured as the total number of species present, or "richness" as defined by Gotelli and Graves (1997)), replacement of native abundant species by exotic or normally rare species that are opportunistic and better adapted to harsh, new conditions (termed retrogression), and a replacement of large, long-lived species by small short-lived species. The BIC analysis specifically examined species richness and replacements, and found no indication of the types of changes that, according to Rapport et al. (1985), would be indicative of a stressed ecosystem.

a. Indicator: Fish Species Presence/Absence

PSEG's first BIC indicator is species presence/absence in pre-operational vs. operational periods. ESSA characterized this indicator as being of limited value because: (1) only fish were examined; (2) only near-field bottom trawl data were used; and (3) preoperational/operational comparisons do not factor out changes due to improvements in water quality or other changes that may have occurred concurrently with the Station startup (ESSA Report, page 102).

PSEG disagrees that the species presence/absence indicator used in the Application is of limited value. The indicator satisfies its objective, which is to provide a robust measure of changes in the composition of the fish community in the vicinity of the Station that could be attributable to Station operations. PSEG's focus on the fish community was appropriate because, as stated in EPA's 1977 draft guidance, fish populations are especially susceptible to adverse impacts caused by entrainment and impingement. Phytoplankton and zooplankton are unlikely to be affected because of their short generation times and high population growth rates; and invertebrate benthos are generally not susceptible to being entrained or impinged. PSEG's nearfield bottom trawl data set is, as documented in the Application, the only data set for which both pre-operational and operational observations exist. Although ESSA states in its review that "additional indicators" are needed, ESSA neither identifies any such indicators nor explains how these indicators would improve the basis for permit decisions. Finally, ESSA's comments that PSEG should compare data for years in which both units were operating to years in which one or both units were shut down in order to distinguish the effects of the Station from other factors lacks merit. Such comparisons can, in fact, be made using the existing data. As shown in Figure VII.D.-1, which includes data for all years through 1999, the two presence/absence measures used by PSEG (species richness and species density) were unaffected by the shutdown that occurred in 1996 and 1997.

b. Indicator 2: Fluctuations in Species Abundance

PSEG's second indicator is fluctuation in species abundance. ESSA characterizes this indicator as inadequate because it does not analyze the implications of species trends for the trophic structure of the ecosystem as a whole. ESSA recommends that PSEG use the ECOPATH simulation model for this purpose (ESSA Report, page 103).

ESSA's comments regarding the "fluctuations in abundance," indicator, like the comments on the presence/absence indicator, also misconstrue the objective of the analysis. As is clearly stated in the Application (Application Appendix F, Section VII.A.2), this indicator was intended to account for the influences of confounding environmental factors through the use of "impact hypotheses," consistent with the ERA Guidelines (USEPA 1998, page 38). This section of the Application compares the trends in abundance of major predator and prey populations in the Estuary to the expected effects of water-quality and habitat improvements, reduced fishing pressure, and Station operations. This indicator was specifically intended to address changes in the relative abundance of species, which would not be reflected in species presence/absence data. ESSA's review *did not even mention* PSEG's use of the impact hypothesis approach, much less review the method or the results. Instead, ESSA substituted its own view of what PSEG's objective should have been (i.e., quantify the effects of Station operations on the food web of the Delaware Estuary) and then criticized PSEG for inadequately addressing ESSA's objective.

c. Indicator 3: Eruptions of Nuisance or Non-Indigenous Species

PSEG's third indicator is eruptions of nuisance species, non-indigenous species, or species indicative of degraded conditions ESSA characterizes the third indicator as important, but states that the data used by PSEG are not fully documented, that the standard of proof required as evidence of no disruptions is unclear, and that "much more sophisticated and subtle diagnostics" are needed (ESSA Report, page 103).

ESSA's comments on PSEG's third indicator correctly characterize the purpose of the indicator but incorrectly characterize the sources of information used by PSEG. These "secondary sources" were comprehensive studies of the Estuary by the Delaware Estuary Program (O'Herron et al. 1994) and the U.S. Environmental Protection Agency (USEPA 1998b). The data collected for these studies is fully documented in the source reports. Neither study reported any outbreaks of nuisance species in the Delaware Estuary. ESSA's suggestion that "early onset of nuisance species and degraded conditions might occur unobserved" is true but irrelevant. Any "early onsets" that may have been occurring undetected in the early 1990s (the period in which the cited studies were conducted) would not likely have been due to the Station, which has been operating since 1977.

2. ESSA Report § 5.3.2: Methods

a. ESSA Report § 5.3.2.1: Scientific Soundness of Methodologies

Many of ESSA's comments on the scientific soundness of the methods used in PSEG's BIC analysis question the value, applicability, or relevance of the methods. Many of ESSA's comments, however, reflect the same misunderstanding of the objectives of PSEG's BIC indicators that was discussed above in Section VII.D.1 of this Response. PSEG's objective was to use the available historical data to determine whether, taking account of changes in water quality, fishing pressure, and habitat over the relevant thirty year period, the operation of Salem has upset or modified the balance of the Delaware Estuary fish community. The objective was not to detect or explain all possible changes that might have occurred over this period. In addition to misunderstanding the BIC analysis objectives, ESSA's criticisms of PSEG's BIC methodologies frequently reflect a selective reading of the scientific literature and/or misinterpret cited publications.

(1) Indicator 1: Fish Species Presence/Absence

(a) Hurlburt's Rarefaction Method

In commenting on PSEG's use of Hurlburt's rarefaction method (Hurlburt 1971), ESSA notes that this method was not included in reviews published by Washington (1984) and Boyle et al. (1990). (ESSA Report, page 104). Although ESSA did not draw any specific conclusion from this observation, readers are left to infer that Washington and Boyle viewed the rarefaction approach as inferior and unworthy of review. ESSA also states that Hurlburt himself had proposed the rarefaction approach as a tool for research on benthic invertebrates, not as a general index of community composition. (ESSA Report, page 104.) (Id.)

ESSA's characterization of the rarefaction approach reflects a selective and inaccurate review of the scientific literature. Ecologists define "diversity" as a measure of both the number of species in a community and their relative abundances (Peet 1974, Gotelli and Graves 1996). Washington (1984) and Boyle et al. (1990) reviewed "diversity indices," i.e., indices that combine information on numbers of species (termed "richness" by ecologists) and relative abundance of species (termed "evenness" by ecologists) into a single number. The rarefaction approach deals only with the number of species present in a community (i.e., richness), and does not consider relative abundance. This is the reason rarefaction was not included in the reviews cited by ESSA. As noted both by Hurlburt (1971) and by Gotelli and Graves (1996), most diversity indices have unclear biological interpretations and lack valid statistical tests. For this reason, Gotelli and Graves (1996, page 23) recommended that ecologists ". . . abandon the idea of incorporating both evenness and species richness into a single index." Further, Gotelli and Graves (1996) recommended Hurlburt's rarefaction method (Hurlburt 1971) as being the preferred method for measuring species richness. ESSA's statement that Hurlburt recommended the rarefaction approach only as a tool for studying benthic invertebrates is simply wrong. Hurlburt's (1971) paper discussed the theoretical foundation of diversity, richness, and evenness indices as applied in all types of ecological studies, not just benthic invertebrate studies. Moreover, Gotelli and Graves (1996) documented applications of the rarefaction approach in studies of fossils, birds, and plants as well as benthic invertebrates.

The meaning of species richness, as measured by the rarefaction method is not "uncertain," as stated by ESSA (ESSA Report, page 104). Because species richness does not consider the relative abundance of species in a collection, it is not sensitive to the various factors evaluated by Boyle et al. (1996). Richness as estimated using the rarefaction approach is, as noted by Gotelli and Graves (1996), affected by the spatial distribution of the organisms being sampled. The influence of spatial distribution in PSEG's analysis was minimized by limiting the study to the near-field region. ESSA's statement that species richness (total number of species present) is insensitive to species turnover (replacement of one species by another) is correct, as acknowledged by PSEG in the Application. For example, Application Appendix F states:

> The measures of the fish community employed in this section rely on counts of the number of individuals belonging to different species, irrespective of which particular species are present. (Application Appendix F, Section VII.A.1, page VII-1.)

The Application addresses the change in species in a separate section entitled Species Turnover (Application Appendix F, Section VII.A.1.d.iii, page VII-6) and in the section summary (Application Appendix F, Section VII.A.1.e., page VII-7). The reasons why data constraints precluded the use of the PSEG bottom trawl data for studying pre-operational vs. operational changes in relative abundance of species are clearly stated in the Application (see Application Appendix F, Section VII.A.1.b, page VII-4).

(b) SpeciesDensity

Although ESSA erroneously refers to it as a measure of species "diversity," (ESSA Report, page 104) this section discusses PSEG's use of numbers of species per trawl sample as a measure of species density. ESSA asserted that

> numbers of species alone do little to illuminate the characteristics of interest in a community such as evenness of distribution of individuals across species, potential changes in trophic structure and disruptions in the food chain, replacement of sensitive species by insensitive ones, relative importance of residents in comparison with migrants, etc. Recognizing that different community indices are sensitive to different pressures and reveal different characteristics, several authors recommend the use of multiple indices in tandem. (ESSA Report, page 104.)

ESSA's comments regarding the failure of the species density measure to characterize evenness of species abundances, changes in trophic structure, disruptions in the food chain, species replacements, etc., are irrelevant. There is no need for PSEG's Section 316(b) Demonstration to fully characterize all aspects of the structure and function of the Delaware Estuary fish community, and the Application does not attempt to do so. The species density measure is only one of several measures used in the BIC analysis. Species density, defined as the number of species collected per unit area or per unit sampling effort, is a widely-recognized and commonly-used measure of community composition. Both Hurlburt (1971) and Gotelli and Graves (1996) showed that species density and species richness are not equivalent and that both provide useful information.

(c) Species Turnover

ESSA challenges PSEG's characterization of pre-operational and operational lists of species as showing a lack of change in fish community structure since the startup of Station operations. (ESSA Report, page 105.) PSEG's conclusion, based on a comparison of pre-operational and operational periods species lists, that the fish community at present is virtually identical to the community that was present prior to startup is supported not only by the percent overlap between the two lists, but also by the identities of the species that were collected during only one of the periods. As is clearly stated in the Application, almost all of the species that were collected in only one of the two periods were marine or freshwater species that should be only rarely found in the vicinity of Salem but are common elsewhere in the Estuary. Failure to collect those species in the vicinity of Salem does not represent "species turnover," i.e., replacements of species that would normally be expected to be present. (See Application Appendix F, Section VII.A.1.d, pages VII-6 and VII-7). Moreover, PSEG's conclusion is consistent with the conclusion of O'Herron et al. (1994), who found "little difference" between the species reported to occur in the Delaware River prior to 1980 vs. since 1980.

(2) Benchmark 2: Fluctuations in Species Abundance

ESSA argues that the "fluctuations in abundance" indicator is inadequate because it considers effects of the Station on only 12 species, does not consider threatened or endangered species, and does not include a ". . . comprehensive set of indices of known sensitivity to a variety of specific stressors. . . ." (ESSA Report, page 105). ESSA also endorses the comment of Goodyear (1999) "[t]he suite of species present and the relative magnitudes of those species could shift in important ways" without being detected by the measures used in the BIC analysis (ESSA Report, page 105).

ESSA's review of this indicator focuses on irrelevant aspects of fish community studies rather than on the analysis actually performed by PSEG. The objective of this indicator was to investigate whether the operation of Salem may have led directly or indirectly to changes in the relative abundance of species. (See, Application Appendix F, Section VII.A.2, page VII-7). This investigation of changes in relative abundance was intended to address a specific, key aspect of fish community structure that cannot be addressed using species presence/absence data. Because many changes in the Estuary have occurred since the 1970s, the analysis focused on changes in the relative abundance of the major predator and prey species. Because the RIS selected for evaluation in the Section 316(b) Demonstration include representatives of predators and prey present in the Estuary, the analysis focused on changes in those species. Changes that would be expected if Salem were depleting susceptible fish populations were contrasted with changes expected due to changes in water quality, sediment quality, habitat quality, and fishing pressure. The predicted effects of each of the above influences were then compared to the observed changes in abundance of predator and prey RIS.

Instead of evaluating the merits of PSEG's approach, ESSA discusses the need to address endangered species and the need to develop additional indicators of community change. (ESSA Report, page 105). Instead of reviewing PSEG's evaluation of documented shifts in the relative abundance of the Estuary's major fish species, ESSA simply cites a statement from Goodyear (1999). PSEG has previously reviewed and responded to Goodyear's comments. (See Attachment I-A to these Comments.) Goodyear's comments focused primarily on PSEG's stock jeopardy analysis and provided only a cursory review of the BIC analysis. With regard to the Goodyear conclusion cited by ESSA, PSEG's Response stated:

> This assertion was unscientific and clearly inconsistent with PSEG's definition and benchmarks. If a change in species composition, or a change in the trophic balance in the Estuary attributable to depletion of predator or prey by Salem, or an outbreak of nuisance species in the vicinity of Salem had occurred, then according to PSEG's definition, an imbalance could exist. (Anthony et al. 2000, pg. 11)

(3) Benchmark 3: Eruptions of Nuisance or Non-Indigenous Species

With regard to PSEG's third indicator, ESSA comments that PSEG should ". . . clarify whether the methods used in the cited studies were sufficient to detect incipient changes in these species" (ESSA Report, page 105).

ESSA's comments are irrelevant to the objective of the third BIC indicator, which was to determine whether outbreaks of nuisance or non-indigenous species had been documented since the startup of Station operations. An "outbreak" means a rapid growth in abundance of such species that could threaten the balance of the community. The studies cited were sufficient to have detected such outbreaks, had they occurred. Whether the studies were powerful enough to detect "incipient" outbreaks that have not yet occurred is irrelevant to the objective of assessing the historical impacts of a facility that has been operating for more than 20 years.

b. ESSA Report § 5.3.2.2: Suitability of Data Used in the Analysis

(1) Representativeness of Bottom Trawl/Sample

ESSA discusses limitations of data from bottom trawl samples collected in the vicinity of the Station, and notes that the fish community present in this small area may not be representative of the Estuary as a whole. (ESSA Report, page 106.) PSEG's Application acknowledged the limitations of the bottom trawl data collected in the nearfield region (see Application Appendix F, Section VII.A.1.d, page VII-5). Although the nearfield region does not encompass the entire Estuary, it is large enough to be representative of the ecological zone (i.e., the highly turbid fresh/saltwater mixing zone) within which the Station is located. Moreover, any limitations of these data pertain only to the species presence/absence indicator. The other two components of the BIC analysis relied on Estuary-wide data.

(2) Inconsistency in Sample Years

ESSA notes that dates for which nearfield bottom trawl data are available are listed in the text of the Application as being 1970 through 1998, excluding 1983, 1987, and 1995, but that the Application (see Application Appendix F, Figure 2) also excluded the years 1984 through 1986 from the data set and that the nearfield bottom trawl data in Application Appendix L do not include any pre-1980 data. (ESSA Report, page 106.)

The inconsistency between the years noted in the text of the Application (Application Appendix F, Section VII.A.1.b) and the years identified in Figure 2 and in Appendix L are due to differences between the BIC presence/absence analysis and the trends analysis (1999 Application Appendix F, Section VIIB). Because the trends analysis relied on quantitative estimates of relative abundance, the trends analysis required more stringent data selection criteria than were necessary for the presence/absence analysis. During the years 1984 through 1987, the full nearfield bottom trawl program was not conducted, but limited sampling was conducted in the immediate vicinity of the Station as part of the W-factor sampling program (see Application Appendix F, Attachment 1, Section III.A.2.b). Because sampling did not cover the full region, these data were not used in the trends analysis. They were, however, used in the presence/absence analysis. The text of Section VII.A.1.b of the Application should have stated that data were available for all years between 1970 and 1998, excluding 1983-1987 and 1995. W-factor samples were collected in 1987; and were used in the presence/absence analysis. Appendix L, Tab 15 provides the annual abundance indices used in the trends analysis (Application Appendix L, Tab 15). The starting date for the PSEG near-field time series was 1979, not 1980 as stated in ESSA's comment. As discussed in Appendix J of the Application, the trends analysis excluded PSEG bottom trawl data collected prior to 1979 because of a change in the sampling protocol that affected the relative abundance estimates (although not the species counts).

(3) Sample Size

ESSA indicates that, with regard to rarefaction curves used to determine a standardized collection size for comparisons between years, the text in Application Appendices F and H refer to a collection size of 650, yet Appendix F Figures 11-13 show it as 65. ESSA assumed that the figure contained a typographical error, but suggests that a collection size larger than 650 would provide greater sensitivity in detecting differences between the pre- and post-operational curves. (ESSA Report, page 106.)

ESSA is correct regarding the typographical error: The correct sample size is 650, not 65. (The last digits of the Y-axis legends on Application Appendix F Figures 11-13 were inadvertently clipped off during printing of the figures.) However, ESSA's recommendation that PSEG should have used a sample size larger than 650 is inconsistent with the relevant scientific literature. The sample size selected for standardization using the rarefaction method cannot be larger than the smallest sample size in the data set. (Gotelli and Graves 1996.) A larger sample size could not have been used without violating this condition. A larger sample size might have demonstrated a statistically significant increase in species richness since startup during the spring and fall seasons, but would not likely have changed the statistical test results for the summer season.

(4) Variability, Confounding Factors, and Impact Hypotheses

Finally, ESSA argues that the absence of detectable changes in species composition may indicate "insufficient sensitivity in the metrics used, relative to the high level of variability inherent in dynamic estuarine systems." (ESSA Report, page 106). ESSA notes that improvements in water quality and changes in fisheries management practices may also have influenced the fish community of the Estuary, and argues that PSEG should develop specific impact hypotheses and then design a monitoring program to test those hypotheses. ESSA characterizes the impact hypotheses developed by PSEG in the Application (Application Appendix F, Section VII.A.2, page VII-7) (the "fluctuations in abundance" indicator) as being "a start" but "very general and not very convincing" (ESSA Report, page 106).

ESSA's comments regarding variability, confounding environmental factors, and hypothesis testing ignore the fact that PSEG did address these issues in the Application. As is clearly stated in the Application (Application Appendix F, Section VII.A.2, page VII-7-8), PSEG *did* recognize the importance of considering confounding environmental factors and *did* address them using impact hypotheses. As noted above, in reviewing this section of the Application ESSA provided no comments on PSEG's summary of information concerning confounding environmental factors, on PSEG's impact hypotheses, or on the data sets used by PSEG to evaluate the hypotheses. ESSA's assertion that PSEG's hypotheses and analyses are "very general and not very convincing" was not supported in any way by specific comments on these hypotheses and analyses. Moreover, additional discussion of confounding factors is provided in Appendix C of the Application, although PSEG recognizes that ESSA was not provided this appendix.

3. ESSA Report § 5.3.3: Validity of Assumptions and Inferences Drawn

According to ESSA, PSEG's BIC analysis is based on a variety of invalid or untested assumptions that ESSA lists in its report. ESSA's assertions concerning "invalid or untested assumptions" are incorrect as detailed below (<u>See</u> ESSA Report, pages 106-107).

ESSA comments that:

> As discussed in Section 5.3.1, benchmarks were selected on the basis of a number of assumptions that are either not valid or untested: 1) focusing on a balanced indigenous fish community is adequate to detect adverse environmental effects at the ecosystem level; 2) other types of biological communities are either unaffected or unimportant; and 3) the three benchmarks are sufficient to reflect changes in the fish community. (ESSA Report, page 106-107)

PSEG never stated that fish community data were adequate to detect adverse changes in other ecosystem components. However, because the fish community is the most likely component to be affected by Station operations, it was appropriate for PSEG to focus its analysis on fish:

> Relative to environmental impact associated with intake structures, affects on meroplankton organisms, macroinvertebrates, and juvenile and adult fishes appear to be the first order problem If preliminary sampling or prior data does not support special or unique value of these organisms at the site, phytoplankton and zooplankton species will generally not be selected. (USEPA 1977 Guidance, page 16).

Similarly, PSEG never asserted that other types of biological communities are "unimportant." The comparatively low sensitivity of most of these communities (e.g., benthic invertebrates, phytoplankton, and zooplankton) to entrainment or impingement effects is explicitly recognized in EPA's draft guidance for Section 316(b) assessments (EPA 1977).

Again contrary to ESSA's implication, PSEG never stated that the three benchmarks (indicators) are sufficient to reflect all changes in the fish community. PSEG's only claim was that these indicators would have reflected impacts related to Station operations if impacts were to occur. Measuring any and all changes in the Delaware ecosystem was never PSEG's intent nor is it PSEG's obligation under applicable regulatory requirements in connection with Section 316 or the NPDES program in general.

ESSA continues by stating:

> Several untested assumptions are inherent in the indices used, for example: 1) that Hurlburt's rarefaction curve is applicable to fish (having been developed for benthos); 2) that it has some ecological significance; 3) that the data from fish that happen to be in the nearfield area reflect something meaningful about the fish community as a whole, etc. (ESSA Report, page 107).

As discussed above in this section of PSEG's Response, many applications of the rarefaction method, to communities other than benthos, were documented by Gotelli and Graves (1996). Furthermore, The ecological significance of species richness, as measured using the rarefaction model, is amply documented by Sanders (1968), Hurlburt (1971), Peet (1974) Gotelli and Graves (1996), and in many other peer-reviewed scientific papers. Finally, PSEG explicitly stated that the results of the species presence/absence analysis applied only to the nearfield region.

In addition, ESSA criticizes PSEG for failing to consider the possibility that "negative effects from the [S]tation may have been masked by improvements from other sources" (ESSA Report, page 107). ESSA states that the "Application should acknowledge that additional benefits might have accrued in response to improvements in water quality and fisheries management, had the [S]tation not been operating" (Id.) According to ESSA, "[o]nly studies with intensive monitoring along spatial-temporal gradients of stressors, with a good understanding of species-specific sensitivities to those stressors and reasonable estimates of abundance, can convincingly ascribe (or exclude) causes to observed changes in community structure" (Id.) ESSA states that the Application should acknowledge these difficulties and apply "appropriate levels of caution to the conclusions." (Id.)

ESSA's assertion that "negative effects from the station may have been masked by improvements from other sources" sounds superficially insightful but in reality states an unfalsifiable hypothesis concerning Station effects. No monitoring program, however intensive, could ever provide the data to prove to 100% certainty that the Station has no effect on the Delaware Estuary fish community, or that observed improvements would not have been even greater in the absence of the Station. However, this level of proof is not required in any type of environmental assessment. PSEG's conclusions concerning the retrospective effects of Salem's operations on community balance are reasonable inferences from three independent indicators of community change. The analysis of species presence/absence data show that there clearly has been no decline in species richness or species since the startup of Station operations. In fact, there has been a statistically significant *increase* in species density. The analysis of fluctuations in abundance of predator and prey species shows that trends in abundance of these species are consistent with expected effects of improved water/habitat quality and reduced fishing pressure, but inconsistent with expected effects of entrainment and impingement at Salem. The evaluation of nuisance species outbreaks - which are easily observable when they occur - shows that none have been observed since the startup of Station operations.

PSEG's conclusion that Station operations have not upset or modified the fish community of the Delaware Estuary was derived from the concordance of all three lines of evidence and was described as such in the Application (Application Appendix F, Section VII.A.4). PSEG does not claim and has not ever claimed that its analyses could detect or explain all possible ecological changes in the Delaware Estuary. Given the size and complexity of this ecosystem, not even the "intensive" monitoring studies discussed by ESSA could achieve such an ambitious objective. The objectives of PSEG's research were much more limited: to determine whether the past 20 years of Station operations had caused an imbalance in the fish community of the Estuary.

4. ESSA Report § 5.3.4: Level of Integration with Other Study Components/Uncertainty

ESSA comments that PSEG's BIC analysis was insufficiently integrated with other components of the Section 316(b) demonstration. In particular, ESSA states that the BIC analysis did not utilize the catch and production foregone calculations of Appendix F-4. According to ESSA, these calculations could help formulate "more specific impact hypotheses to be tested either retrospectively or with better designed future monitoring" (ESSA Report, page 107).

In fact, it would have been inappropriate to use the production foregone calculations presented in Application Appendix F-4 in the BIC analysis. These calculations are conservative model-derived projections intended for use in intake technology evaluations. They are not retrospective measures of actual ecological conditions. Moreover, the hypothesis alluded to by ESSA was, in effect, tested by the BIC analysis. If Station operations had drastically reduced prey production in the Estuary in the way suggested by ESSA, predator abundance should have been reduced. However, the observed trends in predator abundance documented in Appendix J of the Application (i.e., increased abundance of the two most important predators, striped bass and weakfish) are clearly inconsistent with ESSA's hypothesis.

ESSA also states that uncertainty associated with data inputs should be examined more thoroughly, and that "[b]roader uncertainties, concerning the implications of production foregone for the rest of the ecosystem (e.g., energy flows, nutrient transfers, community dynamics, etc.) need to also be considered" (ESSA Report, page 107). PSEG disagrees. PSEG's conclusions do not depend on failure to detect changes due to low statistical power. In many cases (e.g., species density analysis, trends analysis), statistically significant changes were found, but the direction of change was opposite to the direction expected if the Station were adversely affecting the fish community. Hence, it is not clear how further discussions of uncertainty would improve the analyses. The "broader uncertainties" alluded to by ESSA reflect ESSA's own preferred indicator of adverse impacts. As discussed in Section VII.C. above, ESSA's proposed "production foregone" indicator is conceptually flawed and useless as an indicator of AEI.

5. ESSA Report § 5.3.5: Summary and Recommendations

ESSA's summary evaluation of the BIC analysis concludes the Application does not adequately acknowledge the many limitations of the analysis, particularly in the conclusions drawn. (ESSA Report, page 107.) PSEG believes ESSA's comments incorrectly characterize the Application and ESSA's recommendations go far beyond the scope required for a Section 316(b) study.

ESSA first states "that the fish community is not adequately characterized by the indices developed for the Application," and that these indices are "of undocumented but generally low sensitivity to power stations and other stresses, of unknown ecological significance, and based on data from a small geographical subset of the range occupied by the community" (ESSA Report, page 108). In fact, the strengths and weaknesses of species presence/absence data are extremely well-documented in the scientific literature and were acknowledged by PSEG in the Application.

Species richness and species density have been used as response indicators in many studies of ecological effects of chemicals and other stressors (Gotelli and Graves 1996). The nearfield sampling region, although not encompassing the entire Delaware Estuary, is large enough (20 miles in length, encompassing the entire width of the Estuary) to provide meaningful data concerning the structure of the fish community in the vicinity of the Station. Moreover, PSEG did not rely solely on the presence/absence analysis in drawing its conclusions. The conclusions were based on *three* lines of evidence, not one.

ESSA then comments that "it is unrealistic to assume that a few key statistics for one component (fish) are sufficient to detect changes in a highly variable system" (ESSA Report, page 108). PSEG did not, as asserted by ESSA, assume that a few statistics for one component could be sufficient to detect all changes in a "highly variable" system. Rather, PSEG chose indicators that would be expected to respond to Station influences, and used multiple indicators to address the influence of environmental variability. In spite of this variability, statistically significant changes were observed. The directions of these changes are contrary to the directions expected if the Station were having a significant adverse impact on the community. Appendix F, Section VII, A.4.

ESSA comments "that the assumption that 'no observed change' means 'no negative effect'" is unwarranted, given natural variability, high levels of measurement error, changes in sampling methods, and the potential for masking of negative impacts of the [S]tation by improvements in water quality and changes in fisheries management (ESSA Report, page 108). As noted above in Section VII.D.3, variability and measurement error did not prevent PSEG's analysis from detecting increased species density, absence of species turnover, and increased abundance of both predator and prey fish species. And, as also noted above in Section VII.D.3. ESSA's "masking" hypothesis cannot be refuted using any conceivable data set. PSEG's analysis shows that whatever influence the Station may have had on the fish community is small enough that they have not affected the ability of the community to respond quickly to improved environmental conditions and reduced fishing pressure. No amount of additional data or analyses would ever be sufficient to show a complete absence of Station influences; however, it is not necessary to demonstrate such an absence to justify a finding that the Station is not having an adverse environmental impact on the Estuary.

ESSA comments that "in focusing on a balanced indigenous fish community, the Application does not consider other components of the ecosystem such as shellfish, plankton and benthos, as well as other indicators of ecosystem function and structure" (ESSA Report, page 108). As explained above in Section VI.B.1.c, PSEG's focus on the finfish community is consistent with EPA's 1977 draft guidance on Section 316(b) studies. The guidance (p. 16) recommends a focus on fish populations and macroinvertebrates. The other taxa mentioned in ESSA's comments are not highly susceptible to impacts caused by entrainment or impingement. It is not clear what other "indicators of ecosystem function and structure" ESSA might be advocating, but unless directly related to the vulnerable components of the ecosystem (i.e., fish) they would be difficult or impossible to interpret because testable risk or impact hypotheses could not be formulated (USEPA 1998). Without clearly stated impact hypotheses, the lines of evidence needed to implement a weight of evidence approach as recommended by EPA and needed PSEG could not be developed.

ESSA comments that the "Application needs a more rigorous sensitivity analysis of the indices used, open discussion of the weaknesses in the data used, explicit recognition of the confounding influences on fish community structure, and a much more cautious set of conclusions" (ESSA Report, page 108). The rarefaction approach does not employ a model with functions and parameters, so it is not clear what ESSA means in stating that a "more rigorous sensitivity analysis" is needed. The limitations of the data are thoroughly discussed in the Application. Further, one of the BIC indicators (fluctuations in abundance) was developed expressly to examine the effects of the most important confounding influences (i.e., water/habitat quality and fishing). PSEG continues to believe that the conclusions from the BIC analysis are fully justified.

Finally, ESSA recommends that PSEG's monitoring program be redesigned with a "broader set of benchmarks" that are consistent with the U.S. EPA's 1998 Guidelines on Ecological Risk Assessment" and coordinated with other ongoing monitoring programs, and ESSA suggests a variety of "considerations" that PSEG should address in developing such a program (ESSA Report, page 108). As discussed in Section VII.B of this response, the ERA Guidelines (USEPA 1998) recommend a process for designing assessments and do not recommend any specific benchmarks/indicators of ecosystem well-being nor any technical approach for developing such indicators. The development of a comprehensive long-term monitoring program for the Estuary, coordinated with state/federal agencies and other users of the Estuary's resources is certainly a worthy goal, as are many of the considerations identified by ESSA for inclusion in the conceptual framework of such a monitoring program. However, while PSEG supports the goal, developing such a program is outside the scope of the NJPDES permitting process and certainly is not relevant to evaluating the technical merit of PSEG's 316(b) demonstration.

E. ESSA Report § 5.4: Trends and Retrospective Analysis

1. ESSA Report § 5.4.1: Review of Trends Analyses

a. ESSA Report § 5.4.1.1.: Introduction

Section 5.4.1.1 presents the rationale behind ESSA's approach to reviewing PSEG's Trends Analyses. ESSA indicates that the purpose of its review is to"...address the rationale and assumptions, preparation of indices and statistical methods, and the internal and external consistency of the results." (ESSA Report, page 110). ESSA makes no comments regarding the Application in this section of its Report, and PSEG has no comments on this section of the ESSA Report.

b. ESSA Report § 5.4.1.2: Rationale and Assumptions

ESSA criticizes PSEG's decision to focus the Trends Analyses on age-0 fish, indicating that trends in the abundance of adult fish do not always follow trends in age-0 fish. (ESSA Report, pages 110-111.) The fact that trends in abundance of adult fish do not always follow trends in age-0 fish is well known and, as explained below (contrary to ESSA's view) supports PSEG's decision to focus on age-0 fish.

PSEG discusses its rationale for focusing the Trends Analyses on age-0 fish in several places in the Application. Application Appendix H, which addresses the cumulative effects of the Station's operations on fish populations through a retrospective assessment, states: (Application Appendix H, Section 113, page 14)

> The approach for the retrospective assessment provides simple direct evidence of the cumulative effects from all sources of mortality such as fishing, predation, and the effects of Salem on the aquatic biota. The approach does not rely on models nor on speculation regarding threshold level effects that would cause harm to the aquatic population. If an aquatic population is unhealthy and not successfully reproducing as a result of these cumulative effects, a decline in population abundance would be expected over the long term. This type of decline would be observed first in reduced juvenile recruitment. For this reason, the assessment examines changes over time in abundance of finfish RIS up to Age-1. Independent and peer reviewed assessments conducted by other groups such as the Atlantic State Marine Fisheries Commission (ASMFC) and the National Marine Fisheries Service (NMFS) are reviewed and compared whenever possible. (Application Appendix H, Section IB, page 14.)

Appendix J, which documents the methods used for the Trends Analyses, states:

> [T]he trends analysis focused on age-0 fish (which are also referred to as juveniles in this Appendix) because year-class strengths of fish populations generally are established by the end of this life stage and one of the first signs of a decline in population abundance is a downward trend in recruitment (i.e., young fish produced each year). Most effects of the Station are expected to occur during the first year of life. (Application Appendix J, Section I, page 5.)

Finally, Application Appendix F, which addresses the benchmarks of adverse environmental impact, indicates that:

> This benchmark [i.e., Continuing Decline in Population Abundance] for determining whether an adverse environmental impact has occurred is drawn from biology and population dynamics which has demonstrated that a decline that continues long enough will lead to a population crash. (Application Appendix F, Section VII, page 17).

ESSA criticizes PSEG's focus on age-0 fish by arguing that:

> A counterpoint to this assumption is that there are circumstances under which increasing juvenile abundance may not be related to an increase in adult abundance or may not translate into more adults. For example, with strong density-dependent survival between Age-0 recruitment and spawners, or improving conditions for juvenile survival, a stable or increasing trend in juvenile abundance may mask a declining adult population. (ESSA Report, page 110.)

ESSA's statement implies that PSEG assumed that an increase in recruits *always* results in an increase in adult abundance, which would be an incorrect assumption. In fact, the Application does not make such an assumption. PSEG agrees that increases in recruitment do not always result in increases in adult abundance, and that the presence of strong density-dependent survival is likely. However, PSEG disagrees with ESSA regarding the implications of these facts. PSEG believes they support rather than undermine PSEG's decision to focus on age-0 fish for the Trends Analyses.

As stated in the Application, a decline in the number of recruits is one generally recognized warning sign of an adversely impacted fish stock, whether the impact is due to fishing, power plants, or other anthropogenic mortality. Furthermore, as clearly noted in the statement of the rationale for focusing on age-0 fish in Application Appendix J (*see* quote, above), most Station effects occur prior to recruitment, and therefore changes in recruitment provide a much more direct measure of Station effects than changes in adult abundance. Adult abundance is affected by fishing and natural mortality that occur after age-0 and after fish have little vulnerability to Station effects. In particular, fishing mortality can and has had dramatic effects on adult stock sizes, independent of the effects of the Station. In the context of assessing power plant effects on fish (which mostly occur between spawning and recruitment), the end of the first year of life is the most relevant life stage for assessing abundance trends.

(1) Statistical Population of Interest

ESSA criticizes the Trends Analyses by claiming that the "statistical population[s]" associated with each of the indices of fish abundance "are not explicitly stated in the text of Appendix J" (ESSA Report, page 110). Although the Application does not use the technical jargon "statistical population," it does provide clear definitions of the statistical populations. Figures 2 through 6 of Application Appendix F clearly document the spatial limits of the populations subject to sampling by each of the three sampling programs (i.e., the DNREC Juvenile Trawl Survey, NJDEP Beach Seine Survey, and PSEG Bottom Trawl Survey). This information is repeated in the Application. (Application Appendix H, Figure 3). Furthermore, Tables J-2 to J-11 of Application Appendix J clearly document the temporal limits, as well as the additional spatial limits, of the statistical populations for each of the nine RIS. (Application Appendix H, Section B2, page 15.)

ESSA also criticizes the Trends Analyses by implying, incorrectly, that the Application interprets each index of abundance for a species as a measure of the relative abundance of the overall stock:

> Each index therefore represents a narrow and specific spatial, temporal and depth region of the river. To extrapolate results based [on] samples drawn from these narrow regions to the broader regions in which they are found requires the assumption of specific relationships, or models that relate the sampled or statistical population to the population of real interest. These assumptions should be stated explicitly. . . . (ESSA Report, page 111.)

ESSA goes one to state:

> One thing that is not made clear in Appendix J is whether the CPH index values are intended to represent separate indices of the same thing (i.e., absolute population abundance for the Delaware River), or merely the region in which the data were collected. This lack of clarity clouds interpretation of the results. (ESSA Report, page 111.)

This suggests an error in the Trends Analyses that does not exist. The Application does not assume that the trends observed in the abundance index of one sampling program were indicative of trends in stock-wide abundance. The restricted nature of each sampling program was recognized and noted in the Application. For example, Appendix J states clearly:

> Estimates of relative abundance from different sampling programs generally cannot be compared directly due to differences in sampling methods (e.g., tow durations, gear types, *locations sampled, and times of year sampled*) among programs. (Application Appendix J, Section III, page 7, emphasis added.)

This point is also reinforced in appropriate places throughout the Application. For example, the relationship between sample locations of the NJDEP Beach Seine Survey and the spatial distribution of weakfish in the Estuary is noted in Appendix H:

> The NJDEP Beach Seine Survey samples the upriver extreme of the range of weakfish in the Estuary, and therefore is not expected to track abundance trends as well as the down-Estuary sampling programs. (Application Appendix H, Section IIA, page 28).

Further, Appendix H provides clear recognition that different programs sample different portions of each stock and may show different trends:

> The DNREC Juvenile Bottom Trawl survey (H Figure 17) which samples the lower Estuary, shows strong peaks in 1989, 1993, and 1996. These are the years of recent dominant year classes in Chesapeake Bay. H Figure 18 compares the year class strengths of the Delaware and Chesapeake stocks by plotting the two surveys against data from the Chesapeake head of bay stations of Maryland

> Beach Seine Survey. The NJDEP Beach Seine survey, which samples in the freshwater portions of the Delaware River above the C&D canal, shows no correlation with the Chesapeake Bay data for juvenile striped bass. (Application Appendix H, Section 8, page 34.)

The implications of the sampling locations of the NJDEP Beach Seine Survey, in comparison to the sampling locations of the other programs, is further noted in Appendix H:

> Because American shad spawn so far upriver, the NJDEP Beach Seine survey provides the best information on abundance, of the three surveys examined by PSE&G. (H Figure 27). (Application Appendix H, Section II D, page 46.)

And the limited nature of the PSE&G Nearfield Survey is recognized in Appendix J:

> The DNREC juvenile Trawl Survey, which samples a much larger geographic area than the PSE&G Nearfield Survey, did not indicate an exceptionally high average CPH in 1980. This suggests that the high catch observed in the PSE&G 1980 collections represented a local condition, and was not representative of baywide abundance. (Application Appendix J, Section V, page 17.)

ESSA's implication that PSEG assumed that the results from each sampling program apply to Estuary-wide conditions is not credible. In fact, elsewhere in its report ESSA acknowledges that PSEG's Application states that relative abundance indices cannot be directly compared:

> Although Appendix J does state that relative abundance indices cannot be directly compared, this caveat can easily be forgotten when the results are presented in a single summary figure. (See ESSA Report, page 114.)

(2) Relating Relative Abundance to Absolute Abundance

ESSA accepts the assumption of a proportional relationship between indices of relative abundance (i.e., average CPH) and absolute abundance as being a "reasonable starting point" but recommends that this assumption should be assessed as "more information becomes available through future analyses or research efforts." (ESSA Report, page 111.) PSEG agrees that as more information becomes available in the future, the validity of the proportionality assumption should be assessed in light of it. However, the purpose of the Trends Analyses was simply to identify positive evidence for the presence of downward or upward trends, not to draw conclusions based on quantitative estimates of the magnitude of the trends. Therefore, the validity of the proportionality assumption does not affect the conclusions presented in the Application.

c. ESSA Report § 5.4.1.3: Utility of Survey Data

The Report raises concerns about sampling bias that ESSA believes may have resulted from using fish survey data collected by the resource management agencies of the states of New Jersey and Delaware. ESSA's concerns about the DNREC and NJDEP data are:

> The only way to be certain that an estimate of mean annual CPH is unbiased is to conduct a stratified random sampling over the spatial, temporal and depth region of interest. However, the DNREC Juvenile Trawl Survey and the NJDEP Beach Seine Survey sample at fixed locations within particular regions of the Delaware Estuary. Sampling fixed locations does not provide a representative index of Estuary population abundance and may result in biased index values. (ESSA Report, page 111.)

ESSA caveats its position slightly by noting that, "If the spatial and temporal bounds of the data used to create the indices over time do not change and site conditions do not trend over time, this bias may not be so important for a relative abundance index." (ESSA Report, page 112.)

The fish survey data in question are the same data that states collect for use in their management of the fish stocks of Delaware Estuary. For example, the purpose of DNREC's juvenile trawl survey is described in the DNREC Coastal Finfish Assessment Survey Annual Report (Delaware Division of Fish and Wildlife, 1998):

> Effective management of near-shore fisheries is dependent, in part, upon accurate and timely estimates of recruitment for the prediction of future trends in adult stock size and harvest potential. To accomplish this, the Delaware Division of Fish and Wildlife began a 16-foot (4.9-m) trawl survey of the Delaware Bay nursery area in 1977. The purpose of this survey was to assess the annual production of juvenile blue crab. This program was expanded in 1980 to include catch frequency data of juvenile fishes to determine their relative abundance, distribution and, where possible, as an indicator of year-class strength.

In the view of PSEG's scientific experts, these are the best data available on these stocks. Thus, using these data for the Trends Analyses was entirely appropriate and consistent with the legal and regulatory precedent described above in Section I.D. 2 that mandates use of the best information reasonably attainable in Section 316 demonstrations.

(1) Appropriateness of Surveys for Indexing RIS Species

ESSA states that the Trends Analyses "assume that each survey is appropriate for all RIS species," and criticizes the Trends Analyses on this basis (ESSA Report, page 112. There is no support for ESSA's statement in the Application The Application does not make this assumption. Moreover, this assumption is not required for any of the conclusions presented in the Application. As is clearly discussed in Appendix J, PSEG gave careful consideration to inter-annual consistency in sampling techniques, the life histories of each of the RIS, and to the catch rates of each RIS in each region and month of each sampling program (see Application Appendix J, Sections II-III, pages 6-11). Only after this background information was systematically assembled and reviewed, were the programs, and the months and regions for each program selected for the purpose of representing relative abundance of each of the RIS. As documented in Appendix J, not all programs were judged appropriate for all RIS.

Nevertheless, PSEG purposefully erred on the side of including additional information in the application (i.e., data from additional sampling programs) on each RIS, rather than excluding information *a priori*. PSEG believed it was important not to ignore information that might shed some light on the condition of the fish stocks. If the sampling variability of catches from a program for a particular RIS was too large to produce meaningful results, this fact was uncovered by the statistical analyses. Only statistically significant results were relied upon for drawing conclusions.

(2) Length and Span of Time Series

The Report indicates that ESSA agrees with PSEG's rationale, stated in Appendix J of the Application, for including as many years as possible in the Trends Analyses:

> Appendix J notes that it is advisable to use as long a time series as possible in the evaluation of trend[s] to avoid drawing conclusions based upon the short term ups and downs inherent in natural data. We concur.... (ESSA Report, page 113.)

But then ESSA states that "using time series of equal length but that represent different time periods can also give different results" (ESSA Report, page 113). This comment, is irrelevant to evaluating PSEG's Trends Analyses, as is the example ESSA provides to illustrate the point. ESSA contrasts the indices of blueback herring relative abundance derived from NJDEP Beach Seine Survey data by Weisberg, et al. (1996) for the years 1980-1993, which showed no significant trend, to the indices for blueback herring presented in the Application for the years 1986-1998, which show a significant downward trend. The fact that Weisberg, et al found no statistically significant trend indicates that the estimated trend was too imprecise to provide a basis for determining the direction (upward or downward) of the true trend. ESSA incorrectly ignores this result of Weisberg, analyses when ESSA contrasts Weisberg's finding of no significant trend for the period 1980-1993 to PSEG's finding of a significant downward trend for the period 1986-1998. This apples-to-oranges comparison does not indicate the presence of a problem, and does not apply to the validity of PSEG's Trends Analyses.

(3) Confounding Factors

ESSA comments that:

> The times-series of relative abundance are confounded with numerous environmental and anthropogenic factors that drive variation in juvenile abundance. . . . These factors include improved water quality, decreased fishing pressure, and increased habitat quality and quantity. (ESSA Report, page 114.)

ESSA then questions the Trends Analyses, because they do not provide certain kinds of information:

> The severe confounding restricts the scope of the question the Appendix J trend analyses can address to this: For RIS finfish and blue crab, is there trend in average annual Age-0 CPH for the statistical population of interest? The analyses can say nothing about the cause of the observed trends, or the importance of entrainment and impingement by Salem relative to other factors that influence RIS finfish survival. (ESSA Report, page 115.)

The scope of the Trends Analyses is not a scientific flaw. As the ESSA Report fully acknowledges, the objective of the Trends Analyses is "to assess the trends in Age-0 RIS fish" (ESSA Report, page 110). The Trends Analyses were never intended to determine the effects of entrainment and impingement on fish stocks, as ESSA's comment here implies. As is clearly stated in Appendix J of the Application, the Trends Analyses were used simply to characterize empirical trends in abundance of age-0 RIS fish for the period of record. (Application Appendix J, Section III.A.2, page 11).

Moreover, the results from the Trends Analyses were never intended to be, and were not, interpreted in a vacuum. Interpretations of the results from the Trends Analyses are discussed in Appendix F and Appendix H of the Application. In Appendix F, the results from the Trends Analyses were interpreted in the context of alternative impact hypotheses as part of the BIC assessment. In Appendix H, the Trends Analyses were the source of only one of many types of information on the historical condition of the RIS stocks that were reviewed as part of a cumulative assessment.

d. ESSA Report § 5.4.1.4: Preparation of Indices

(1) Potential Bias in Average CPH Abundance Estimates Derived from NJDEP BSS Data

This section of the ESSA Report discusses its request that PSEG re-run the Trends Analyses based on the NJDEP Beach Seine Survey data to determine whether dropping data from replicate hauls at a site (other than the first haul), as recommended by Wilson and Weisberg (1993), would change the results from the analyses. ESSA made this request to determine if there was a potential bias in the average CPH abundance estimates derived from NJDEP's BSS data. PSEG complied with the request, and provided the supplemental analysis to address this question in December 1999. As the ESSA Report indicates, ESSA's review of PSEG's supplemental analysis concluded that "the general results as reported in Appendix J did not change" (ESSA Report, page 116).

(2) External Consistency of Indices

ESSA comments that the results from Appendix J should be compared to results of trends analyses based on the same data that were conducted by other researchers. ESSA attempts to make such a comparison between indices of abundance based on the NJDEP Beach Seine Survey that were computed by Weisberg, et al. (1996) with corresponding indices from Appendix J. ESSA concludes that:

> The results show that striped bass, white perch and alewife compare well, American shad compare reasonably well, but that blueback herring does not compare well. The greatest differences between the two series for blueback herring occur prior to 1991 (Figure 5.7). The poor correspondence between the two time series for the blueback herring data lead to the different trend results discussed above. (ESSA Report, page 116.)

Furthermore, even if ESSA had used the values reported in Weisburg, differences between Weisberg and PSEG's estimates would exist. Although the average CPH estimates for blueback herring presented in Weisberg, et al. (1996) and the corresponding average CPH estimates in (Section VI, page 15-17) Appendix J were computed using raw data from the NJDEP Beach Seine Survey, different methods were applied. The blueback herring estimates presented in Appendix J used data from August through October, and from the Upper and Mid-River Regions (referred to as regions 6 and 5 in Appendix J), whereas the blueback herring estimates presented in Weisberg, et al. were based on data from the same period but from three rather than two regions (the Upper, Mid-River and Lower Regions, referred to as regions 6, 5 and 4 in Appendix J). Therefore, some differences in the results would not be unexpected. (Application, Appendix J, Section VI, pages 15-17.)

e. ESSA Report § 5.4.1.5: Statistical Methods

(1) Linear Regression

In this section, ESSA simply summarizes PSEG's method for estimating the slope of a trend in average CPH and for testing the statistical significance of the slope, and does not raise any concerns.

(2) Analysis of Differences

In this section, ESSA simply summarizes PSEG's method for estimating the difference between mean CPHs (earlier versus later years) and for testing the statistical significance of the difference, and does not raise any concerns.

(3) Assumptions of Linear Regression

ESSA identifies certain assumptions of linear regression in this section that are not directly relevant to the Trends Analyses conducted for the Application. ESSA's list of assumptions is for linear regressions in which the sum of squared residuals (i.e., differences between the predicted linear trend line and the observed data) is assumed to provide an estimate of the error variance. (ESSA Report, pages 118-119.) In that case, the assumptions of linearity, constant variance, and independence of data are important. However, the method used in the Application relies on independent estimates of variance from the sampling programs, not on residuals between the fitted model and the observed data (See e.g., Draper and Smith (1966), regarding pure error and model lack of fit). Therefore, these assumptions are not directly relevant to PSEG's Trends Analyses.

In its discussion of these assumptions, ESSA highlights the problems that would be caused if the assumptions were relevant to the Trends Analyses and if the assumptions were not satisfied. Unfortunately, ESSA does not clearly state that these assumptions are not relevant to the methods used in the Trends Analyses. For example, regarding the assumption of linearity, ESSA states:

> This assumption is almost certainly false. Use of a linear model when it is not correct inflates the error variance, but under certain circumstances, corrections can be made for model lack of fit (i.e., to estimate "pure error"). The statistical methods applied in Appendix J take advantage of the estimated within year variance to adjust residual error for model lack of fit. As is stated in Appendix J, this reduces the error variance used in statistical hypothesis tests increasing the power of the test for trend. (ESSA Report, page 118.)

ESSA's discussion omits the fact that the methods used in the Trends Analyses rely entirely on estimates of pure error, so that model lack of fit, and thus the linear model assumption, are totally irrelevant issues. The fact that the Trends Analyses rely entirely on estimates of pure error is documented on page 13 of Appendix J (Application, Appendix J, Section III.B.), and was discussed with ESSA during a meeting with PSEG experts in Seattle on December 6-7, 1999 as well as documented in the additional summary of statistical methods provided to ESSA by PSEG in December 1999.

Regarding the assumption of constant variance, ESSA states that "this assumption appears to be adequately addressed" (ESSA Report, page 119).

Regarding the assumption of independence of data, ESSA states that:

> Data collected in a time sequence will tend to have errors associated with one observation in time correlated with the errors of adjacent observations (Rawlings et al. 1998). . . . For example, positively correlated residual error increases Type I error rate (i.e.,

> increases the chance of getting a false significant result) above that selected for the statistical hypothesis test (e.g., Pyper and Peterman 1998). (ESSA Report, pages 118-119.)

ESSA's statement identifies a potential concern relating to the use of residuals to estimate the error variances. As described above, however, the methods used in the Trends Analyses relied on estimates of pure error, not residuals, to estimate error variances, and ESSA was, or should have been, fully aware of this fact. Therefore, ESSA's discussion here regarding the issue of correlated errors is entirely irrelevant to PSEG's Trends Analyses.

(4) Normally Distributed Error

ESSA correctly notes that the raw CPH data are not normally distributed. However, ESSA is incorrect in assuming (based on the symmetry of the approximate confidence limits for estimates of average CPH) that the Trends Analyses assumed the "error is normally distributed within years" (ESSA Report, page 119). For graphical presentations of the data, PSEG computed approximate confidence limits to depict the magnitude of sampling error associated with each annual estimate of average CPH. As documented in Appendix J at page 12, approximate 95% confidence limits of the abundance index values were estimated as the mean ± 1.96 x standard error and shown as vertical lines (see Application, Appendix J, Section III.A, page 12).

ESSA recommends using geometric means for the Trends Analyses to reduce the influence of unusually large catches on the estimated mean. (ESSA Report, page 119.) ESSA does not, however, note that estimates of geometric mean CPH reflect both the abundance of fish and the variability in catch between hauls (i.e., the spatio-temporal patchiness of fish in the Estuary). The effect of between-haul variability on estimates of geometric means can be so great that true trends in abundance can be masked beyond recognition. Although the statistical power of tests for trends based on arithmetic means (as were used in the Application) can be diminished due to high between-haul variability, the estimated trends based on arithmetic means are not subject to bias due to changes in between-haul variability, as is the case for geometric means (e.g., see Kendall and Stuart 1977). For these reasons, PSEG questions the value of conducting the trends analyses using geometric means.

(5) Influential Data Points

ESSA correctly observes that "useful diagnostic plots in Appendix J allow visual inspection and subjective consideration of potential influential data points." (ESSA Report, page 119.) ESSA then recommends further analyses be conducted: "There are standard statistics used for quantifying the influence of data on regression results and these should be reported in Appendix J for each test." (ESSA Report, page 119.)

PSEG believes the diagnostic plots in Appendix J are more than adequate for identifying influential data points. ESSA's general reference 'standard statistics' does not provide convincing evidence that a better method is available. For ESSA's recommendation to be meaningful, it should include reference to a specific method, identify exactly which question can be addressed using the method, list the required input data, and identify the conditions under which the method is valid. As stated, ESSA's recommendation is unjustified, unsupported and unanswerable.

(6) Comments on Using Normal Probability Distribution to Estimate p-Value

ESSA correctly notes that the statistical tests applied in Appendix J assume that the sampling distributions of the slope of the trends lines and the sampling distributions of the estimates of differences (in mean CPH between earlier and later years) were normally distributed. ESSA also correctly notes that "as degrees of freedom decrease (<30), the sampling distribution becomes better represented by the t distribution" (ESSA Report, page 120). Based on these observations, ESSA recommends that "[t]he estimated degrees of freedom for each test should be included in Appendix J to justify the use of the normal probability for tests of [statistical] significance" (ESSA Report, page 120).

PSEG agrees with this recommendation, and acknowledges an oversight in not including estimates of degrees of freedom in Appendix J. (Application, Appendix J, Section II, page 5.) However, the sample sizes (i.e., the total number of hauls) on which the estimates of slopes and differences were based ranged from 203 (for indices of abundance of Atlantic croaker, alewife and white perch from the PSEG Nearfield Trawl Survey) to 3109 (for indices of abundance of spot from the DNREC Juvenile Trawl Survey) (*see* Table V.D-1). Therefore, even allowing for reductions in degrees of freedom due to multiple strata (e.g., regions, months and years), the degrees of freedom for all tests greatly exceeds 30, which justifies the normal probability assumption.

(7) Statistical Power and Ecological Effect Size

ESSA states that "[t]he analyses in Appendix J assume implicitly that only statistically significant negative trends are important" (ESSA Report, page 121). This statement by ESSA is not accurate. The purpose of the statistical tests performed as part of the Trends Analyses was to identify apparent trends (increasing or decreasing) in the indices of abundance that could be explained simply by the magnitude of sampling error in the annual estimates of average CPH (i.e., the indices of abundance). Even if there is no underlying trend in abundance of a fish stock, the sampling error in average CPH estimates generally will produce non-zero estimates of slopes (or differences) in the average CPH estimates. The purpose of the statistical tests, as applied in the Trends Analyses, was to identify which trends in average CPH estimates could have been due to sampling error alone, even if there was no underlying trend in abundance. Because those trends were viewed as unreliable, they were labeled as not being statistically significant and were ignored when the results from the Trends Analyses were interpreted.

ESSA also errs by suggesting that the Trends Analyses generated negative trends that were not statistically significant, and that these trends should have been discussed in terms of their ecological significance:

> A statistically significant trend is not necessarily the same as an ecologically significant trend. Statistical significance is an arbitrary concept; ecological significance is rooted in the fundamentals of population dynamics. A negative trend in abundance may be ecologically important long before it is statistically significant. (ESSA Report, page 121.)

In fact, as documented in J Table 12 and J Table 13 of Appendix J (Results of Trends Analyses for RIS), the only results that were not statistically significant were *positive* trends. Thus, ESSA's comments here discuss at some length a hypothetical condition and the scientific flaws associated with the hypothetical condition, is irrelevant to the actual data and analyses in the Application. ESSA's comments do not pertain, therefore, to any analysis presentation in the Application.

ESSA goes on to state that Appendix J does not apply the results of the trends analyses to assess ecological relevance.

> It is ... important that statistical results be evaluated in the context of ecological relevance. Appendix J does not provide any insight into what magnitude of trend is important to detect. (ESSA Report, page 120.)

As discussed above, the Trends Analyses were never intended to separate the effects of Station operation from the effects of other anthropogenic activities (like fishing) on fish populations. (Application Appendix J, Section II.B, page 6.) Appendix J, as clearly stated in the Application, documents that the Trends Analyses are used simply to characterize empirical trends in abundance of age-0 RIS fish for the period of record. Interpretations of the results from the Trends Analyses for these purposes are discussed in the Application. (Application Appendix F and Appendix H.)

To address this stated omission in Appendix J, ESSA recommends additional analysis:

> An additional analysis that could be used to estimate an effect size of importance to detect would be for PSE&G to project what trends in Age-0 abundance would be expected from harvest rate (F) changes alone. Then PSEG could compare observed trends against those expected trends (e.g., fishing harvest rate reductions alone would be expected to result in a 30% increase, but only a 10% increase was observed). Of course this method does not include any expected increase in abundance due to water quality changes which is very difficult to quantify. (ESSA Report, page 121.)

This recommendation does not properly consider the feasibility of conducting the analysis or the validity of its results. The analysis would require a stock-recruitment model for each of the RIS. At the time the Application was submitted to the NJDEP in March 1999, the composed of independent scientists and representatives from various regulatory agencies, including the New Jersey Department of Environmental Protection (NJDEP), the Delaware Department of Natural Resources and Environmental Control (DNREC), and the U.S. Fish and Wildlife Service.

The proposed plan includes numerous improvements to the existing Biological Monitoring Work Plan (BMWP) that was established as a condition of the 1994 NJPDES Permit. Improvements include increased plant effects and baywide monitoring efforts to allow the NJDEP and PSEG to assess the Station's effects on biota as well as the biological efficacy of conservation measures. A comparison of sampling effort between the 1995-1999 BMWP with the proposed 5-year BMP illustrates the proposed increase in data collection:

Sampling Program	**1995–1999 BMWP**	**Proposed 5-year BMP**
Entrainment Sampling	1356	**6672**
Impingement Sampling	4680	**7800**
Ichthyoplankton Net Sampling	0	**1680**
Bottom Trawl Sampling	1400	**1740**
Pelagic Trawl Sampling	0	**1680**
Beach Seine Sampling	1200	**1200**

Consistent with ESSA's recommendations, the proposed changes to the BMWP were developed to expand spatial and temporal coverage of the sampling program and to increase sampling frequency, while maintaining continuity with the methods used in previous years.

Response to ESSA – Appendices

PSEG's Response to the ESSA Report

Summaries of Experts' Qualifications

APPENDIX A

March 14, 2001

VAUGHN C. ANTHONY, Ph.D.

Summary of Qualifications

Dr. Vaughn Anthony is the former Chief Scientific Advisor for the National Marine Fisheries Services, Northeast Region and has spent more than 40 years assessing the health of fish stocks. Dr. Anthony has a strong stock assessment background of North Atlantic species and has had practical participation in the international fisheries arena for 30 years. He was the leader of U.S. science efforts in population dynamics for demersal, pelagic and anadromous species in the northwest Atlantic for 15 years. In his role as Chief Scientific Advisor he devised and implemented multidisciplinary-research for assessing the status of fish and shellfish stocks; provided oversight on product quality of research documents; and advised the Science Director and Regional Director of the Northeast Region on all assessment activities. He also served as the sole spokesman to media, management councils, Congress and others on stock assessment and management interactions. In his role of Chief of the Conservation and Utilization Division at the National Marine Fisheries Service in Woods Hole, Massachusetts, Dr. Anthony served as supervisor and budget director for as many as 250 people and 14 million dollars annually. Dr. Anthony has authored over 100 publications and received numerous honors and awards.

Dr. Anthony received his B.S. in Wildlife Conservation from the University of Maine, Orono, Maine, in 1959 and his M.S. in Fisheries from the University of Michigan, in Ann Arbor, Michigan, in 1960. His thesis title was *Stream populations of Atlantic salmon, Salmo salar, and other fishes in Maine*. Dr. Anthony received his Ph.D. in Fisheries from the University of Washington, in Seattle, Washington, in 1972, with his Dissertation entitled *Population dynamics of Atlantic herring in the Gulf of Maine*.

DAVID G. AUBREY, Ph.D.

Summary of Qualifications

Dr. David Aubrey has 22 years of academic research and nearly 15 years of consulting experience in coastal processes and sediment transport, and has conducted research on coastal processes, sediment transport, tidal inlets, sea-level and climate change, beach nourishment, water quality, management of marginal seas, and ecosystem health. Dr. Aubrey specializes in collection, analysis and interpretation, and integration of field data into project design, including the design of field studies/programs to measure waves, currents, water levels, water quality, and suspended sediment transport in various environments. In his consulting sphere, he has been actively consulting for intergovernmental, governmental and private clients, focusing on innovative, scientifically defensible solutions to international marine environmental problems, with sensitivity to economic and environmental concerns. As Chief Expert to the United Nations Development Programme for the Caspian and Yellow Sea Regions, Dr. Aubrey also has specialized in Global Environmental Facility projects.

Dr. Aubrey's activities include implementing shoreline erosion management plans and funding strategies; finding innovative solutions to problems involving coastal erosion, sediment transport, tidal inlets, sea-level change, beach nourishment, channel stabilization, the effects of tidal inlet and shore protection structures, longshore sediment transport and shoreline response; collection of oceanographic and geotechnical data; permit support for a variety of water-related issues (at intergovernmental, national, state, and local levels). He has published well over 100 papers in major peer-reviewed publications, and has several technical books in print.

Dr. Aubrey received a B.S. in Civil Engineering and a B.S. in Geological Sciences from the University of Southern California in 1973. In 1978, David Aubrey received his Ph.D. in Oceanography from Scripps Institution of Oceanography at the University of California at San Diego. From 1978 to the present he has been associated with the Woods Hole Oceanographic Institution, first on their Scientific Staff (where he attained the position of Senior Scientist) and now as an Adjunct Scientist. He has directed the companies associated with the Woods Hole Group since 1986.

LAWRENCE W. BARNTHOUSE, Ph.D.

Summary of Qualifications

Dr. Barnthouse is the President and Principal Scientist of LWB Environmental Services, Inc. He was formerly a Senior Research Staff Member in Oak Ridge National Laboratory's Environmental Sciences Division. During 19 years at Oak Ridge National Laboratory he was involved in dozens of environmental research and assessment projects involving development of new methods for predicting and measuring environmental risks of energy technologies. From 1977 through 1980, he was a member of an expert team assembled by the U. S. Environmental Protection Agency to evaluate impacts of entrainment and impingement at the Indian Point, Bowline Point, and Roseton stations on fish populations in the Hudson River. Later, he served as a expert advisor to EPA during the development of EPA's Guidelines for Ecological Risk Assessment, and organized an assessment team that was responsible for all ecological risk assessments performed on the U.S. Department of Energy's Oak Ridge, Tennessee, Portsmouth, Ohio, and Paducah, Kentucky sites.

After leaving Oak Ridge National Laboratory in 1995, he spent two and a half years with McLaren-Hart, Inc. During this time He served as a senior technical advisor on major ecological risk assessment projects and provides expert advice to McLaren-Hart clients involved in RCRA/CERCLA actions, NPDES permit proceedings, and Natural Resource Damage Assessments. Since establishing LWB Environmental Sciences in 1998, he has been part of PSEG's assessment teams for the Salem and Mercer stations. On behalf of other clients, he has been involved in pesticide registration support, Superfund assessments, environmental restoration planning, and other activities involving close interactions with regulatory and resource management agencies.

Dr. Barnthouse received an A.B. in Biology from Kenyon College in 1968, and a Ph. D. in Biology from the University of Chicago in 1976. He has authored or co-authored more than 80 publications relating to ecological risk assessment. He is a Fellow of the American Association for the Advancement of Science and Hazard/Risk Assessment Editor of the journal *Environmental Toxicology and Chemistry.*

DAVID HARRISON, JR., Ph.D.

Summary of Qualifications

David Harrison is a Senior Vice President at National Economic Research Associates (NERA) in its Cambridge office and director of NERA's environmental practice. Before joining NERA, Dr. Harrison was an Associate Professor at the John F. Kennedy School of Government at Harvard University, where he taught courses in environmental and natural resource economics and policy, energy policy, benefit-cost analysis, and other topics. He was a member of the Faculty Steering Committee of the Harvard Energy and Environmental Policy Center and on the Advisory Board of the Interdisciplinary Program in Health at the Harvard School of Public Health. Dr. Harrison earlier served as a Senior Staff Economist on the President's Council of Economic Advisors, where his areas of responsibility included environmental regulation, natural resource policy, and energy policy. He was the senior staff member of the Regulatory Analysis Review Group and White House representative to the Regulatory Council, which developed cost-benefit guidelines for federal agencies. Dr. Harrison has extensive experience in the application of cost-benefit analysis to environmental policies, including those related to fish protection alternatives. He is the author or co-author of four books or monographs and numerous articles on environmental economics and policy.

Dr. Harrison holds a Ph.D. in Economics from Harvard University, a M.Sc. in Economics from the London School of Economics, and a B.A. in Economics from Harvard University.

DOUGLAS G. HEIMBUCH, Ph.D.

Summary of Qualifications

Dr. Heimbuch is Associate Vice President of PBS&J, a consulting company specializing in environmental engineering and science. Dr. Heimbuch's fields of technical competence and experience include fishery science, biostatistics, population dynamics, statistical analysis of environmental data, development of environmental sampling designs, estimation of parameters of animal populations, and assessment of effects of power plant operations on fish populations. Dr. Heimbuch has authored papers on biostatistics, fisheries and estuarine science. Dr. Heimbuch has conducted numerous studies on fish populations of the Hudson River estuary, including: estimation of the effects of entrainment and impingement on fish populations inhabiting the Hudson River, assessments of the health of Hudson River fish populations, assessment of the effectiveness of potential mitigative measures for reducing entrainment and impingement mortality rates, design of a mark-recapture program for Hudson River striped bass population, and estimation of survival and abundance of Hudson River striped bass using mark-recapture data. Dr. Heimbuch participated in the design, development and implementation of the Maryland Biological Stream Survey (a state-wide survey of the status of fish populations inhabiting streams in Maryland), since its inception. His involvement including development of sampling design and statistical data analysis methods, and estimation of the state-wide abundance of fish populations inhabiting streams in Maryland. For the USEPA EMAP Estuaries Program, Dr. Heimbuch participated in the evaluation and development of sampling designs for monitoring estuarine resources of the East and Gulf Coasts of the United States, developed statistical methods for analyzing data collected by the EMAP Estuaries program, and conducted analyses of data from the EMAP Estuaries Program. For the Tampa Bay National Estuary Program, Dr. Heimbuch developed sampling designs for a long-term environmental monitoring program for Tampa Bay, developed data analysis protocols for data collected as part of the Tampa Bay long-term monitoring program, directed a synthesis of historical biological data from Tampa Bay and the development of a data management strategy for TBNEP, evaluated physical impacts to habitats and mapped living resources within Tampa Bay. Dr. Heimbuch has also conducted estuarine research for the Hudson River Foundation for Science and Environmental Research (development of an Atlas of Hudson River Fish Distributions), the Southwest Florida Water Management District (development of a long-term environmental monitoring program), and the New York District Corp of Engineers (fisheries assessments regarding the potential impacts of the Westway Highway Project).

Dr. Heimbuch received his B.S. from the University of California at Berkeley in 1973, his M.S. from Cornell University in 1978, and his Ph.D. from Cornell University in 1982. He was co-founder and Vice President of Coastal Environmental Services, Inc., an environmental consulting firm specializing in estuarine sciences, prior to joining PBS&J in 1996.

RAY HILBORN, Ph.D.

Summary of Qualifications

Dr. Ray Hilborn is professor of Aquatic and Fisheries Sciences at the University of Washington. He has published well over 100 peer-reviewed papers in major journals, and he has authored three books, the Ecological Detective, with Marc Mangel in 1997, Quantitative Fisheries and Stock Assessment with Carl Walters in 1992, and Adaptive Environmental Assessment and Management with 8 co-authors in 1978. He is an associated editor of Reviews in Fish Biology and Fisheries and Fish and Fisheries. He is a member of the Ocean Studies Board of the National Research Council and has served on two NRC panels on fisheries stock assessment. He was a member of the panel that prepared the guidelines for the precautionary approach to fisheries management for the FAO. He has served as an advisor to several international fisheries commissions and at present is a member of a panel of independent experts advising the Commission for the Conservation of Southern Bluefin Tuna.

Dr. Hilborn received his B.A. from Grinnell College and his Ph.D. from the University of British Columbia. Prior to joining the University of Washington he was on the faculty of the University of British Columbia and worked as Senior Fisheries Scientist for the South Pacific Commission.

RANSOM A. MYERS, Ph.D.

Summary of Qualifications

Dr. Ransom A. Myers holds the Killam Chair of Ocean Studies at Dalhousie University in Halifax, Nova Scotia. Dr. Myers current, major research is on the meta-analysis of data from many populations. By treating each population as a realization of a natural experiment, it is possible to discover patterns in nature that have not been seen before because they are lost in the noise in the dynamics of individual populations. This work is exciting because it is possible to arrive at solutions to pure and applied problems in population biology and resource management. In order to carry out the meta-analysis, Dr. Myers has compiled much of the population dynamics data on fish in the world. This is data on over 750 time series, and provides the empirical basis for his theoretical analysis.

He has carried out fundamental work on the causes for the collapse of fish stocks, in particular cod stocks in Eastern Canada. Dr. Myers is also actively involved in developing methods for the optimal management of exploited populations. Recently, this work has turned to models of extinction, which is a growing concern in the marine environment. He is currently working on models for the extinction of salmonid species, elasmobranchs, and marine turtles.

Dr. Myers has served on the Board of Directors of The International Oceans Institute of Canada, Ocean Institute of Canada, and the Resource Modeling Association. Dr. Myers research has been supported by a wide variety of government, industry, conservation, and private foundations. These include Killam Foundation, National Science and Engineering Research Council, Canadian Foundation for Innovation, Great Lakes Indian Fish and Wildlife Commission, Canadian Dept. of Fisheries and Oceans, Environment Canada, Nova Scotia Power, Inc, Conservation Council of New Brunswick, World Wildlife Fund, and Canada Trust-Friends of the Environment Foundation.

Dr. Myers received his B.Sc. in Physics from Rice University, and his M.Sc. in Mathematics and Ph.D. in Biology from Dalhousie University. Dr. Myers has published over 100 refereed scientific publications in diverse fields of aquatic ecology.

ARTHUR N. POPPER, Ph.D.

Summary of Qualifications

Dr. Arthur N. Popper is professor of Biology (and former chair) at the University of Maryland, College Park. He also is director of the Neuroscience and Cognitive Science doctoral program at UM. He has published well over 100 peer-reviewed papers in major journals, and he has edited over 15 books. He is editor of the Springer Handbook of Auditory Research, the major set of books on auditory neuroscience. He is American editor of the journal Bioacoustics and he serves in a variety of capacities with international scientific societies. He is a fellow of the Acoustical Society of America and of the American Association for the Advancement of Science. Professor Popper's research is on the mechanisms of hearing by fishes, but he is also interested in basic mechanisms of hearing by vertebrates and his current interests include trying to understand the evolution of hearing. He has recently extended his interest in basic issues of hearing to applied aspects of acoustics and hearing by fishes. He has served on several National Research Council committees (and chaired one) that dealt with the impact of human generated (anthropogenic) sounds on marine animals, and he has considerable interest in the effects of sound on hearing and acoustic behavior of fishes.

Dr. Popper received his B.S. from New York University (University Heights) and his doctorate in Biology from City University of New York. He was on the faculty of the University of Hawaii and Georgetown University School of Medicine before joining the University of Maryland as professor and chair of Zoology (now biology).

EDWARD P. TAFT, M.S.

Summary of Qualifications

E.P. Taft is President of Alden Research Laboratory, Inc., an international consulting engineering and environmental. Mr. Taft is also responsible for Alden's environmental services, primarily fisheries issues at water intakes. Prior to his joining Alden, Mr. Taft was a Program Manager with Stone and Webster Engineering Corporation. Mr. Taft provides overall technical and managerial guidance to a team of fisheries biologists and engineers, and personally participates on projects. Having been involved with fish protection and passage for 28 years, Mr. Taft is a recognized expert on the development of innovative fish protection systems, the evaluation and recommendation of alternative fish passage and protection systems for application at water intakes, the design and optimization of fish ladders and lifts, and licensing studies. Numerous laboratory and field research projects led by Mr. Taft have resulted in the development and implementation of various systems that reduce fish losses at electric generating facilities. He has been instrumental in developing advanced screening systems and behavioral barriers, and he received a patent for a novel fish screening system known as the Modular Inclined Screen (U.S. Patent No. 5385428). With more than 200 projects dealing with fish passage and protection to his credit, he has developed a positive relationship with regulatory agency personnel, ensuring that systems will receive the required approval. Mr. Taft is often invited to participate in various national and international conferences and workshops, for which he has prepared and presented over 50 technical papers. He also has coauthored two American Society of Civil Engineers' books on the design of water intakes, with emphasis on the passage and protection of fishery resources. (*Design of Intakes for Hydroelectric Plants*, 1995; *Design of Water Intake Structures for Fish Protection*, 1982)

Mr. Taft has participated in a variety of national activities, including: President - American Fisheries Society Bioengineering Section (August 2000 to date); Chairman - American Fisheries Society Committee to Develop Guidelines for Evaluating Fish Protection Technologies (1997 to 2000); Member - U.S. Congress Task Committee on Fish Passage Issues at Hydroelectric Projects; Member - ASCE Hydropower Task Committee on Intakes for Hydroelectric Plants (1992 - 1995); Member - ASCE Committee on Hydraulic Structures, Task Committee on Fish Handling Capability of Intake Structures (1975-1982); and Coordinator - American Fisheries Society AFS Monograph on the Hudson River Case, Mitigation Section of a comprehensive review of the case (1983-1987).

Mr. Taft received his B.A. from Brown University, in 1972 and his M.S. from Northeastern University, in 1983. Both degrees are in Biology.

PSEG's Response to the ESSA Report

Experts' Curriculum Vitae

APPENDIX B

March 14, 2001

David G. Aubrey, Ph.D., B.S., B.S.

Chairman and CEO, Woods Hole Group, Inc.
Senior Scientist, Woods Hole Oceanographic Institution

Education	Ph.D.	Oceanography, Scripps Institution of Oceanography, University of California at San Diego, 1978.
	B.S.	Civil Engineering, University of Southern California, 1973.
	B.S.	Geological Sciences, University of Southern California, 1973.

Experience

Chairman, Woods Hole Group, Inc., East Falmouth, MA, 1986-Present.

Senior Scientist, Woods Hole Oceanographic Institution, Woods Hole, MA, 1991-present.

Director, Coastal Research Center, Woods Hole Oceanographic Institution, Woods Hole, MA, 1987-1992.

Visiting Professor, Department of Environmental Sciences, University of Virginia, Charlottesville, VA, Spring 1987.

Consultant, Department of Ocean Engineering, Massachusetts Institute of Technology, Boston, MA, 1983.

Associate Scientist, Woods Hole Oceanographic Institution, Woods Hole, MA, 1982-1990.

Assistant Scientist, Woods Hole Oceanographic Institution, Woods Hole, MA, 1978-1982.

Research Assistant, Scripps Institution of Oceanography, 1973-1978.

Exploration Geologist, Amoco Production Company, Denver, CO, 1973.

Soils and Foundation Engineer, Advanced Foundation Engineers, Long Beach, CA, 1971-1973.

Geologist, Bridge Department, California Division of Highways, Los Angeles, CA, 1970-1971.

Professional Societies

American Geophysical Union
Oceanography Society
Phi Bet Kappa
American Association for the Advancement of Science

Professional

Committee on Coastal Oceans (CoCO), Ocean Science Board, National

Committees Research Council, 1989-1995.

Chairman, Cooperative Marine Science Program for the Black Sea (CoMSBlack) 1991-1996.

Editorial Board, Estuaries, Estuarine Research Federation, 1987-1990.

Editor, Pacific Climate Monograph, PACLIM Working Group, 1987.

Committee on Coastal Engineering Management Systems. Commission on Engineering and Technical Systems, National Research Council, 1986-1989.

Ad Hoc Committee on the Relationship Between Land Ice and Sea Level, National Research Council, 1984-1985.

Editorial Board, Coastal, Estuarine and Shelf Processes.

Publications Refereed Jrnls

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- Doctor of Philosophy, 1984, Biology, Dalhousie University
- Master of Science, 1981, Mathematics, Dalhousie University
- Bachelor of Science, 1974, Physics, Rice University

Employment

- April 1, 1997: Killam Chair in Ocean Studies, Dalhousie University, Halifax, Nova Scotia, Canada
- 1983 - 1997: Research Scientist, Department of Fisheries and Oceans, St. Johns, NF, Canada
- 1977 - 1982: Graduate Student, Dalhousie University
- 1974 - 1976: Schlumberger Overseas, S.A.

Awards

- 2000: Advisory Board on Fisheries: Atlantic Policy Congress
- 1999: Board of Directors: Ocean Institute of Canada
- 1999: The Great Auk Lectureship
- 1998: Who's Who in Canada
- 1994-1999: Board of Directors, Natural Resource Modelling Association
- 1996: Awarded first Killam Chair in Ocean Studies, Dalhousie University
- 1996: Visiting Fellow, Centre for Population Biology, Silwood Park, Imperial College
- 1994: Wilfred Templeman Publication Award
- 1990: Adjuct Professor of Memorial University of Newfoundland

International Conferences Organized or Co-organized

- 1999: World Conference on Natural Resource Modelling, Halfiax, Nova Scotia.
- 1993: Meeting of the Natural Resource Modelling Association in St. John's, Newfoundland.
- 1992: The Methods Working Group of the International Council for the Exploration of the Sea.

Invited Presentations (from 1997)

Myers, R.A. Meta-Analysis and Biological Reference Points. Mote International Symposium. Oct. 2000. Sarasota, Florida.

Myers, R.A. A Meta-Analysis of Fish Productivity. West Coast Groundfish Productivity Workshop. Seattle, March 2000.

Myers, R.A. Sustainable hunting principles: some lessons from the sea. Norwegian University of Science and Technology, Feb. 2000.

Myers, R.A. Ecological perspective on the history of fishing on the Grand Banks. Feb. 2000.

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ALDEN

EDWARD P. TAFT (1 of 9)

President
Alden Research Laboratory, Inc.

EXPERIENCE SUMMARY

E.P. Taft is Chief Executive Officer of Alden, an international consulting engineering laboratory providing a wide variety of services for electric power utilities, architect-engineering firms, equipment manufacturers, and governmental agencies. Alden is an independent corporation employing about 45 people and conducting numerous physical and analytical hydraulic model studies, environmental research and analysis, and flow meter calibrations. Mr. Taft is also responsible for Alden's environmental services, primarily fisheries issues at water intakes. He is a recognized expert in this area and has overall responsibility for all Alden services in fish protection and passage. Mr. Taft provides overall technical and managerial guidance to a team of fisheries biologists and engineers, and personally participates on projects.

Prior to his joining Alden, Mr. Taft was a Program Manager with Stone and Webster Engineering Corporation, where he designed and evaluated state-of-the-art fish protection and passage systems, performed numerous laboratory and field research and development studies, and assessed fish protection technologies throughout North America for EPRI.

EXPERTISE

- Evaluation of alternative fish protection systems
- 316(b) alternative intake technology studies
- Development of advanced mechanical screening devices
- Design and installation of behavioral fish guidance systems
- Development of sonic fish deterrence system (sound and infrasound)
- Evaluation and design of fish ladders and lifts
- FERC relicensing studies
- Biological field studies and evaluations
- Analyses for design and economic feasibility
- Coordination of client, contractor, and agency negotiations

SELECTED PROJECTS

Alternative Fish Protection System Evaluations - numerous evaluations of alternative systems for preventing fish passage and mortality at steam electric stations (to satisfy 316b requirements) and hydroelectric projects (to meet FERC licensing requirements) throughout North America; systems evaluated included fish screens, diversion devices and behavioral barriers; many evaluations included an assessment of the feasibility of conducting fish passage and mortality studies; at hydroelectric project, upstream fish passage facilities were also identified for many sites.

EPRI Research and Development Studies - extensive nationwide studies to evaluate and assess fish protection technologies; studies throughout the U.S. to evaluate Eicher screen (Elwha), sound, strobe lights, mercury lights (York Haven, Holtwood, Ludington, Holyoke/Hadley, Turners Falls, Wanapum, Wapatox), and Modular Inclined Screen (Alden Research Laboratory; Green Island) to enhance safe passage around turbines; conducted comparative assessment of hydroacoustics and netting for evaluating turbine passage rates (Pine, Buzzards Roost).

Field and Laboratory Studies - various steam electric and hydroelectric power plant intakes to alleviate problems of fish losses, leading to development of several fish protection systems (such as Ristroph screens, fine-mesh screens, louvers, angled screens, sound, lights, air bubble curtains, fish pumps and fish handling facilities); co-inventor of Modular Inclined Fish Diversion Screen, which has proven nearly 100 percent effective in safely diverting a wide variety of fish species at high flow velocities.

Public Service Electric and Gas Company - participated in the development and evaluation of sonic (>50 Hz) and infrasound (<50 Hz) fish protection systems for use at the Salem Generating Station on Delaware Bay. Laboratory and field studies were conducted to determine the behavioral response of nine fish species occurring at the site. Installation and testing of the prototype system is being performed under Mr. Taft's direction in 1998.

Infrasound Generator Development - participated in the development and evaluation of two infrasound (<50 Hz) generators (patent pending). Conducted laboratory evaluations of the response of Atlantic salmon to the sources with excellent results.

Impact Assessment and Conceptual Engineering Design Studies - pumped storage projects controlled by Savannah, Kansas City, and Omaha Districts of U.S. Army Corps of Engineers to develop engineering, biological, and cost data on numerous alternative fish protection facilities to minimize fish mortality during plant operation; prepared study plans for hydroacoustic and netting evaluations of fish entrainment and mortality for the H.S. Truman and R.B. Russell projects.

Fisheries Research Facility Design - design of fish protection test facility, required by FERC licensing, to evaluate alternative protection systems for 15 proposed hydro developments in Upper Ohio River Basin.

Fish Ladder and Lift Design - four Susquehanna River fish lifts; four Charles River ladders, Metropolitan District Commission; Saco River lift and ladders, Central Maine Power; Daniels Dam ladder, Patapsco River, State of Maryland; feasibility and cost evaluations throughout the U.S.

EDUCATION

B.A., Brown University, 1972, Biology
M.S., Northeastern University, 1983, Biology

Additional Training

U.S. Fish & Wildlife Service, Fisheries Academy, "Fish Passageways and Diversion Facilities," 1986

Hydroacoustic Technology, Inc., "Using Hydroacoustics to Monitor Fish Entrainment at Hydropower Dams," 1990

PROFESSIONAL ACTIVITIES

Membership

American Fisheries Society

Selected National Activities

President - American Fisheries Society Bioengineering Section (August 2000 to date)

Chairman - American Fisheries Society Committee to Develop Guidelines for Evaluating Fish Protection Technologies (1997 to 2000)

Member - U.S. Congress Task Committee on Fish Passage Issues at Hydroelectric Projects

Member - ASCE Hydropower Task Committee on Intakes for Hydroelectric Plants (1992 - 1995)

Co-author - ASCE book: Design of Intakes for Hydroelectric Plants (1995)

Member - ASCE Committee on Hydraulic Structures, Task Committee on Fish Handling Capability of Intake Structures (1975-1982)

Co-author - ASCE book: Design of Water Intake Structures for Fish Protection (1982)

Coordinator - American Fisheries Society AFS Monograph on the Hudson River Case, Mitigation Section of a comprehensive review of the case (1983-1987)

Public Hearing for EPA, Region II, NPDES Permit Hearings on the design of intake structures for minimizing losses of aquatic organisms at three Hudson River power plants, February 1978

ADDITIONAL ACCOMPLISHMENTS

Having been involved with fish protection and passage for 28 years, Mr. Taft is a recognized expert on the development of innovative fish protection systems, the evaluation and recommendation of alternative fish passage and protection systems for application at water intakes, the design and optimization of fish ladders and lifts, and licensing studies. With more than 200 projects dealing with fish passage and protection to his credit, he has developed a positive relationship with regulatory agency personnel, ensuring that systems will receive the required approval. Mr. Taft is often invited to participate in various national and international conferences and workshops, for which he has prepared and presented over 50 technical papers. He also has coauthored two American Society of Civil Engineers' books on the design of water intakes, with emphasis on the passage and protection of fishery resources.

Numerous laboratory and field research projects led by Mr. Taft have resulted in the development and implementation of various systems which reduce fish losses at electric generating facilities. He has been instrumental in developing advanced screening systems and behavioral barriers, and he recently received a patent for a novel fish screening system known as the Modular Inclined Screen (U.S. Patent No. 5385428) which will be tested in the field under Mr. Taft's guidance in the fall of 1995. He has been responsible for conducting studies throughout the United States for the Electric Power Research Institute, which have led to the development of other types of fish screens, as well as sonic and light behavioral barrier protection devices. Results of these studies have been used by the resource agencies to develop acceptance criteria for the design and operation of various fish protection systems.

Mr. Taft has been responsible for the design of many fish ladders and fish lifts to move migratory species upstream, primarily around hydroelectric projects. Work is closely coordinated with the fishery resource agencies through the design effort to ensure that the proper type of fishway is selected, that it is placed in an optimum location for fish attraction, and that the design and operational details (dimensions, water velocities, flow patterns, cycling times, etc.) are adequate for passing the expected population size that will utilize the facility.

Mr. Taft's depth and breadth of experience have resulted in numerous requests to participate in private and public processes intended to resolve major fisheries issues related to hydropower production in the United States. He frequently provides consultation services to the resource agencies responsible for managing the nation's fisheries to help formulate biologically sound and cost-effective approaches to resolving conflicts between these agencies and project developers. Recently, he was named to a task committee of the United States Congress to help address major issues confronting the hydroelectric industry and to develop a nationwide approach to conflict resolution.

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PSEG's Response to the ESSA Report

APPENDIX C

March 14, 2001

APPENDIX C: The Ricker Model and Beverton-Holt Models Generally Fit the Data Equally Well, but the Ricker Model Gives Much More Conservative Estimates: Why the Estimates Used for the Salem Submission are not Positively Biased

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1 Introduction

This report summarizes results and methods of estimating the variability in the reproductive parameters, in particular the maximum reproductive rate (sometimes called the compensatory reserve or steepness), a meta-analytic perspective. We show that the Beverton-Holt model and Ricker models generally fit the data equally well, but the Ricker estimate of the compensatory reserve is always more conservative.

1.1 The Beverton-Holt and the Ricker Models f i t the data equally well

This analysis will consider the four most commonly used spawner-recruitment models. Let R be recruitment, $E(R)$ be the expectation of R, and S be spawner

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abundance. We consider the models:

Cushing	$E(R) = \alpha S^{\beta}$
Ricker	$E(R) = \alpha S e^{-\beta S}$
Beverton-Holt	$E(R) = \dfrac{\alpha S}{1+(S/K)}$
Shepherd	$E(R) = \dfrac{\alpha S}{1+(S/K)^{\gamma}}$

For the Ricker and Beverton-Holt models, the parameter α has dimensions of recruitment per unit spawner abundance and gives the slope of the function at $S = 0$. This parameter is crucial to setting the limits of overfishing (Myers and Mertz 1998). Note that this parameter must be positive. The "Shepherd Function", first proposed by Maynard Smith and Slatkin (1973), is a generalization of the Beverton-Holt model and is discussed in Bellows (1981). The parameter γ may be called the "degree of compensation" of the model, since it controls the degree to which the (density-independent) numerator is compensated for by the (density-dependent) denominator (Shepherd 1982).

A critical factor for the practical selection of a recruitment model is its behaviour at low population sizes, in particular, the slope at the origin. We would like any model to behave in a reasonable manner at low population sizes. Using this criterion gives a very strong preference for the use of the Ricker or Beverton-Holt model. The Ricker model almost always gives a biologically plausible estimate of the slope at the origin. The Beverton-Holt often does, although unreasonable estimates are not uncommon (see next section). The Cushing model will almost always estimate an infinite slope at the origin, with the rare exception of a zero slope estimate. The Shepherd model has similar difficulties: if $\gamma = 1$, the Beverton-Holt model is recovered; if $\gamma < 1$, survival is estimated to be infinity as $S \rightarrow 0$; if $\gamma > 1$, the derivative of survival as $S \rightarrow 0$ will always be zero. Therefore, for $\gamma \leq 1$, the Shepherd model may be unreliable for the use of extrapolation of low population sizes.

These arguments give us *a priori* reasons to prefer the Ricker or Beverton-Holt model. We report the results in detail for only the Beverton-Holt and Ricker models. The alternative models generally did not fit the data better.

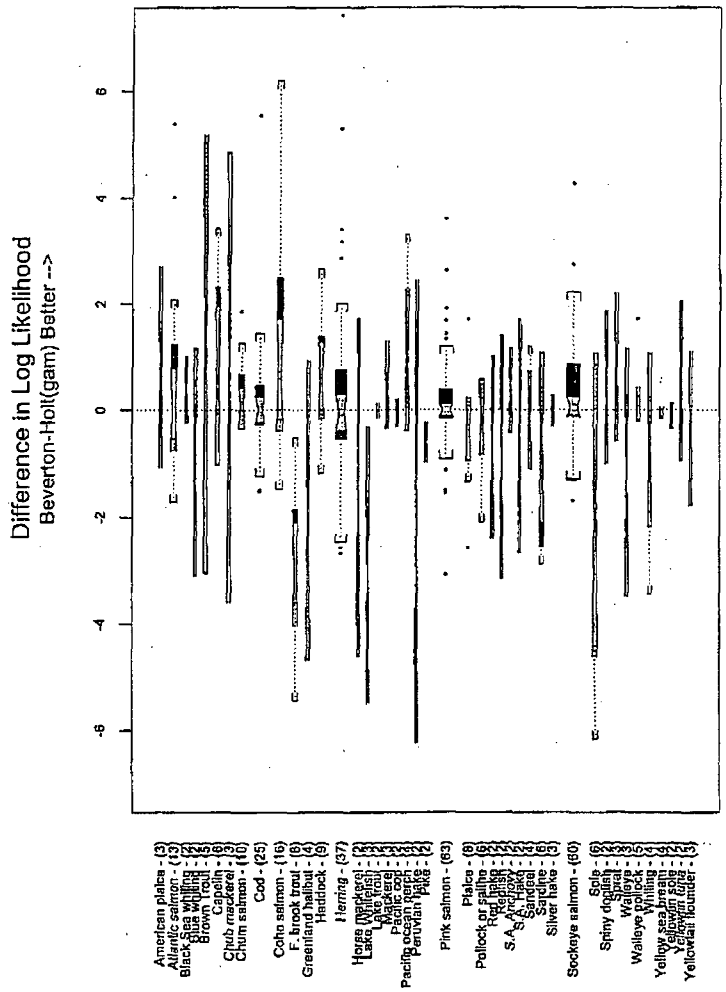

Figure 1: Boxplots of the difference in maximized log likelihoods of the Ricker and Beverton-Holt models for each species. Positive differences means that the alternative to the Ricker model is superior. The boxplots show the limits of the middle half of the data (the white line inside the box represents the median). The upper quartile and lower quartile provide the outline of the box. Whiskers are drawn to the nearest value not beyond 1.5*(inter-quartile range) from the quartiles; points beyond are drawn individually as outliers. The numbers in the pararentheses are the number of stocks used in the analysis.

It would be very useful if one model consistent fit and predicted recruitment better for a given taxonomic group (Fig. 1). Unfortunately, this is rarely the case; for most species neither the Ricker nor the Beverton-Holt models consistently fit the data better (Fig. 1). or are superior at predicting recruitment (Fig. 2). Similar results were obtained for the fit under the alternative assumptions of lognormal or gamma error.

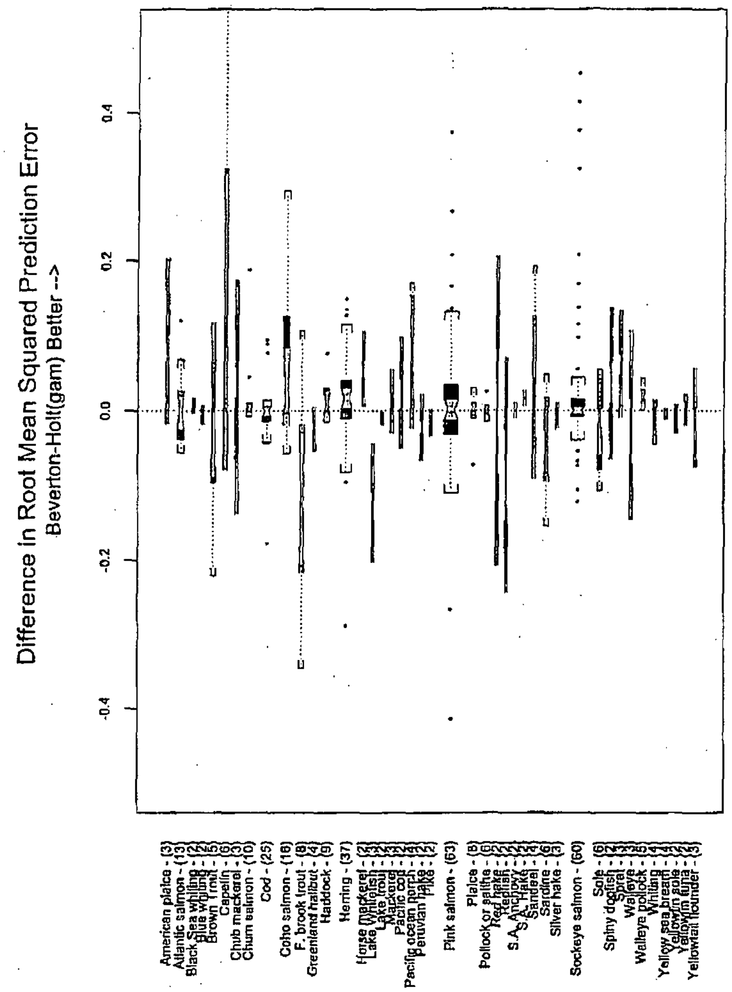

Figure 2: Boxplots of the difference in root mean squared prediction accuracy of the Ricker and Beverton-Holt models for each species. See the legend of Fig. 1 for an explanation of the boxplots.

1.2 Our Estimates of the Beverton-Holt Compensation Parameter are Conservative

Since we used the Beverton Holt model for the model dynamics, because it gave conservative model dynamics, it would be reasonable to use the fit of the Beverton Holt model to estimate the model parameters. However, we choose to use a much more conservative approach. That is we estimated the α (the slope at the origin) for the Beverton Holt model from the fit of the Ricker model. We did this, because it produces much more conservative estimates, i.e. it produced lower estimates of the compensation reserve. At the limit of low population size, the slope at the origin has the same meaning for both, but for the same data, the point estimates for the α for the Beverton-Holt model are always greater than the Ricker.

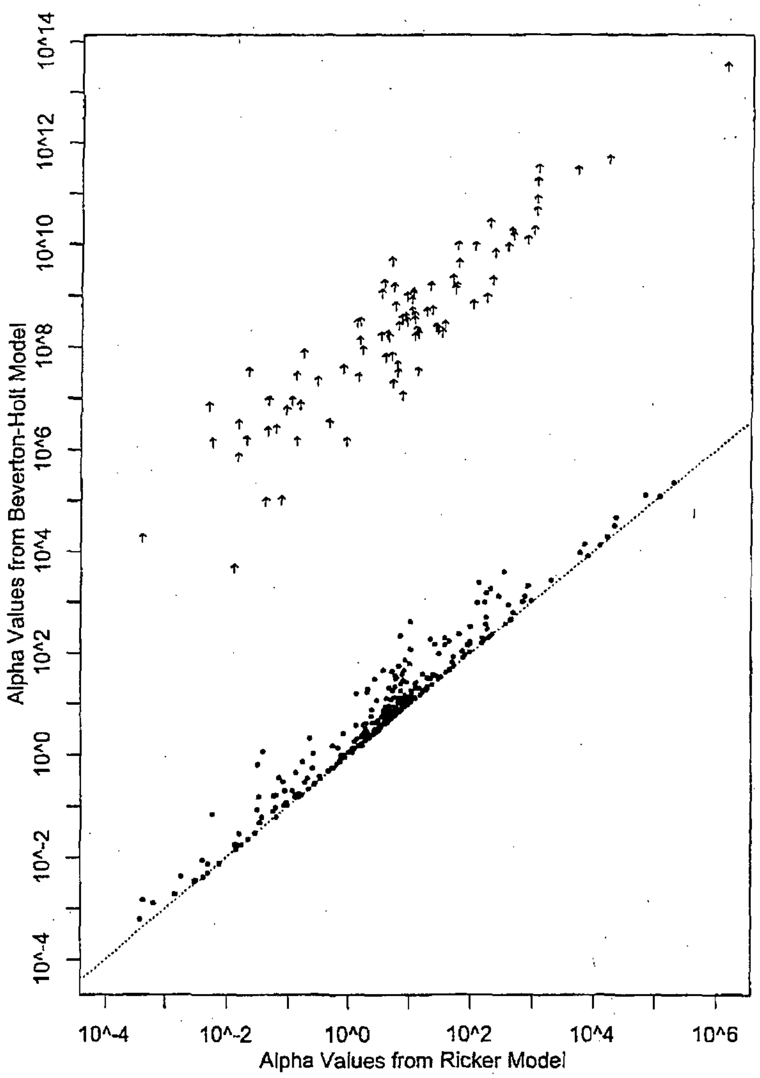

Figure 3: A comparison of the slope at the origin estimated from the Ricker model with that estimated from the Beverton-Holt. In order to spread the data out, we have not standardized the slopes: they are in the "raw" units in the database. The cloud of arrows in the upper part of the figure represents cases where the slope at the origin estimated from the Beverton-Holt model is effectively infinite. The dotted line is the one-to-one line.

This is due to two different processes. First, it is possible to estimate "infinite" in the Beverton-Holt model, so that many estimates of the slope at the origin will be infinity. That is, if $K \rightarrow 0$, then $\alpha \rightarrow \infty$ is a perfectly feasible solution. A second reason for the positive bias has to do with the extrapolation to the origin. A simple way to think about this is to convert to $\log(\frac{R}{S})$, and think about the problem as a regression on S. On this scale, the Ricker model is

$$\log\frac{R}{S} = \log\alpha - \beta S, \tag{1}$$

so that the log of α is the y-intercept, and the Ricker model is a linear extrapolation.

The Beverton-Holt model may be written as

$$\log\frac{R}{S} = \log\alpha - \log(1+\frac{S}{K}). \tag{2}$$

Note that $-\log(1+\frac{S}{K})$ is a convex function of S, and the model will tend to estimate a higher y-intercept.

The Ricker model has the advantage that the estimates almost always are consistent with the biological constraints when plotted on the z scale. That is, $z \rightarrow 0$ as $z \rightarrow 1$, whereas this is not true for the Beverton-Holt model. This produced a much lower estimate of the compensation reserve, typically by about 50% for good data in a mixed effect model (Myers, Bowen, and Barrowman 1999).

2 Summary

The Beverton Holt and Ricker models generally fit spawner recruitment data equally well as judged by a likelihood ratio criterion or a prediction accuracy criterion. However, the Ricker model always gives lower estimates of the compensatory reserve, i.e. the maximum reproductive rate or steepness. For at least 10% of the data sets, the Beverton Holt produces an infinite estimate. For good data, the Ricker linear mixed model approach for estimating the compensatory reserve should underestimate the true value by about 50% if the data actually follows the Beverton Holt model.

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PSEG'S Response to the ESSA Report

APPENDIX D

March 14, 2001

Appendix D : Measurement Error and Bias in the Maximum Reproductive Rate for the Ricker Model

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1 Summary

We investigated the consequences of estimation errors of spawner abundance on the estimates of maximum reproductive rate (α). This rate is equivalent to the slope at the origin for the Ricker model, and can be used to calculate steepness. We simulated four levels of error for data from 250 fish populations. The mean bias caused by estimation error of spawner abundance, when averaged over all populations, was effectively zero. For individual populations, the estimates of α were consistently biased positively or negatively, and the magnitude of this bias increased with the level of measurement error. However, for what we considered the most realistic level of measurement error, 78% of populations experienced a bias of $< \pm 10$ %. We explored the use of mixed effects models to reduce measurement error bias. These models eliminated extreme outliers that were present in the individual model fits, and have the potential to reduce bias for some individual species.

2 Overview of the measurement error problem

In regression analysis, it is a well-known theoretical result that the presence of measurement error in the independent variable can result in both biased and inconsistent parameter estimates (Fuller 1987). The basis of the problem is a lack of independence between the covariates (X), which must now be considered as random variables, and the errors, which is a standard assumption in regression (Fuller 1987). Let X_t denotes the true spawner abundance in year t, then

$$X_t^* = X_t + \delta_t$$

are the observed abundances with measurement error δ_t. The standard regression model becomes:

$$Y_t = \beta_0 + \beta_1(X_t^* - \delta_t) + \varepsilon_t$$

$$Y_t = \beta_0 + \beta_1 X_t^* + (\varepsilon_t - \beta_1 \delta_t)$$

It can be shown that the new error term, $(\varepsilon_t - \beta_1\delta_t)$, is not independent of the X_t^*, due to the constraint: $X_t^* - \delta_t = X_t$. This results in a bias of $\widehat{\beta}_1$ towards zero (Fuller 1987).

3 Relevance of measurement error bias to fisheries science

In fisheries science, predicting recruits (R) from spawners (S) is a common goal, and spawner numbers (or biomass) are rarely estimated without measurement error. Thus, whenever a stock-recruitment relationship is fit, there is a risk of obtaining biased parameter estimates. However, when the log Ricker model is used, the situation is slightly different than for the classical problem, since measurement error added to S appears as a component of both the dependent variable and the "independent" variable. Let R_t be the recruits resulting from spawners at time t (S_t). The linearized Ricker function given by:

$$\log\left(\frac{R_t}{S_t}\right) = \log\alpha - \beta S_t + \varepsilon_t \quad \text{where} \quad \varepsilon_t \sim N(0, \sigma^2)$$

Thus the consequence of adding measurement error to S is not obvious at first glance.

Walters and Ludwig (1981) investigated the measurement error problem in some detail, and developed consistent estimators for the parameters in the Ricker stock-recruitment function. They dealt with cases where either the measurement error variance or more simply, the ratio of environmental to measurement error variance is known (Ludwig and Walters 1981). However, their estimators performed poorly for short, and hence, realistic, time series (< 20 years). In practice, the measurement error variance is not known for such series and the ratio of variances can only be guessed. Moreover, for many of their simulations, spawners were estimated as a function of recruits, and thus measurement errors were added over time (Walters and Ludwig 1981). This will likely overemphasize the effect of measurement error for most stocks, where spawners are estimated independently of recruits. Although the general problem with measurement error is well documented in the fisheries literature, no accepted solution exists (Hilborn and Walters 1992; Quinn and Deriso 1999).

For realistic simulations, our goal is to quantify the effects of error in measuring spawners and investigate whether improved estimates can be obtained using mixed effects models (Myers et al. 1999). The focus, however, is not bias in the estimated slope, but rather in the intercept. The intercept represents the maximum reproductive rate (α), which is a critical parameter in fisheries management (Myers and Mertz 1998; Quinn and Deriso 1999).

4 Methods

We used existing spawner and recruit data from 250 stocks involving 57 species, and added four levels of random error to the observed spawner data. Data sets and their descriptions can be obtained from `http://fish.dal.ca./welcome.html`, and is the same data set used in previous studies (Myers et al. 1999). Using real data avoids the arbitrariness of simulated data, and allows us to measure the importance of measurement error bias in practical terms.

As we did not know the true measurement error for each population, we based the levels of measurement error on the residual error variance ($\hat{\sigma}^2$) estimated from individual Ricker fits to each of the 250 populations. The estimated σ^2 represents the total unaccounted variability in $\log(R)$, including both process (environmental) and measurement error. Since the estimation error variance in S should usually be at most as large as that in R (Quinn & Deriso 1999), then $\hat{\sigma}^2$ is the upper boundary for the level of measurement error we could reasonably expect to observe. The true level of measurement error, however, is likely to be some fraction of σ^2. For each stock, four levels of random normal measurement error were added to $\log(S)$;

$$\log(S^*) = \log(S) + u_t \quad \text{where} \quad u_t \sim N(0, \sigma_m^2).$$

The four levels of measurement error were - low: $\sigma_m = 0.1*\hat{\sigma}$, medium: $\sigma_m = 0.3*\hat{\sigma}$, high: $\sigma_m = 0.6*\hat{\sigma}$, and extreme: $\sigma_m = 1.0*\hat{\sigma}$. Adding normal error to $\log(S)$ is equivalent to adding log normal error to S, however, by so doing we change the expected value of S. If $S_t^* = S_t e^{u^t}$ where $u_t \sim N(0, \sigma_m^2)$, then $E[S^*] = S(e^{\sigma_m^2/2})$. If we solve this problem by letting $u_t \sim N(-\sigma_m^2/2, \sigma_m^2)$ then we are no longer adding zero-mean measurement error on the $\log(S)$ scale. We thus modeled error both ways, where the addition of each level of error was repeated 100 times for each stock, and the relative bias (positive or negative) of $\log\alpha$ was calculated. Relative bias in $\log\alpha$ was calculated as

$$\frac{\widehat{\log\alpha} - \log\alpha_{true}}{|\log\alpha_{true}|}$$

where $\widehat{\log\alpha}$ is the mean $\log\alpha$ estimated from the 100 simulations and $\log\alpha_{true}$ is the parameter value obtained from the Ricker model fit for each stock with no measurement error.

We also tested mixed effects models (Myers et al. 1999). For a particular species with $j = 1, \ldots, J$ stocks, the linear mixed effects model is:

$$\log\left(\frac{R_{tj}}{S_{tj}}\right) = \log\alpha - \beta S_{tj} + \varepsilon_{tj}$$

We let $\log\alpha$ be a random effect, i.e. $\log\alpha = a + b_j$ where a is fixed and $b_1, \ldots, b_J \overset{\text{iid}}{\sim} \mathrm{N}(0, \sigma_b^2)$, and estimated stock-specific β's. We applied this model on populations of the 6 species for which we had the most data: haddock (*Melanogrammus aeglefinus*), herring (*Clupea harengus*), whiting

(*Merlangus merlangus*), cod, (*Gadus morhua*), sockeye salmon (*Oncorhynchus nerka*) and chum salmon (*Oncorhynchus keta*).

5 Results

We first describe the bias combined over all stocks (Fig. 1, Fig. 2, Table 1). Results for zero-mean additive error on the log scale and mean of 1 multiplicative error on the original scale were identical, and we present the former. Figure 1 displays the relative bias for each stock.

Remarkably, the distribution of relative bias for all stocks was centered around zero; the median bias was less than 1% for our guess at the most likely level of estimation error variance ($0.3 * \hat{\sigma}$), and only about 2% for high ($0.6 * \hat{\sigma}$) estimation error variance.

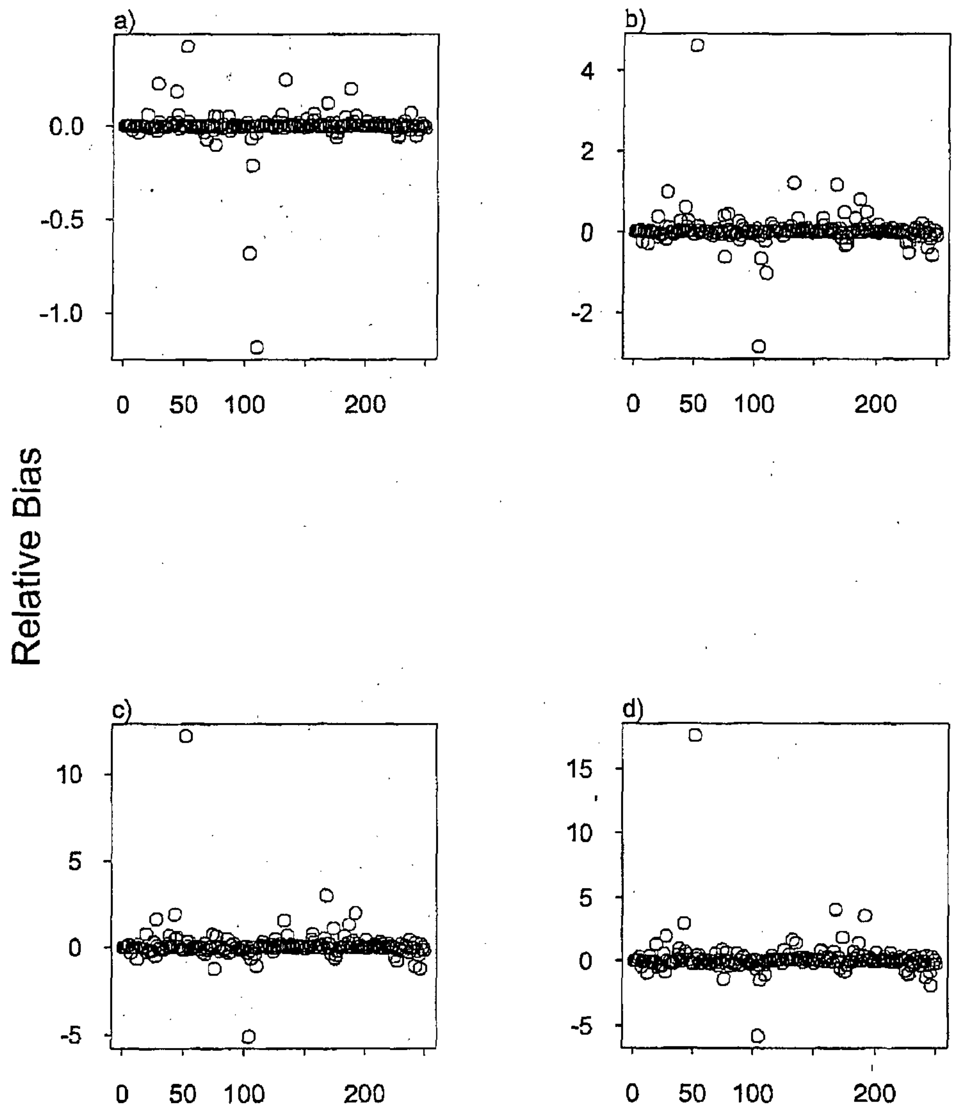

Figure 1: Plot of relative bias for 250 stocks at four levels of measurement error - a) low - $0.1*\hat{\sigma}$, b) medium: $0.3*\hat{\sigma}$, c) high: $0.6*\hat{\sigma}$ and d) extreme: $1.0*\hat{\sigma}$ (see text). Note the changes in the limits of the y-axis as the level of measurement error increases and the presence of extreme outliers.

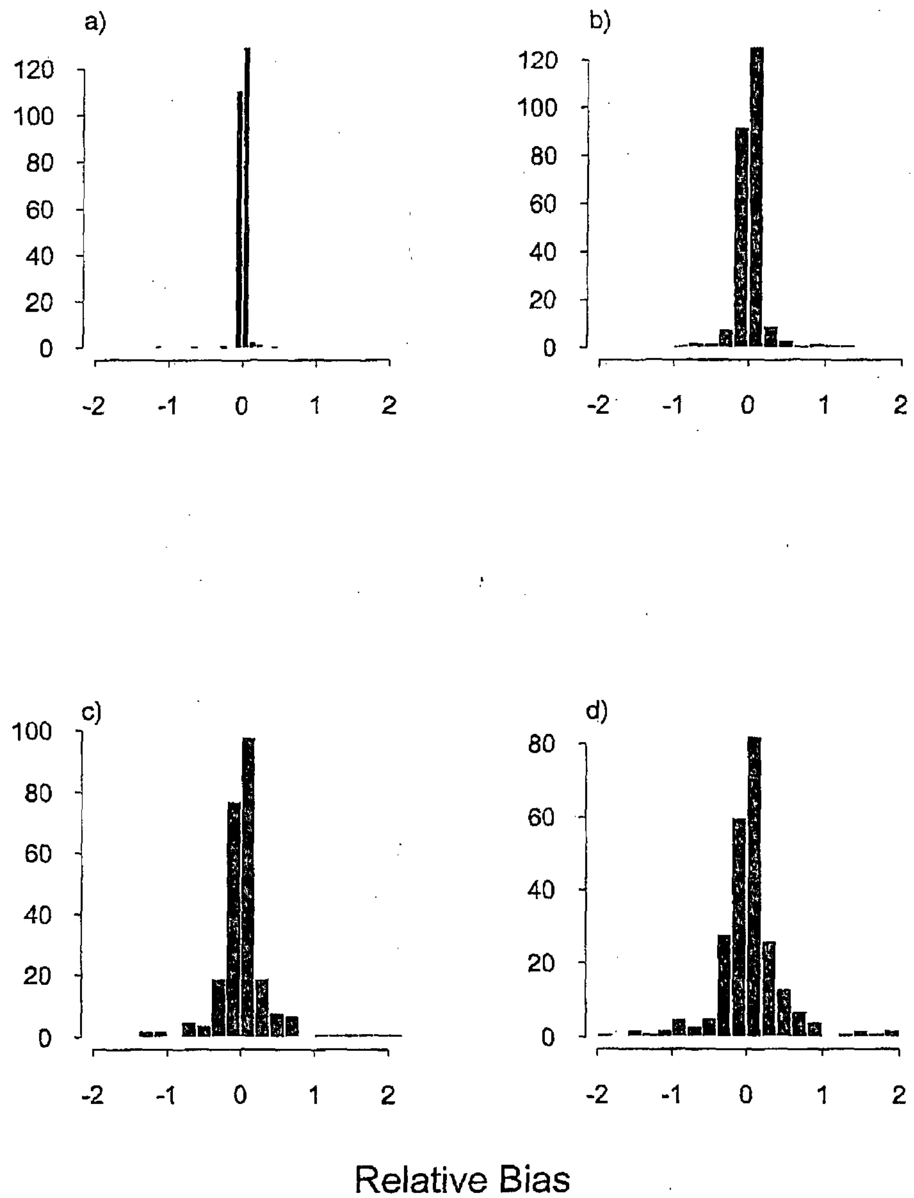

Figure 2: Histograms of relative bias in $\log \alpha$ for 250 stocks at four levels of measurement error in spawner abundance - a) low - $0.1*\hat{\sigma}$, b) medium: $0.3*\hat{\sigma}$, c) high: $0.6*\hat{\sigma}$ and d) extreme: $1.0*\hat{\sigma}$ (see text). Only values lying between -200 % and + 200% bias are depicted.

There are some very large outliers, which tend to pull the mean away from the center of the distribution (Table 1). Thus, if the 250 stocks can be thought to represent a random sample of all stocks, then we'd expect to see close to zero bias on average for a randomly chosen stock (Figure 2).

Table 1. Mean and median percent bias of log α 250 stocks, based on 100 simulations at four levels of measurement error in spawner abundance. Differences between mean and median reflect the presence of a few extreme outliers (~ 3) whose bias showed dramatic increases or decreases with increasing measurement error.

Level of error	Mean percent bias	Median percent bias	% of stocks with bias < ± 10%	% of stocks with bias < ± 20 %
$0.1*\hat{\sigma}$	-0.20	0.098	96.4	97.6
$0.3*\hat{\sigma}$	2.87	0.068	78.4	87.2
$0.6*\hat{\sigma}$	8.31	2.07	51.2	70.0
$1*\hat{\sigma}$	12.76	3.50	36.4	56.8

It is important to examine the range of relative biases experienced at each level of measurement error in order to evaluate what the consequences of this error are. At low levels of measurement error the bias is negligible. At what is likely the most realistic level of measurement error, the medium level, most stocks experience a moderate bias (± 10%). Only at higher levels of measurement error does the bias in most stocks become serious.

Although the mean bias across all stocks appears to be near zero, for a particular population, the estimates of α were consistently biased positively or negatively, and the magnitude of this bias increased with the level of measurement error. For example, we see a very close match between relative bias at the high and extreme levels of measurement error (Figure 3.)

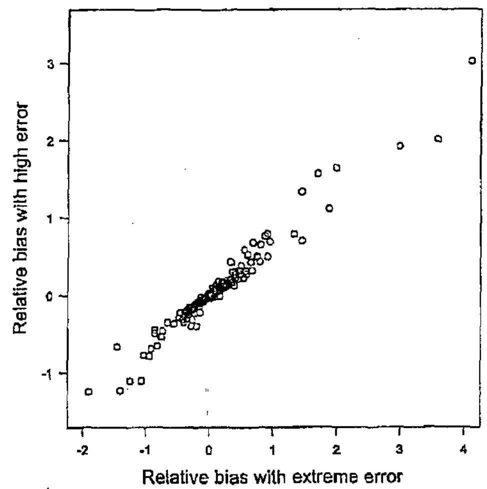

Figure 3: Comparison of relative bias of all stocks with high and extreme amounts of measurement error added to spawner abundance. Two outliers are not shown (-5.77,-5.08) and (17.60,12.17).

Unlike simple linear regression models, the Ricker model produces estimates with almost no overall bias. For the Ricker model, measurement errors usually move the estimated position of the observation parallel to the true regression line (Fig. 4). Measurement error translates the points roughly parallel to the "true" regression line because an overestimate of S causes $\log(R/S)$ to be underestimated. Similarly, an underestimate will cause $\log(R/S)$ to be overestimated. If such translation of the observed data was exactly parallel to the true, it would result in no bias. The pattern observed for the alewife data in Fig. 4 is typical of most data sets.

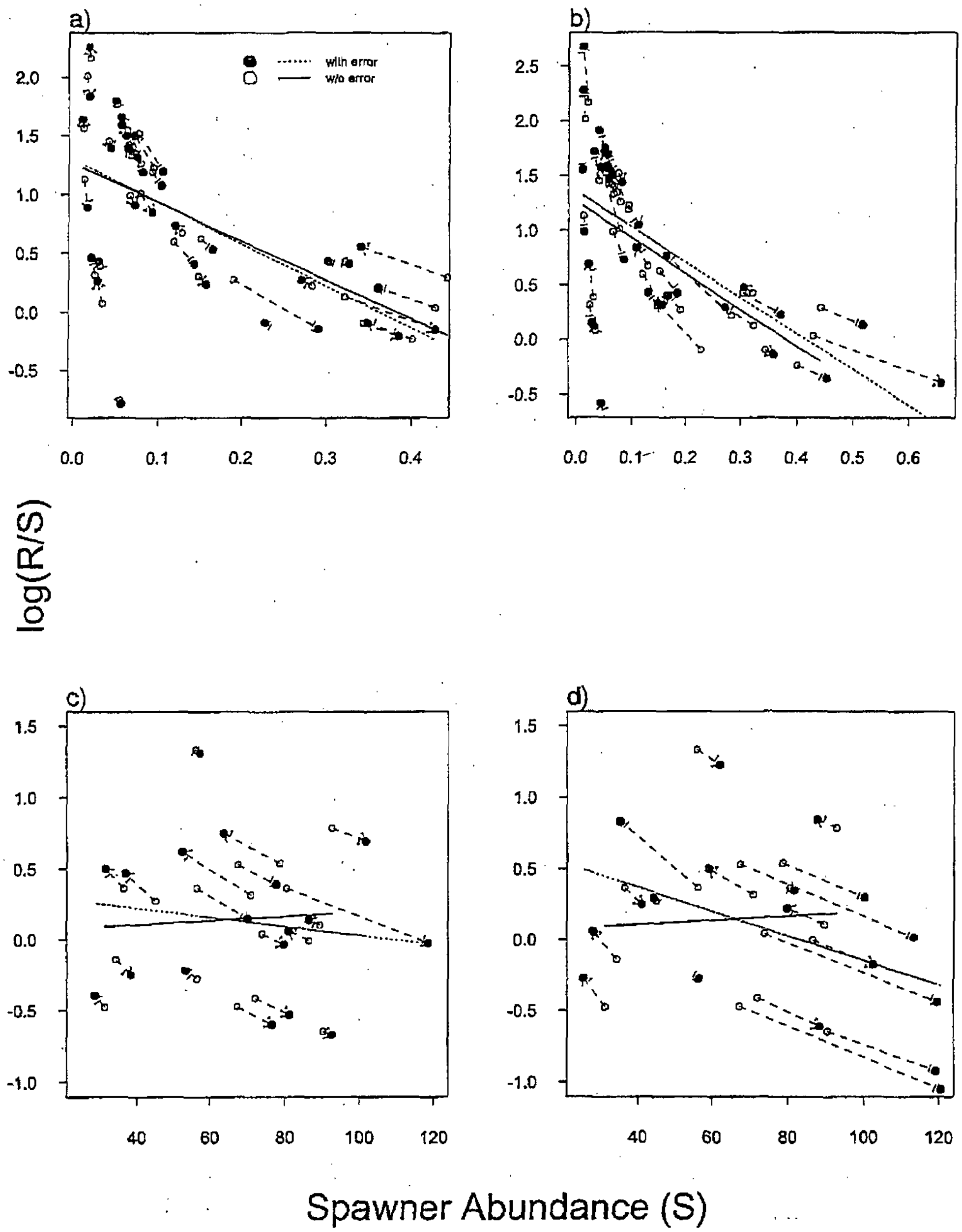

Figure 4: Plots for the alewife (*Alosa pseudoharengus*) in Damariscotta Lake, Maine (a & b) and for cod on George's Bank, indicating what happens to the data (filled circles) after adding measurement error (open circles) which are connected by dashed arrows. Ricker function for original data (solid) and data with error (dashed line) are indicated. Regression line is unaffected by changing the level of measurement error: a) $ c) low - 0.3*$\hat{\sigma}$ and b) & d) high - 0.6*$\hat{\sigma}$.

In the cases with large biases, the measurement error does not translate all the points parallel to the regression line. This is illustrated using data for cod on Georges Bank (Fig. 4). The range of observed spawner abundances was small, and since the slope of the linearized Ricker function was positive, which is unusual, measurement error did not move the observations parallel to the "true" regression line. We were unable to derive a general, reliable rule that allowed these biases to be predicted reliably.

In general the mixed model results differed little from the individual model fits, except in two important respects. The mixed model estimates did not result in either of the two extreme outliers seen from the individual model fits. Also, for sockeye salmon, the estimates of log α resulted in lower estimates of bias (Figure 5).

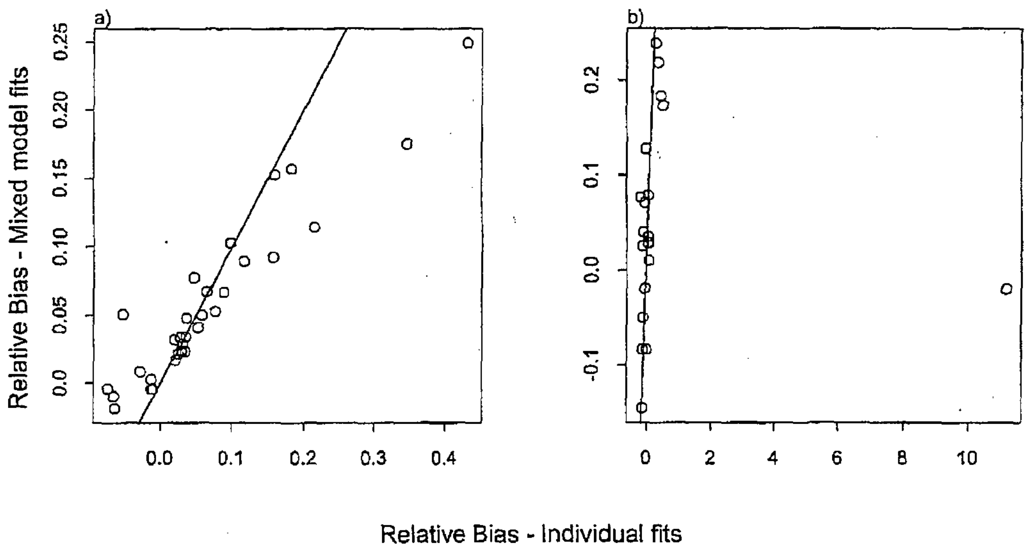

Figure 5: Comparison of relative bias for parameter estimates from individual model fits and from a mixed model fit for a) sockeye salmon and b) cod, both for a high level of measurement error (0.6*$\hat{\sigma}$). Mixed model fits result in reduced bias for sockeye data sets and remove the outlier for cod data sets. The dashed line represents 1:1 equality.

6 Conclusion

Our results suggest that the effect of measurement errors in spawner abundance does not, in general, result in a serious bias in the estimate of maximum reproductive rate. Across all stocks, the average bias is very small. This suggests that when a large database is used to derive a prior, as was done in the PSEG submission, then measurement error bias is not an important factor. This result is supported by our mixed model simulations, which effectively eliminated very few data series that had large negative or positive biases. Thus, we should expect no bias in the estimation of the distribution of maximum reproductive rate, or steepness, when many populations are examined, as was done in the PSEG submission, and recommended as a general method by (Myers, Barrowman, Hilborn, and Kehler 2001).

On an individual population basis, we found that for realistic levels of measurement error, 78 % of populations experienced a bias of $< \pm 10$ %. However, a few populations may have significant biases if analyzed on an individual stock basis. Thus, a mixed effect model or a simulation study, similar to the ones described here, can be used to either eliminate the large biases, or estimate the size of the bias.

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PSEG'S Response to the ESSA Report

APPENDIX E

March 14, 2001

APPENDIX E: Evidence for Compensatory Mechanisms In Fish Populations

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In this appendix we describe some of the compensatory mechanisms that cause survival, growth, or fecundity to increase at low abundance (see also (Goodyear 1980), examples of which are presented in Table 1. We also describe how they are studied in practice. Increased survival at low abundance has been observed due to a variety of mechanisms. Predators may reproduce more rapidly, or migrate into an area, when prey are abundant (numerical response), or may become conditioned to seek the more abundant prey (functional response) (Hassell 1978). In many fish populations, cannibalism acts in a compensatory manner because the large number of parents from which large broods arise may constitute a large pool of predators (MacCall 1981). In addition to predation, parasites, disease and limited food availability typically have a greater suppressive effect when the population is large than when the population is small. Parasites and disease usually spread more rapidly when population density is high than when it is low. At high population abundance, starvation may increase because of competition for limited food resources (Nordeide, Fossa, Salvanes, and Smedstad 1994). Many fish species exhibit territorial behavior or have spatial requirements that can lead to density-dependent mortality (Elliott 1994) or emigration to areas of low survival (Crisp 1993).

Although such territorial behavior is associated with food utilization, it often results in higher predation mortality and immigration as well as decreased somatic growth for individuals without territories. At higher population sizes, competition for food normally translates into slower growth and, in turn, into a delay in sexual maturity and a decrease in the number of eggs or offspring produced (LeCren, Kipling, and McCormack 1972; Schoenherr 1977; Jones 1987). Because growth is indeterminate in fish, and age at sexual maturity and fecundity are very elastic parameters, fish can generate very large compensatory responses through changes in growth and fecundity. Faster growing individuals also tend to reach sexual maturity at an earlier age and to produce more eggs per spawning than slower growing fish. Both younger age at maturation and increased eggs per spawning result in higher life time egg production (Nikolsky, Bogdanov, and Lapin 1973). An increased percentage of sexually mature individuals in the younger ages can cause a significant increase in reproduction because the younger age groups usually consist of large numbers of fish.

Different compensatory factors often interact. For example, slower growth caused by food scarcity may leave a particular life stage of a fish vulnerable to predation for a longer period of time and hence result in higher mortality. Immigration and emigration act as safety valves to reduce numbers at times of peak density, and to increase them when environmental resources are abundant relative to population numbers. The stress of more intense competition due to crowding may cause behavioral or physiological changes in individual organisms that result in lower survival or lower reproductive capacity.

Although compensation affects survival, growth, reproduction and movement, the greatest factor is almost always survival during early ages. This is the assumption used in the PSEG permit application stock jeporady analysis.

Table 1 Examples of compensatory mechanisms affecting survival (S), growth (G), reproduction (R), and movement (M).

mechanisms life-history stage	habitat	species	study	affects	reference
functional feeding response of predators					
juv.	pelagic,estuary	bluefish	field, exp.	S	Buckel and Stoner (2000)
adult	benthic	clam	lab.	S	Eggleston et al. (1992)
limited refuge from predation					
juv.	demersal, ocean	cod	field	S,G	Tupper and Boutilier (1995)
juv.	demersal, estuary	blue crab	exp.	S	Dittel et al. (1995)
juv.	demersal	cod	lab	S	Lindholm et al. (1999)
juv.	demersal	plaice	field	S	van Der Veer (1986)
juv.	pelagic,ocean	pollock	field, exp.		Rangeley and Kramer (1998)
cannibalism					
juv.	demersal	tiger shrimp	lab	S	Abdussamad and Thampy (1994)
adult-egg	pelagic	anchovy	field	S	MacCall (1981)
juv.	demersal	cod	field	S	Nordeide et al. (1994)
adult-egg	demersal, estuarine	stickleback	field	S	Whoriskey and FitzGerald (1985)
juv.	pelagic,lake	smallmouth bass	sim. model	S	Dong and DeAngelis (1998)
larvae, juv.	demersal, lake	sharptooth catfish	lab	S	Hecht and Appelbaum (1988)
juv		crucian carp	field, exp.	S	Tonn et al. (1994)
parasitism					
adult	demersal, ocean	Dungeness crab	field, theory	S	Hobbs and Botsford (1989)
food limitation (general)					
larvae	pelagic	plaice	field	S	Shelbourne (1957)
larvae	pelagic	bloater	field	S,G	Rice et al. (1987)
larvae	pelagic, ocean	general	theory	S,G	Shepherd and Cushing (1980)
post egg	pelagic, lake	vendace	field	G	Auvinen (1995)
post egg	pelagic, lake	vendace	field, exp.	G	Salojarvi (1991)
juv, adult	demersal, ocean	cod	field	G	Millar and Myers (1990)
adult	demersal, ponds	common carp	exp.	G	Lorenzen (1996)
fry	stream bed	steelhead salmon	field, exp.	G	Close and Anderson (1992)
juv.	pelagic, pond	walleye	field, exp.	G	Fox and Flowers (1990)
juv	pelagic, lake	gizzard shad	field	G	Buynak et al. (1992)
larvae	stream bed	sea lamprey	field, exp.	G	Morman (1987)
larvae, juv.	pelagic	bay anchovy	sim. model	S,G	Cowan et al. (1999)
juv.	pelagic, lake	smallmouth bass	sim. model	S,G	DeAngelis et al. (1991)
juv.	pelagic, lake	gizzard shad	field, exp.	S,G	Dettmers and Wahl (1999)
juv.	pelagic, lake	rainbow trout	lab	S,G	Holm et al. (1990)
larvae	pelagic, lake	gizzard shad	field	S,G	Michaletz (1997)
adult	benthic	slimy sculpin	field	G,R	Owens and Noguchi (1998)
juv.	stream	creek chub	field	S,G,M	Schlosser (1998)

mechanisms life-history stage	habitat	species	study	affects	reference
food limitation (territorial behaviour)					
juv.	stream bed	coho salmon	field	S	Sandercock (1991)
juv.	demersal, ocean	cod	field	S,G	Tupper and Boutilier (1995)
larvae	pelagic, lake	bluegill	field	S,G	Partridge and DeVries (1999)
territorial behaviour					
juv.	stream bed	brown trout	field	S,G,M	Elliott (1990)
dispersal					
fry	stream bed	brown trout	field, exp.	S,M	Crisp (1993)
competition for refugia					
juv,adult	pelagic, lake	cisco	field	S,G,M	Aku and Tonn (1997)
suffocation caused by crowding					
eggs	demersal	herring	field		
larvae	stream bed	pink salmon	field	S	Heard (1978)
overturning of egg nests					
adult-eggs	streams	pink salmon	field	S	Heard (1991)
spawning inhibition					
adult	pelagic	tilapia	lab	R	Coward and Bromage (1995)
adult	pelagic, lake	brown trout	field	R	Elliott and Hurley (1998)
sex determination					
larvae	stream bed	least brook lamprey	field	R	Docker and Beamish (1994)
maturity					
adult	pelagic, lake	brown trout	field	R	Elliott and Hurley (1998)
fecundity					
adult	pelagic, ocean	orange ruffy	field	R	Koslow et al. (1995)
adult	pelagic, lake	white crappie	field	R	Mathur et al. (1979)
adult	benthic	slimy sculpin	field	G,R	Owens and Noguchi (1998)
adult	pelagic, ocean	Atlantic herring	field	R	Winters et al. (1993)

Table 2. Latin names of species listed in Table 1.

Common name	Scientific name
Atlantic herring	*Clupea harengus harengus*
Anchovy	*Engraulis sp.*
Bay anchovy	*Anchoa mitchilli*
Bloater	*Coregonus hoyi*
Blue crab	*Callinectes sapidus*
Bluefish	*Pomatomus saltatrix*
Bluegill	*Lepomis macrochirus*
Brown trout	*Salmo trutta*
Cisco	*Coregonus artedi*
Clam	*Macoma balthica*
Cod	*Gadus morhua*
Coho salmon	*Oncorhynchus kisutch*
Common carp	*Cyprinus carpio*
Creek chub	*Semotilus atromaculatus*
Crucian carp	*Carassius carassius*
Dungeness crab	*Cancer magister*
Gizzard shad	*Dorosoma cepedianum*
Herring	*Clupea harengus*
Least brook lamprey	*Lampetra aepyptera*
Northern anchovy	*Engraulis mordax*
Orange ruffy	*Hoplostethus atlanticus*
Pink salmon	*Oncorhynchus gorbuscha*
Plaice	*Pleuronectes platessa*
Pollock	*Pollachius virens*
Sea lamprey	*Petromyzon marinus*
Sharptooth catfish	*Clarias gariepinus*
Slimy sculpin	*Cottus cognatus*
Smallmouth bass	*Micropterus dolomieui*
Sockeye salmon	*Oncorhynchus nerka*
Steelhead salmon	*Oncorhynchus mykiss*
Stickback	*Gasterosteus aculeatus*
Tiger shrimp	*Pemaeus monodon*
Tilapia	*Tilapia tholloni*
Rainbow trout	*Oncorhynchus mykiss*
Vendace	*Corgonus albula*
Walleye	*Stizostedion vitreum*
White crappie	*Pomoxis annularis*

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PSEG'S Response to the ESSA Report

APPENDIX F

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Appendix F: Time-series Bias and the Estimates of Compensation for the Analysis of RIS in the Salem Submission

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Contents

1 Abstract

In this appendix, I examine the role of "time-series" bias on the estimates of compensation used in the Salem Power Plant submission. In the analyses used to carry out the estimates of compensation for the Salem submission, these biases were

well know, and steps were taken to ensure that other model choices were made so that the overall estimates would be conservative, i.e. compensation would be underestimated. Here we provide quantitative estimates of the source of "time-series bias". We found that 7 of the RIS species, the time-series bias will generally be positive, and on the order of 10%. For the remaining species, bay anchovy, we found that time-series bias, along with positive environmental variation in survival, would probably lead to an underestimate of compensation.

2 Introduction

Biases can occur in parameter estimates for stock-recruitment models because the stock sizes are not chosen independently, being correlated with variability in recruitment. We examine the importance of this "time series bias" for the estimation of the compensation parameter, α (which is used to calculate steepness, z) in an analysis of available stock-recruitment data and the use of simulations. For iteroparous species, i.e. species that reproduce more than once, significant biases occur if the populations are exploited at close to the maximum that is biologically possible. Given moderate sample sizes and moderate levels of exploitation, time series bias is small for species such as cod (*Gadus morhua*), for which α, the slope of the relationship between recruitment and number of spawners as the number of spawners goes to zero, is large. For most species, the i.e. those with maximum annual reproductive rates of 3 to 5, the bias should be positive and on the order of 10%. The bias becomes substantial for short time series, i.e. 10 observations or less, in which exploitation occurs at an unsustainable level (we had few such short series that was used to contruct priors for the PSE&G impact assessment).

For one RIS species in the Salem impact study, we found that the bias was likely to be negative, i.e. that the maximum reproductive rate would be underestimated caused by the interaction between time-series bias and environmental autocorrelation in interannual survival. This case is species that are essentially univoltine, e.g. bay anchovy. For these species we would expect the compensation to be underestimated.

The estimation of density-dependent mortality in fish, or in any species, is not a simple matter. Biases in the estimation of density-dependent processes have two widely known causes (Hilborn and Walters 1992). One cause is errors in the estimation of spawning population size, which is dealt with in Appendix D. Bias can also be introduced because the "independent" variable, spawning population size, is not independent of the interannual variation in the stock-recruitment relationship: for a given spawning population, above-average recruitment tends to result in higher spawning populations, while below-average recruitment tends to result in lower spawning populations. This is called *time series bias*, and causes the density-dependent mortality to be overestimated. (Walters 1985) was the first to identify this potentially important source of bias, and has proposed a clever method of reducing the bias (Walters 1990). The time series bias is seldom dealt with when density-dependence is examined, even though it has important theoretical and management implications.

The purpose of this analysis is to investigate when time series bias is important for the Ricker stock-recruitment model in the estimation of the maximum reproductive rate, i.e. the compensation reserve. We estimate bias using simulations with realistic parameter values obtained from a comprehensive analysis of stock and recruitment data (Myers, Bridson, and Barrowman 1995; Myers and Cadigan 1993).

Our analysis is based upon our previous simulations (Myers and Barrowman 1995), and recent comprehensive analyses (Myers, Bowen, and Barrowman 1999)

3 Stock-Recruitment Model

We consider a Ricker stock-recruitment model that gives the number of recruits at age a in year $y+a$, R_{y+a}, resulting from the number of spawners in year y, S_y. The model has the form

$$R_{y+a} = \tilde{\alpha} S_y e^{-\beta S_y - \varepsilon}. \quad (1)$$

where $\tilde{\alpha}$ is the number of recruits produced per spawner at low population size, β is the density-dependent mortality parameter, and ε is a normal random variable with mean 0 and variance σ_ε^2 Our model implies a lognormal distribution for the variability in recruitment for a given stock size.

4 Realistic Ranges of Simulation Parameters

In order to conduct plausible simulations to investigate the bias, realistic ranges of parameters were required. These were obtained from the database compiled by Myers et al. (1995) and included estimates of

- a standardized form of the initial slope,
- the density-dependent parameter,
- the variance and autocorrelation in the stochastic component of natural mortality,
- and the mean, variance, and autocorrelation in fishing mortality.

We used only data in which aging is not known to be problematic. In some species (e.g. tuna and swordfish), aging can only be undertaken via length-based methods; such stocks are not included in the analysis. The database contained 131 stocks having at least 15 years of data including 95 stocks having at least 20 years of data. However, not all data were available for all stocks.

4.1 Standardized Initial Slope

Estimates of the slope of the Ricker stock-recruitment curve at the origin were obtained from Myers et al. (1995). These slopes were converted into a *standardized* form which allows them to be compared across different stocks and species. The standardization is required because the model of Myers et al. (1995) differs from ours in two ways. First, they modeled *mean* recruitment, and second, for many stocks they used *spawning stock biomass* rather than number of spawners. A scaling factor is required for each of these differences.

The model used by Myers et al. (1995) can be written

$$E(R_{y+a}) = \alpha^* B_y e^{-\beta B_y}, \tag{2}$$

where α^* is the slope at the origin measured as recruits per unit biomass and B_y is the spawning stock biomass in year y. Our model, given in (1), can be rewritten in terms of B_y as

$$R_{y+a} = \alpha^{\dagger} B_y e^{-\beta B_y - \varepsilon}, \tag{3}$$

where $\alpha^{\dagger}$ is the slope at the origin measured as recruits per unit biomass. To obtain the first scaling factor, note that the expected recruitment for our model is

$$E(R_{y+a}) = (\alpha^{\dagger} e^{\frac{1}{2}\sigma_{\varepsilon}^2}) B_y e^{-\beta B_y}, \tag{4}$$

since $E(e^{-\varepsilon}) = e^{\frac{1}{2}\sigma_{\varepsilon}^2}$. Comparing (4) and (6) we see that

$$\alpha^* = \alpha^{\dagger} e^{\frac{1}{2}\sigma_{\varepsilon}^2}. \tag{5}$$

That is, estimates from Myers et al. (1995) of the slope at the origin will be inflated by a factor $e^{\frac{1}{2}\sigma_{\varepsilon}^2}$.

To obtain the second scaling factor, we begin by defining the spawning stock biomass in year y as

$$B_y = \sum_{c=1}^{A} R_{y-c} w_{y,a+c} P_{y,a+c} e^{-\sum_{b=1}^{c-1} (M_{y-c+b,a+b} + F_{y-c+b,a+b})} \tag{6}$$

where A is the maximum age observed, R_{y-c} is the recruitment in year $y-c$ (at age a), $w_{y,a+c}$ is the weight at age $a+c$ at the beginning of year y, $P_{y,a+c}$ is the proportion mature at age $a+c$ in year y, $M_{y-c+b,a+b}$ is natural mortality at age $a+b$ in year $y-c+b$ and $F_{y-c+b,a+b}$ is the fishing mortality at age $a+b$ in year $y-c+b$. The scaling factor we use is $\text{SPR}_{F=0}$, the spawner quantity per recruit when fishing mortality is zero (Mace 1994). This scaling factor may be used in general to obtain the same units for spawner quantity and recruitment. In the present case the spawner quantity is expressed as spawning stock biomass. Consider a year-class of R individuals. Over the lifetime of the year-class, the total contribution to the spawning stock biomass is

$$\text{Total}(B) = \sum_{i=1}^{A} w_i P_i R e^{-\sum_{c=1}^{i-1} M_c + F_c} \tag{7}$$

where w_i is the weight at age i, P_i is the proportion mature at age i, M_c is the natural mortality at age c, and F_c is the fishing mortality at age c. Setting $F_c = 0$ and dividing by R gives

$$\mathrm{SPR}_{F=0} = \sum_{i=1}^{A} w_i P_i e^{-\sum_{c=1}^{i-1} M_c}. \qquad (8)$$

The *standardized* initial slope, α, is obtained by scaling the initial slope $\alpha^{\dagger}$ by $\mathrm{SPR}_{F=0}$, i.e.

$$\alpha = \alpha^{\dagger} \cdot \mathrm{SPR}_{F=0} = \alpha^{*} e^{-\frac{1}{2}\sigma_{\varepsilon}^{2}} \mathrm{SPR}_{F=0}. \qquad (9)$$

Estimates of $\mathrm{SPR}_{F=0}$ were extracted from the database compiled by (Mace and Sissenwine 1993) and are based on the same age-at-recruitment, growth, and maturation schedules used in the Myers et al. (1995) database of stock and recruitment estimates. We used estimates of α that were in the range of the observed values in the simulation study.

In the simulations, we used a realistic range of α's. Semalparous species typically had a lower lifetime maximum reproductive rate than interoparous species, therefore we used smaller α's for them than the semelpaous species, i.e. $\alpha = 4$ and 10. For iteroparous species, 6 to 30, which reflects the higher lifetime reproductive rate of these species.

4.2 Density Dependent Parameter

The parameter β varies with the size of the population and cannot readily be compared between populations. Fortunately, time series bias is relatively insensitive to β (Walters 1985). We initially assume $\beta = 1$, where the units of β are one over the units of the spawners.

4.3 Stochastic Component of Natural Mortality

The standard deviation in the interannual variability in mortality, σ_{ε}, is available from Myers, Bridson, and Barrowman (1995) for 169 populations using the Ricker model under the assumption that the variation follows a lognormal distribution. The median is 0.57. We chose σ_{ε} of 0.1, 0.5, and 1.0 to investigate in the simulations, which represent the 2th, 36th, and 85th percentiles respectively.

Walters showed that autocorrelation in the stochastic component of natural mortality increased time series bias; however, estimation of this autocorrelation is not easy (Walters 1990). First, the simple sample autocorrelation is negatively biased (Kendall, Stuart, and Ord 1983) (section 48.3). Second, if research vessel estimates of abundance at age are used, estimation error will bias the sample autocorrelation towards zero. Third, aging errors in the analysis of commercial catch-at-age data will make recruitment estimates appear to be positively correlated, even if they are not (Bradford 1991).

Each of these difficulties was overcome by Myers and Cadigan (1993a) using a latent variable model of multiple research survey estimates of abundance to estimate the autocorrelation between adjacent cohorts. Their method is not biased by aging errors because they used only data from juveniles where the aging errors are minimal. They also found that other types of biases in the estimates of autocorrelations were small. They found evidence of negative autocorrelation between adjacent cohorts of cod; this pattern is consistent with density-dependent mortality between adjacent cohorts. There is one region where positive autocorrelation does appear to be real for cod; in the North East Arctic, both cod and haddock appear to have significantly positive autocorrelation. This is probably because the autocorrelation in the environment is more important in this region. The autocorrelations are positive for all the flatfish populations examined; however, even here the median, 0.43, is not large. It appears that autocorrelation is typically small, and even negative if there is density-dependent mortality between adjacent cohorts. There may be populations where the autocorrelation is greater, but probably not much greater than 0.5. It is apparent that the degree of autocorrelation estimated by Myers and Cadigan (1993a) is very much lower than that estimated by commercial catch-at-age data. This is almost certainly caused by the aging error used in the commercial catch-at-age analysis.

4.4 Fishing Mortality

In order to provide realistic estimates of the statistical properties of fishing mortality we examined the estimates of fishing mortality compiled in Myers et al. (1995). We analyzed those data series having at least 20 years of data, for a total of 95 series. The 10th percentile, median, and 90th percentile mean fishing mortality are 0.25, 0.55, and 1.28 respectively. The median standard deviation in fishing mortality is 0.21. The median autocorrelation in fishing mortality is 0.47. Our simulations begin with mean fishing mortality $\mu_F = 0.5$, standard deviation $\sigma_F = 0.18$ (based on an earlier estimate), and autocorrelation $\rho_F = 0.5$.

5 Simulations to Estimate Bias

Populations were simulated using combinations of the parameter values described in the previous section. For each combination of parameters, 100 simulations were used. We investigated sample sizes of 10, 15, and 30. Sample sizes of 10 were investigated for completeness; we do not recommend such small sample sizes in general.

5.1 Fishing Mortality

For semelparous species, fishing mortality is assumed to occur only on fish before they spawn. In this case the dynamics of the spawners is given by

$$S_y = e^{-F_y} R_y. \tag{10}$$

Combining the stock-recruitment model (1) with (10) gives

$$S_{y+a} = e^{-F_{y+a}} \tilde{\alpha} S_y e^{-\beta S_y - \varepsilon}. \tag{11}$$

In the semelparous case, spawners and recruitment have the same units, therefore $\tilde{\alpha}$ is equal to the standardized initial slope, α, thus

$$S_{y+a} = e^{-F_{y+a}} \alpha S_y e^{-\beta S_y - \varepsilon}. \tag{12}$$

Note that the product $e^{-F_{y+a}}\alpha$ gives the initial slope relative to the intensity of fishing. If fishing mortality is constant at F_0 then a deterministic equilibrium is given by

$$S_0 = \frac{1}{\beta} \ln\left(\frac{\alpha}{e^{F_0}}\right). \tag{13}$$

In most simulations of fish populations, fishing mortality is held constant; however, it is probably best considered in the context of time series analysis (Gudmundsson 1994). We simulate the interannual variation in fishing mortality by a Markov process, i.e. a first order autoregressive model. To prevent the process from straying beyond realistic values we used reflecting boundaries at 0.1 and 1.5. Let $\dot{F}_y$ represent the deviation in year y of fishing mortality from the long-term mean, i.e. $\dot{F}_y = F_y - \mu_F$, where μ_F is the long-term mean. We assume that fully recruited fishing mortality is described by

$$\dot{F}_y = \rho_F \dot{F}_{y-1} + \zeta_y, \tag{14}$$

where ρ_F is the autocorrelation between adjacent fishing mortalities and the $\{\zeta_y\}$ are a sequence of independent and identically distributed normal random variables with mean zero and variance σ_ζ^2. Therefore

$$\mathrm{Var}(F_y) = \sigma_F^2 = \frac{\sigma_\zeta^2}{1-\rho_F^2}. \tag{15}$$

We initialized the simulations by setting the fishing mortality equal to its mean and calculating the resulting equilibrium spawners using (13). To ensure that the initial conditions were not too important for the results, we simulated an initial ten years of data that were not used in the bias estimates.

5.2 Modeling Age Structure

To investigate the effect of age structure we use the Clark model (Clark 1976), which avoids the complicated formalism of full age structured models. Let the survival of adults between years in the absence of fishing mortality be $\ell = e^{-M}$. The formulation we use simulates a fishery that occurs on the spawning ground just before spawning occurs. The number of spawners in year y for our iteroparous model is given by

$$S_y = e^{-F_y}(\ell S_{y-1} + R_y \mathrm{SPR}_{F=0}), \tag{16}$$

where, in this case, $\mathrm{SPR}_{F=0}$ is the *number* of spawners per recruit at zero fishing mortality. Recall that in the semelparous case, in the absence of fishing mortality, a single recruit results in a single spawner, hence $\mathrm{SPR}_{F=0} = 1$, i.e. $\alpha = \tilde{\alpha}$. In the iteroparous case, however,

$$\mathrm{SPR}_{F=0} = \sum_{i=0}^{\infty} \ell^i = \frac{1}{1-\ell}. \tag{17}$$

Thus the standardized initial slope is given by

$$\alpha = \tilde{\alpha} \cdot \mathrm{SPR}_{F=0} = \frac{\tilde{\alpha}}{1-\ell}, \tag{18}$$

i.e. $\tilde{\alpha} = \alpha(1-\ell)$. Combining the stock-recruitment model (3) with (18) and (20) gives

$$S_{y+a} = e^{-F_{y+a}}(\ell S_{y+a-1} + \alpha S_y e^{-\beta S_y - \varepsilon}). \tag{19}$$

If fishing mortality is constant at F_0 then a deterministic equilibrium is given by

$$S_0 = \frac{1}{\beta} \ln\left(\frac{\alpha}{e^{F_0} - \ell}\right). \tag{20}$$

As in the semelparous case, simulated recruitment were generated using (3) but with $\tilde{\alpha} = \alpha(1-\ell)$. We allowed fishing mortality to vary in the same manner as we did for the semelparous case, i.e. as an autoregressive process.

5.3 Estimation

Standard linear least squares estimation was used to estimate the parameters of the Ricker stock recruitment model. The regression equation is obtained from equation (3) by dividing both sides by S_y and taking the logarithm:

$$\log\left(\frac{R_{y+a}}{S_y}\right) = \log(\tilde{\alpha}) - \beta S_y - \varepsilon. \quad (21)$$

We estimated the mean and standard error of the estimates of the density-dependent mortality term, β. We also estimated the mean and standard error of the residual variance.

6 Results and Discussion

6.1 Semelparous species

Data on semelparous species, i.e. species that die after they reproduce, is not the focus of this report because data from such species were not used in the final meta-analytic estimates for the Salem plant. However, we include this section because most of the research for this problem has focused on such species, and such a comparison is needed for this study to be evaluated.

We first consider the bias in α in the Ricker stock-recruitment model for species with semelparous reproduction using the base fishing mortality assumptions described above (Table 1). Note that the results are in percent bias. We use an age at maturity of 4 years, which simulates a Sockeye salmon (*Oncorhynchus nerka*) life history. The time series bias does not appear to be important unless $\alpha e^{-\mu_F}$, the product of the standardized initial slope, α, and the survival after harvest at mean fishing mortality, $e^{-\mu_F}$, is small. Kope (1988) noted that changes in the survival rate have the same effect on bias as changes in α. The bias is increased for smaller sample sizes, increased recruitment variation and autocorrelated recruitment, but these factors are of secondary importance. Thus, our conclusions about time-series bias for semelparous species will primarily depend upon α and harvest rates for real populations.

Our results are consistent with those of other workers (Walters 1985; Kope 1988; Caputi 1988). However, the biases that they estimate are greater than those inferred for many of the populations for which we have data. This is because the α they used was smaller than that observed for most populations. For example, Walters (1985, 1990) and Kope (1988) assumed $\alpha = e \approx 2.72$; only two of the semelparous populations from Myers et al. (1995) had α's that low.

The most important factor in the consideration of time-series bias for semelparous species is the product of the survival from the fishery and the reproduction rate as the number of spawners goes to zero, αe^{-F}. If this factor is around 2.5 then the bias in the estimate of the density-dependent mortality ranges from 2 to 19%. The bias is greater when data series are short (around 10 data points) and have large stochastic variability.

6.2 Iteroparous species

We investigated the effect of changing the age at maturity, a_{mat}, natural survival after reproduction, ℓ, and mean fishing mortality, μ_F (Table 2). Time series bias appears to be more important with overlapping generations if similar values of α are assumed; however, species with survival after reproduction tend to have larger α's. For an α of 10 with the assumed fishing mortality, time series bias reduces to what may be an acceptable level of approximately 20%. Autocorrelated stochasticity in recruitment increases the bias. If natural survival after reproduction decreases then the bias decreases. This is consistent with the results from Table 1 where the survival was zero. If age of maturity decreases, the bias increases slightly.

Some species, such as cod, appear to have such a large α that time series bias will generally not generally be important.

Other species, such as herring, are in between cod and the hakes, which have low α's; a few populations appear to have a low α, which may result in significant biases. There is one case for which bias is always a concern. If data are only available for a population during a time period when the fishing mortality was unsustainable, (i.e. one has a population going into commercial extinction), then there is a good chance that estimates for such a population may be significantly biased, and simulation tests should be carried out.

We investigated the robustness of the above conclusions by considering alternative parameters. The general conclusions were not changed when β was reduced by two order of magnitude. This conclusion holds for the semelparous simulations as well, and is consistent with other studies (Walters 1985; Cass 1989).

6.3 Univoltine Species

There is one case we investigated in which autocorrelated stochastic mortality does not create a positive bias (Table 3). If the age at maturity is one, autocorrelated mortality causes the mortality to be underestimated in all cases. However, this bias is caused by model misspecification rather than time series bias; the density-dependent parameter is confounded by environmental autocorrelation. Nevertheless, time series bias can be discerned in Table 3; for small α the estimates are less negative for small sample size.

The bay anchovy is essentially a univoltine species, i.e. it lives one year. In this case, estimates for this and related species may be negatively biased.

7 Conclusions

The claims by ESSA that the time series bias represents an insurmountable barrier to the estimation of spawner recruitment parameters is incorrect. They present no theoretical or simulations studies to support their assertions the magnitude of the bias; here, I have shown that the ESSA estimates are wildly inaccurate. We show that time-series bias for the compensation, i.e. the maximum lifetime reproductive rate, is positive and around 10%. For bay anchovy, and related species, they estimates will probably be negatively biased.

For species with low α's, such as hakes and sardines, time-series bias may be important. For species with generally high α's, such as cod, time series bias can sometimes be ignored for the Ricker model. Species such as herring, must be examined on a case by case basis. The most outstanding observation from the simulations concerns the effects of overexploitation. Overexploited stocks result in high bias. That is, if a population is overexploited relative to its life-history, then large biases probably occur.

A further important result from our analysis is that α is significantly negatively biased for univoltine (one generation per year) species if environmental variability is positively autocorrelated. The direction of this bias is the opposite of that expected for time series bias. This is caused by confounding of the autocorrelated environmental stochasticity with density-dependence with a one year lag. This result is very relevant for the bay anchovy, which is essentially univotine, and is subject to autocorrelated environment forcing. Thus, our estimate for the bay anchovy population may the compensation parameter significantly.

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8 Table 1.

Percent bias in estimates of the α parameter of the Ricker stock-recruitment model from simulations of a semelparous population with an age of maturity of 4 years. The bias is given for selected values of the following parameters: variability in the stochastic component of natural mortality, σ_ε; sample size, n; autocorrelation in the stochastic component of natural mortality, ρ; and slope at the origin, α. Fishing mortality was assumed to be an autoregressive process with mean $\mu_F = 0.5$, standard deviation 0.18, and autocorrelation 0.5. The term $\alpha e^{-\mu_F} = \alpha e^{-0.5}$ is given in parentheses next to α. The percent bias has been rounded to the nearest integer. In order to save space, not all combinations are displayed.

			α ($\alpha e^{-\mu_F} = \alpha e^{-0.5}$)	
σ_ε	n	ρ	4 (2.43)	10 (6.06)
.1	10	0	8	-1
		0.5	2	4
	15	0.5	4	-4
	30	0	3	1
		0.5	1	-1
.5	10	0	11	3
		0.5	17	21
	15	0.5	28	5
	30	0	8	3
		0.5	2	2
1	10	0	32	12
		0.5	40	
	15	0.5	27	5
	30	0	5	0
		0.5	12	11

9 Table 2.

Percent bias in estimates of the α parameter of the Ricker stock-recruitment model from simulations of an iteroparous population. The sample size, n, is fixed at 15. The bias is given for selected values of the following parameters: age of maturity, a_{mat}; survival of adults between years in the absence of fishing mortality, ℓ; mean fishing mortality, μ_F; and standardized slope at the origin, α. Fishing mortality was assumed to be an autoregressive process with standard deviation 0.18, and autocorrelation 0.5. Parameter combinations for which there were no equilibrium numbers of spawners are denoted by "–". The percent bias has been rounded to the nearest integer. The difficulty in interpreting these results is that some of the paramter combinations lead to unrealistic estimates of the maximum annual reproductive rate (Myers et al 1999). For most populations this value should be between 2 and 6, we have put the combinations of α and natural survival that yield values in this range in **bold**. These are the values that should be considered realistic.

a_{mat}	ℓ	μ_F	α 6	10	30
3	.5	.5	**14**	**8**	0
	.8	.5	27	**21**	**9**
	.9	.5	–	36	**13**
6	.5	.5	**13**	**10**	2
	.8	.5	24	**15**	**10**
	.9	.5	–	22	**13**

10 Table 3.

Percent bias in estimates of the α parameter of the Ricker stock-recruitment model from simulations of a semelparous population with an age of maturity of 1 year and with autocorrelation in the stochastic component of natural mortality, $\rho = 0.5$. The bias is given for selected values of the following parameters: variability in the stochastic component of natural mortality, σ_ε; sample size, n; and slope at the origin, α. Fishing mortality was assumed to be an autoregressive process with mean $\mu_F = 0.5$, standard deviation 0.18, and autocorrelation 0.5. The percent bias has been rounded to the nearest integer.

		α		
σ_ε	*n*	4	10	30
.1	10	- 4	-3	-1
	15	- 7	-15	-1
	30	-10	- 8	-0
.5	10	- 8	-17	-10
	15	-17	-31	-3
	30	-36	-18	-6
1	10	-14	-13	-7
	15	- 7	- 6	-4
	30	-15	-15	-7

Table IV-1. Probabilities associated with all possible outcomes (number of fish observed in a sample) for the example in which the true number of fish collected is 8, and each fish has a 1 in 9 chance of being retained in the sampling net.

Number of Fish Observed in the Sample [X]	Probability of Observing X Fish in the Sample [Pr(X)]	Adjusted Number of Fish in the Sample [9 times X]	Pr(X) times [9 times X]
0	0.38974	0	0.00000
1	0.38974	9	3.50770
2	0.17051	18	3.06924
3	0.04263	27	1.15096
4	0.00666	36	0.23978
5	0.00067	45	0.02997
6	0.00004	54	0.00225
7	<0.00001	63	0.00009
8	<0.00001	72	0.00000

Table IV-2. Summary of impingement sampling frequency (average number of samples per week)

Year	Months											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1977*	0	0	0	0	72	32	30	41	35	3	32	35
1978*	0	0	0	0	4	22	59	108	90	81	90	75
1979*	73	73	87	60	62	64	87	58	65	77	81	75
1980*	78	80	78	83	79	65	84	75	68	74	72	74
1981*	104	94	98	73	74	72	84	73	63	55	67	74
1982*	95	89	97	84	40	73	83	75	68	68	76	77
1983*	91	85	81	78	79	75	67	63	60	39	37	42
1984	6	6	6	6	18	18	18	18	18	6	6	6
1985	6	6	6	6	18	18	30	30	24	18	6	6
1986	6	6	6	12	18	18	18	18	18	6	6	6
1987	12	6	6	12	18	18	18	18	18	6	6	6
1988	6	6	12	12	12	12	12	12	12	12	12	12
1989	12	12	6	6	6	6	6	6	6	6	6	6
1990	6	6	6	6	6	6	6	6	6	6	6	6
1991	6	6	6	6	6	6	6	6	6	6	6	6
1992	6	6	6	6	6	6	6	6	6	6	6	6
1993	6	6	6	6	6	6	6	6	6	6	6	6
1994	6	6	6	6	6	6	6	6	6	6	6	6
1995	10	10	10	10	10	10	10	10	10	10	10	10
1996**	10	5	10	10	10	10	5	10	10	5	0	5
1997	30	30	30	30	30	30	30	30	30	30	30	30
1998	30	30	30	30	30	30	30	30	30	30	30	30

* Monthly variability due to "Environmental Event Reporting Procedure" in effect – additional samples were required when triggered by a threshold impingement rate for certain target species.
** Extended two-unit outage year.

Table IV-3. Comparison of ELS mortality rates from literature to rates derived using life-cycle balancing (LCB) methodology

			Eggs	YSL	PYSL	JUV 1
Weakfish	Literature		0.332	0.947	0.199	0.041
						0.027
						0.015
	LCB		*0.522*	*0.447*	*0.373*	*0.019*
Bay anchovy	Literature					
		min.	0.02	1.27	0.07	0.0041
		max	4.46	1.27	4.25	0.0081
		median	1.33	1.27	0.27	0.0063
	LCB		*1.04*	*0.78*	*0.19*	*0.0039*
Striped bass	Literature		2.35	0.32	0.10	0.005
			0.09	0.97	0.12	
	LCB		*0.69*	*0.37*	*0.11*	*0.017*
White perch	Literature		0.12	0.12	0.09	0.006
	LCB		*0.79*	*0.52*	*0.13*	*0.006*
Spot	Literature		no data	no data	no data	0.030
						0.061
	LCB		*0.41*	*0.41*	*0.41*	*0.013*
Croaker	Literature		no data	no data	no data	0.0300
						0.0800
						0.0230
	LCB		*0.41*	*0.41*	*0.41*	*0.0099*
American shad	Literature		0.359	0.359	0.072	0.015
						0.018
						0.010
						0.013
						0.017
	LCB		*0.470*	*0.470*	*0.094*	*0.022*
Alewife	Literature		0.15	0.22	0.056	0.033
				0.31	0.065	
					0.058	
					0.087	
					0.146	
					0.221	
	LCB		*0.093*	*0.14*	*0.043*	*0.020*
Blueback herring	Literature		no data	no data	0.22	0.033
	LCB		*0.094*	*0.14*	*0.044*	*0.021*

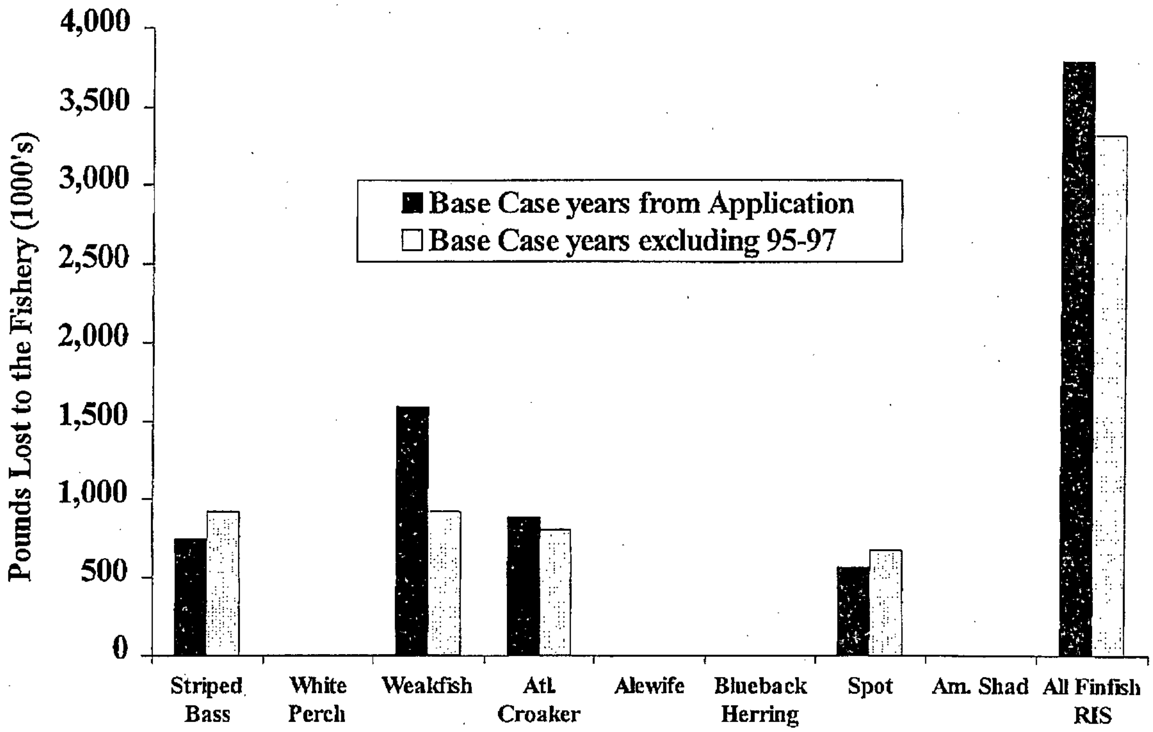

Figure IV-4. Effect of excluding data from 1995-1997 on Base Case scenario loss estimates (expressed in terms of pounds lost to the fishery) for the finfish RIS. Values presented in this graph are from PSEG (1996).

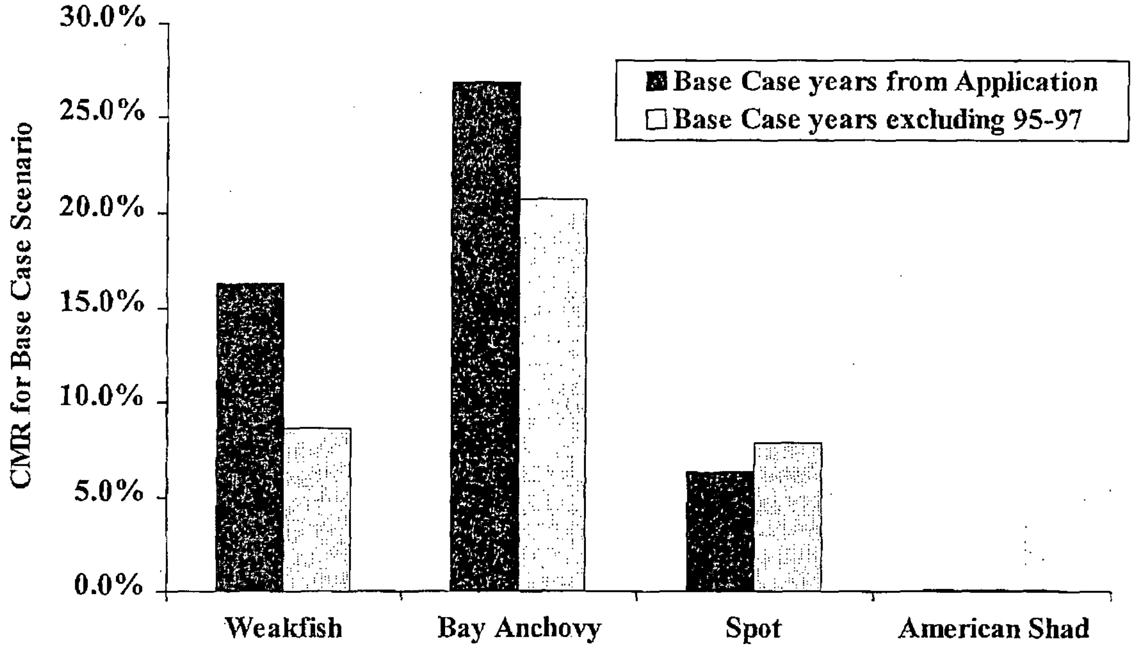

Figure IV-5. Effect of excluding data from 1995-1997 on Base Case scenario loss estimates (expressed in terms of pounds lost to the fishery) for the finfish RIS. Values presented in this graph are from PSEG (1996).

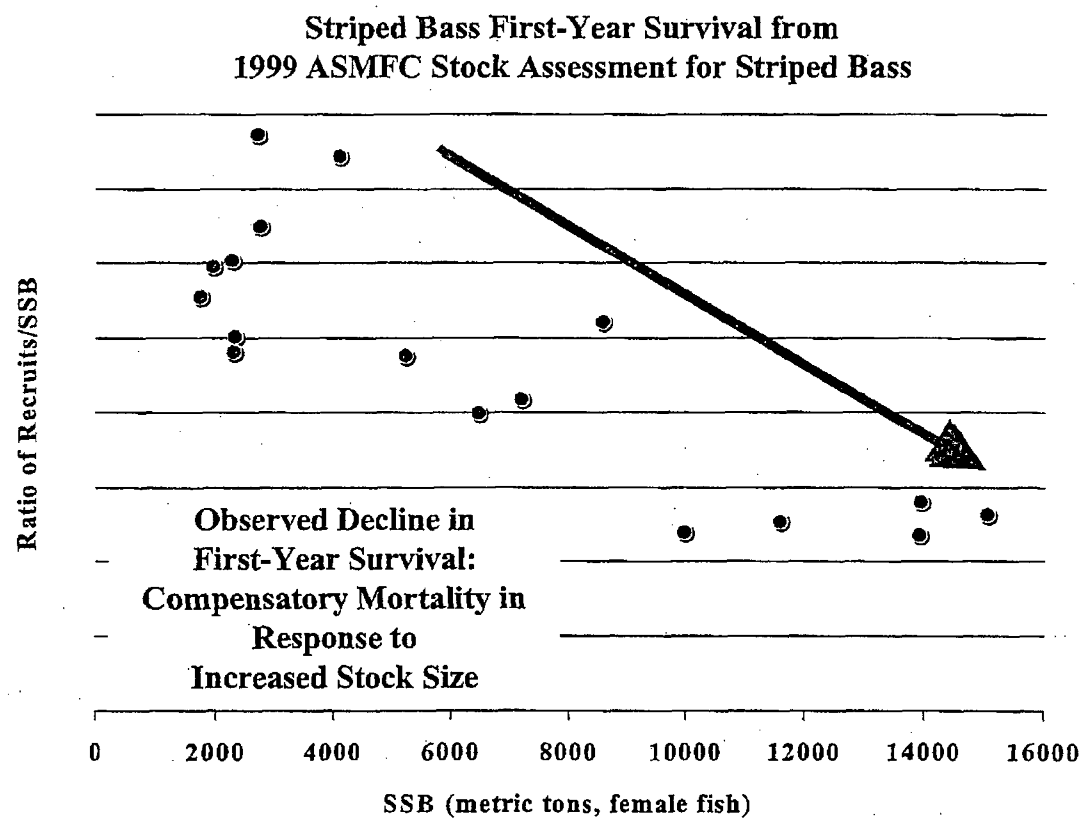

Figure IV-6. Ratio of number of striped bass recruits (age-1 fish in January) to the spawning stock biomass (SSB) of striped bass that generated the recruits (i.e., SSB from the previous calendar year) as an index of first-year survival. Data are from the Virtual Population Analysis presented in the August 1999 stock assessment report on striped bass prepared by the Atlantic States Marine Fisheries Commission (ASMFC, 1999).

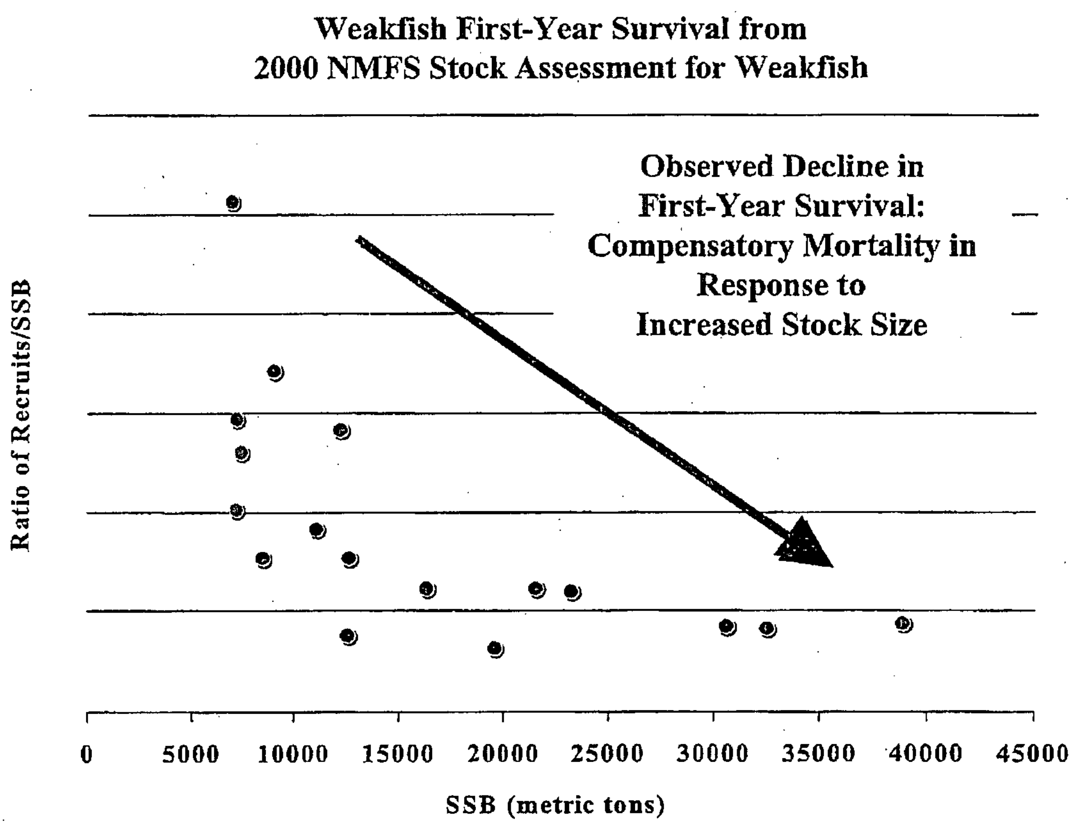

Figure IV-7. **Ratio of number of weakfish recruits (age-1 fish in January) to the spawning stock biomass (SSB) of weakfish that generated the recruits (i.e., SSB from the previous calendar year) as an index of first-year survival. Data are from the Virtual Population Analysis presented in the 30th Stock Assessment Review Committee report (NMFS, 2000).**

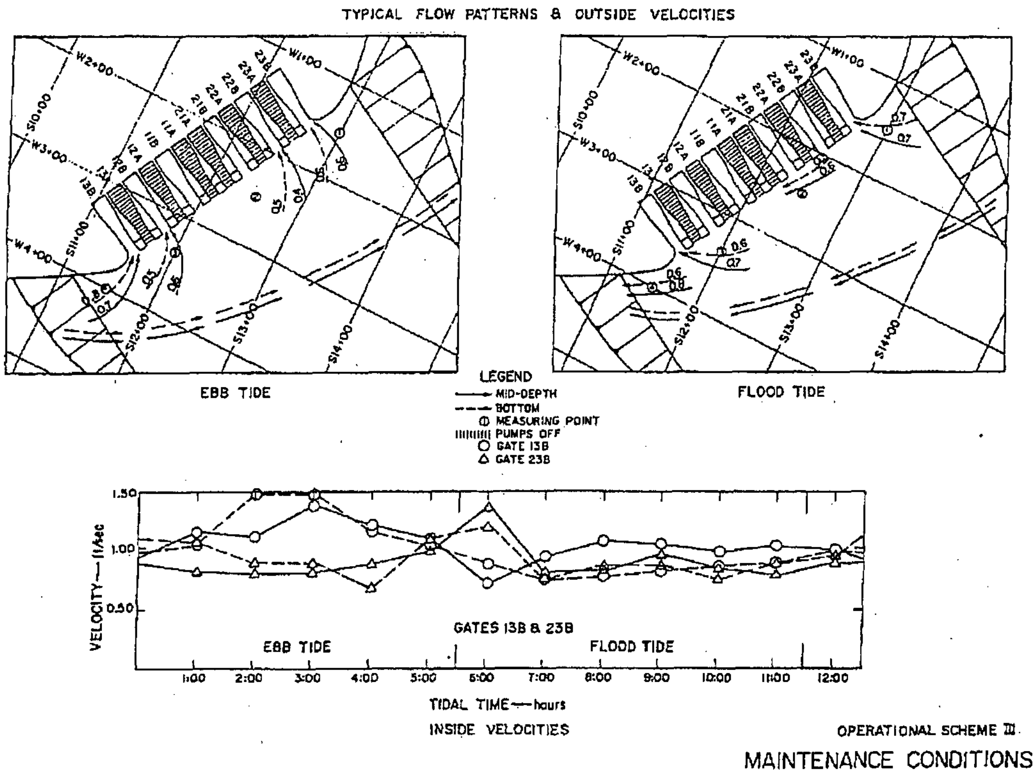

Figure IV-8. **Current patterns at the CWIS (HRS 1969).**

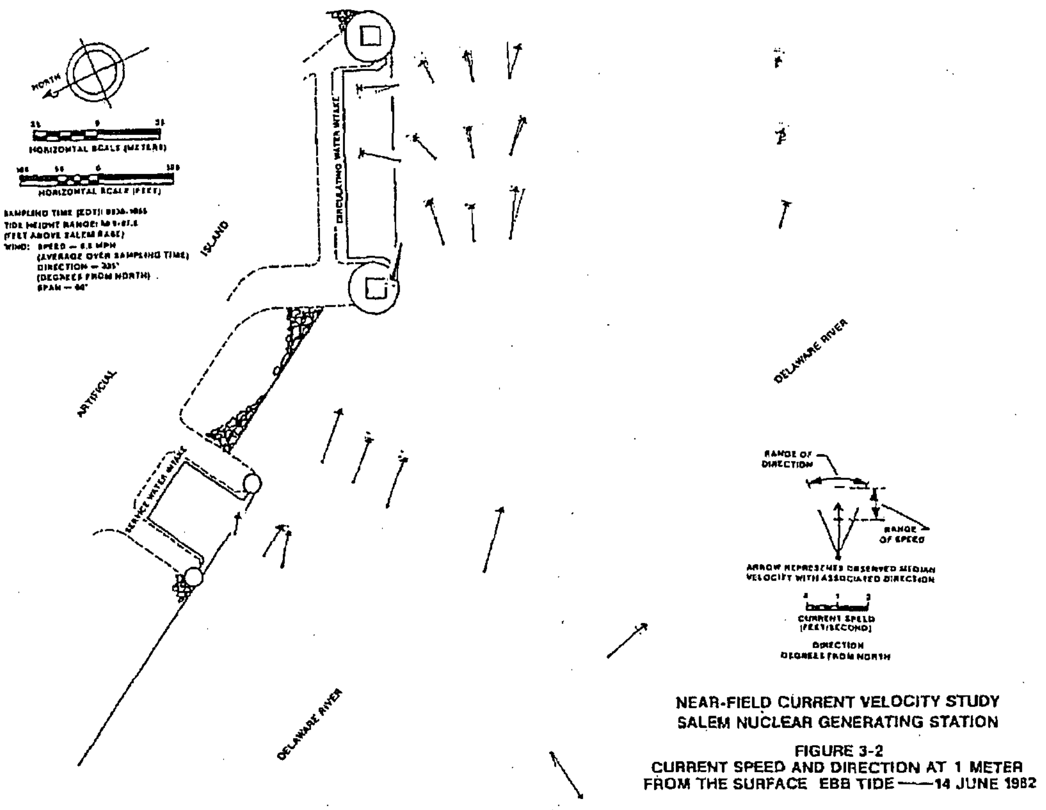

Figure IV-9 **Current patterns at the CWIS on an ebb tide (Weston 1982).**

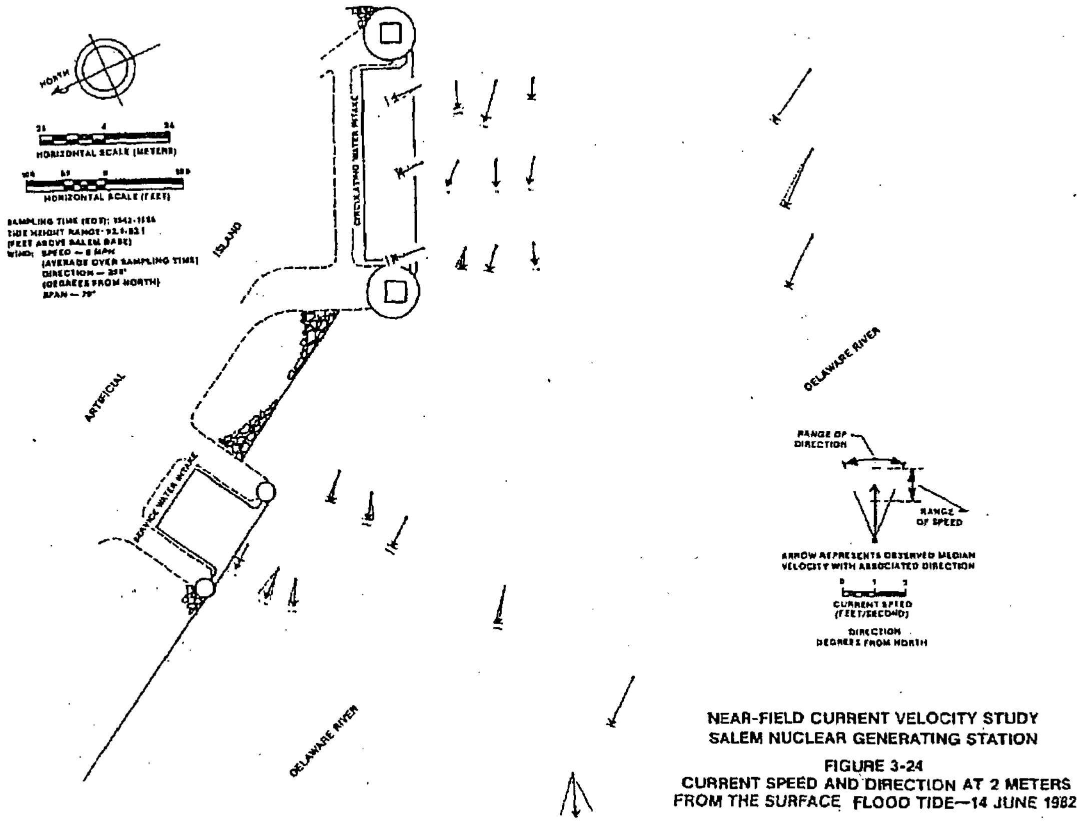

Figure IV-10 Current patterns at the CWIS on a flood tide (Weston 1982).

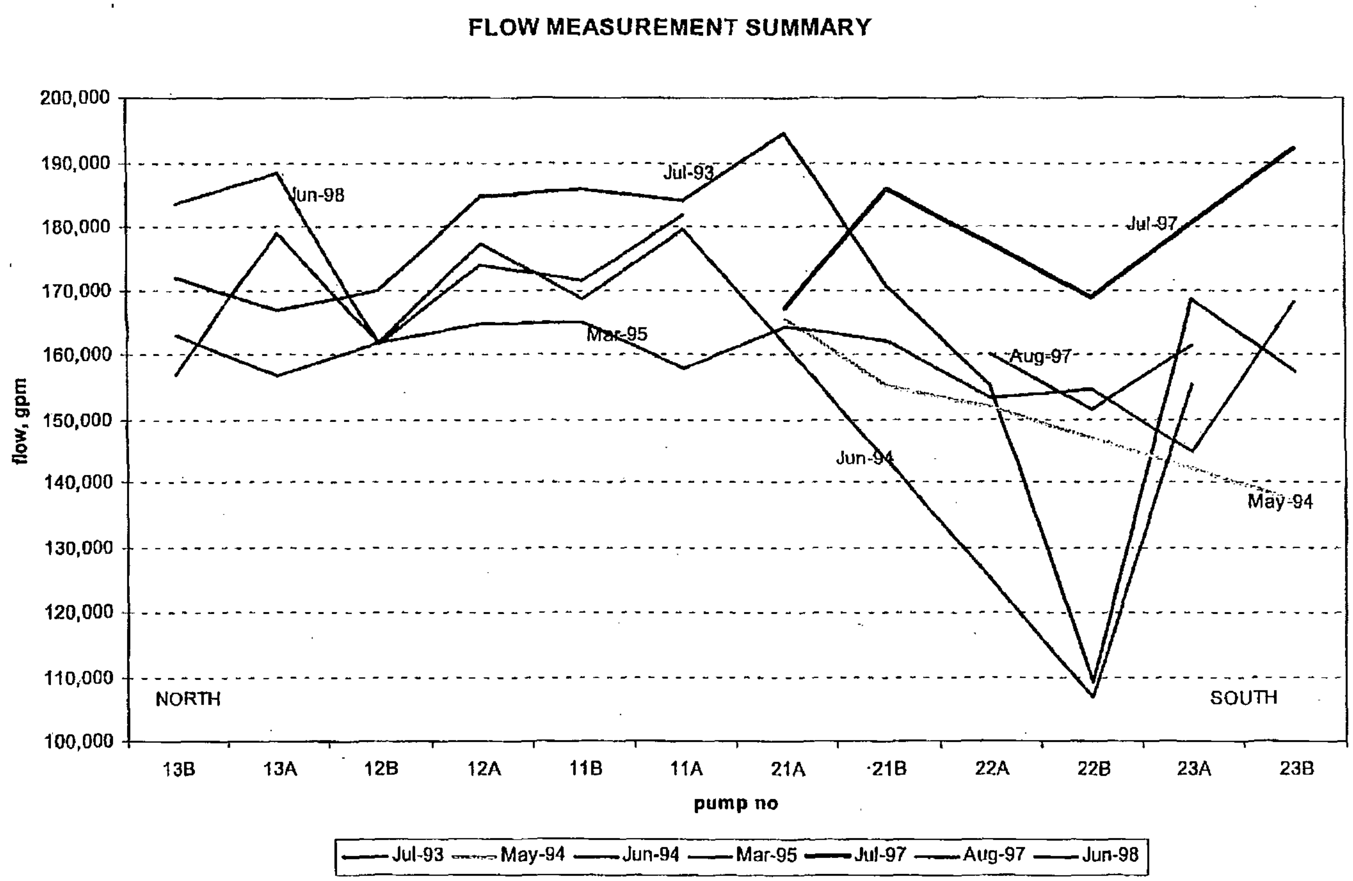
FLOW MEASUREMENT SUMMARY
200,000
190,000
180,000
170,000
160,000
150,000
140,000
130,000
120,000
110,000
100,000
flow, gpm
Jun-98
Jul-93
Jul-97
Mar-95
Aug-97
Jun-94
May-94
NORTH
SOUTH
13B
13A
12B
12A
11B
11A
21A
21B
22A
22B
23A
23B
pump no
Jul-93
May-94
Jun-94
Mar-95
Jul-97
Aug-97
Jun-98

Figure IV-11

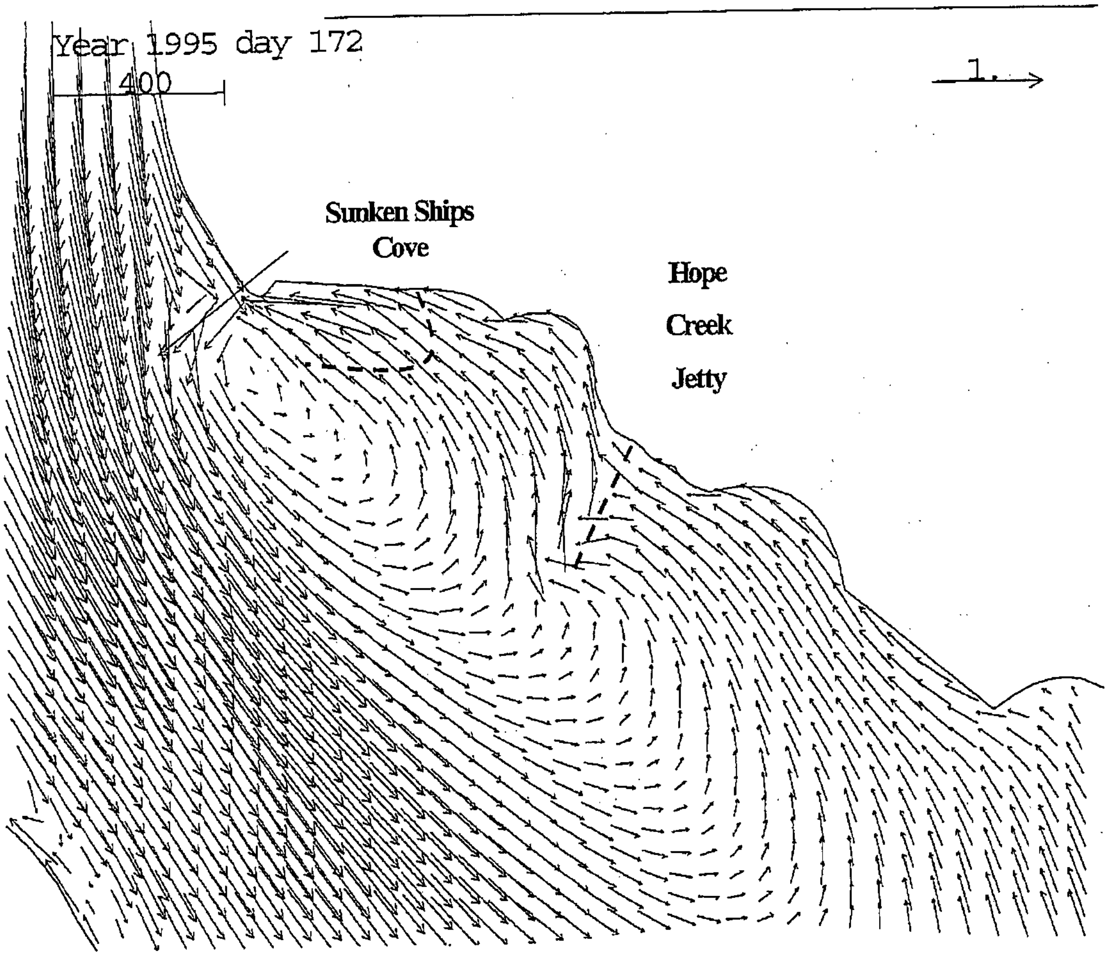

Figure IV-12

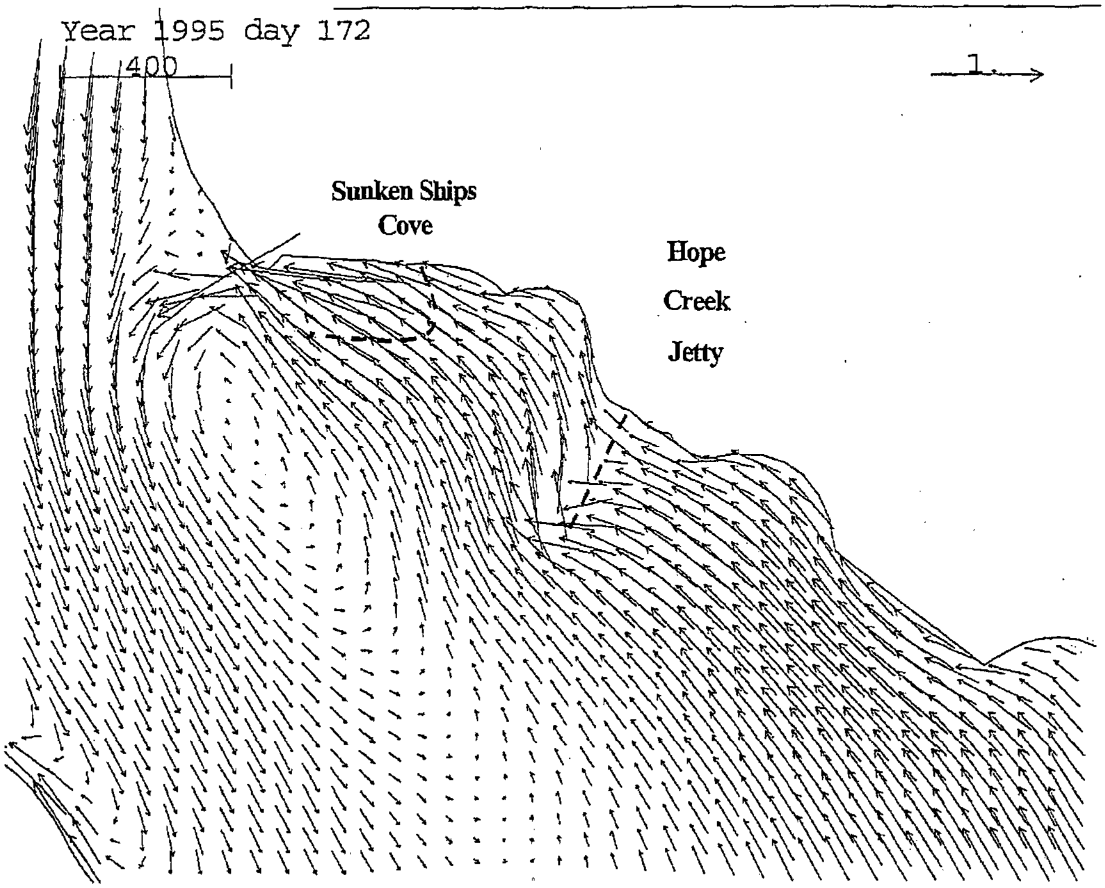

Figure IV-13. Offshore movement of the eddy-type motion shown in Figure 4 (15 minutes later) (WHG 1995b).

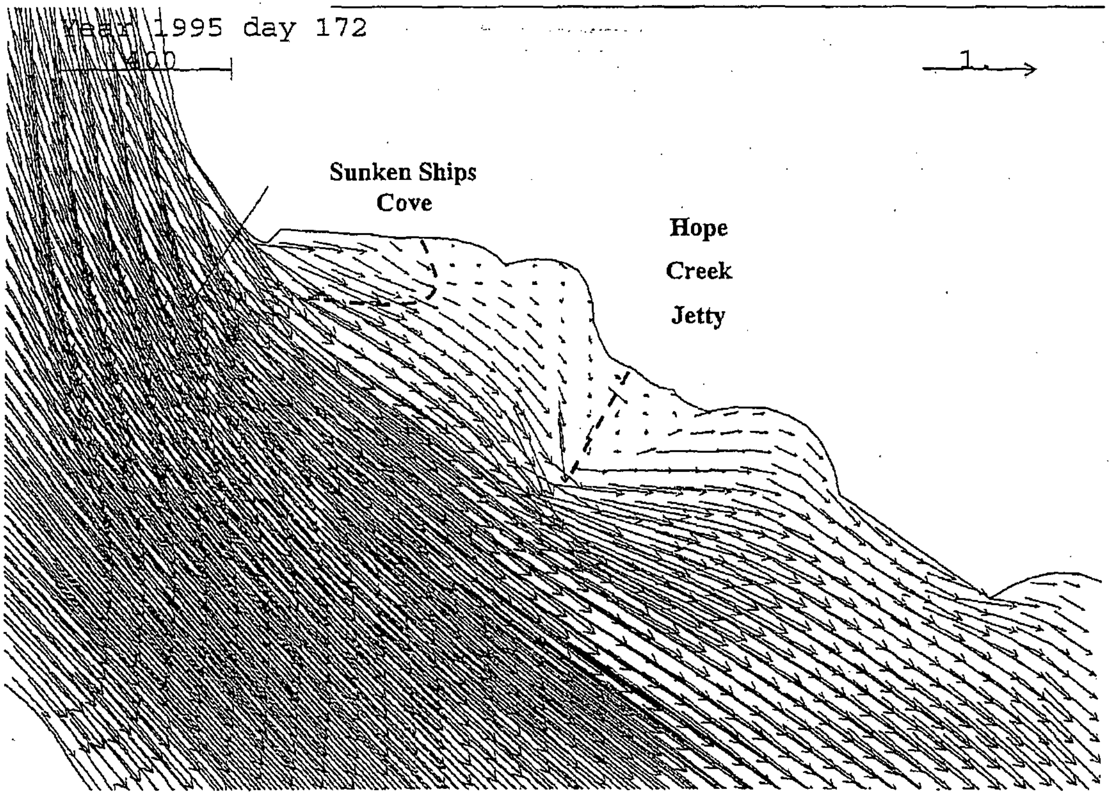

Figure IV-14. Ebb flow conditions in the Estuary when Hope Creek Jetty is dry (WHG 1995b).

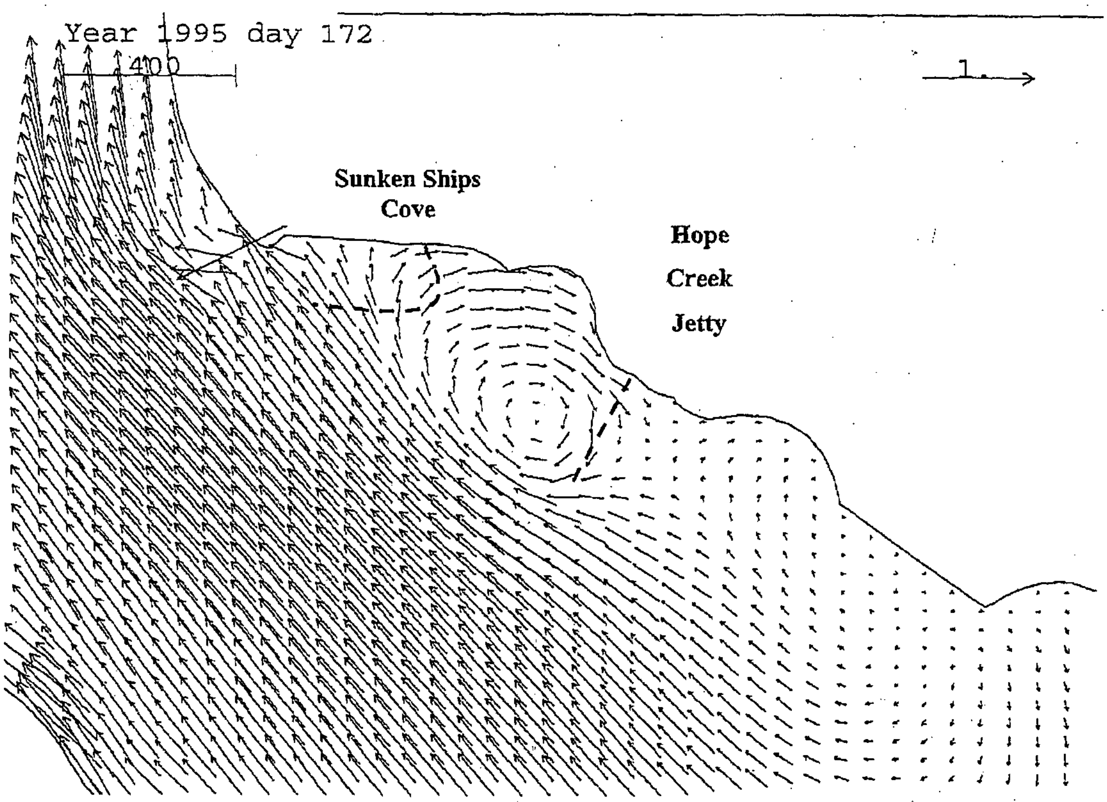

Figure IV-15. Eddy-like motion south of the Station during the change from flood to ebb tide (WHG 1995b).

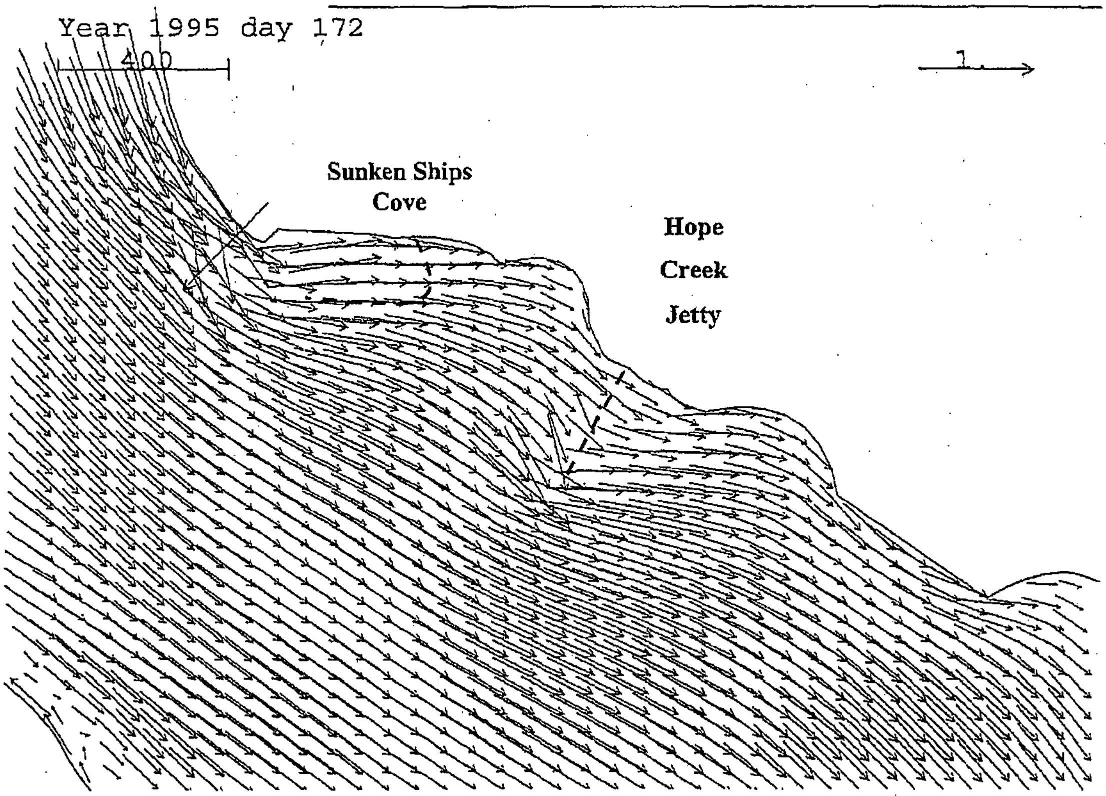

Figure IV-16. Typical ebb flow patterns during ebb tide when Hope Creek Jetty is wet (1995b).

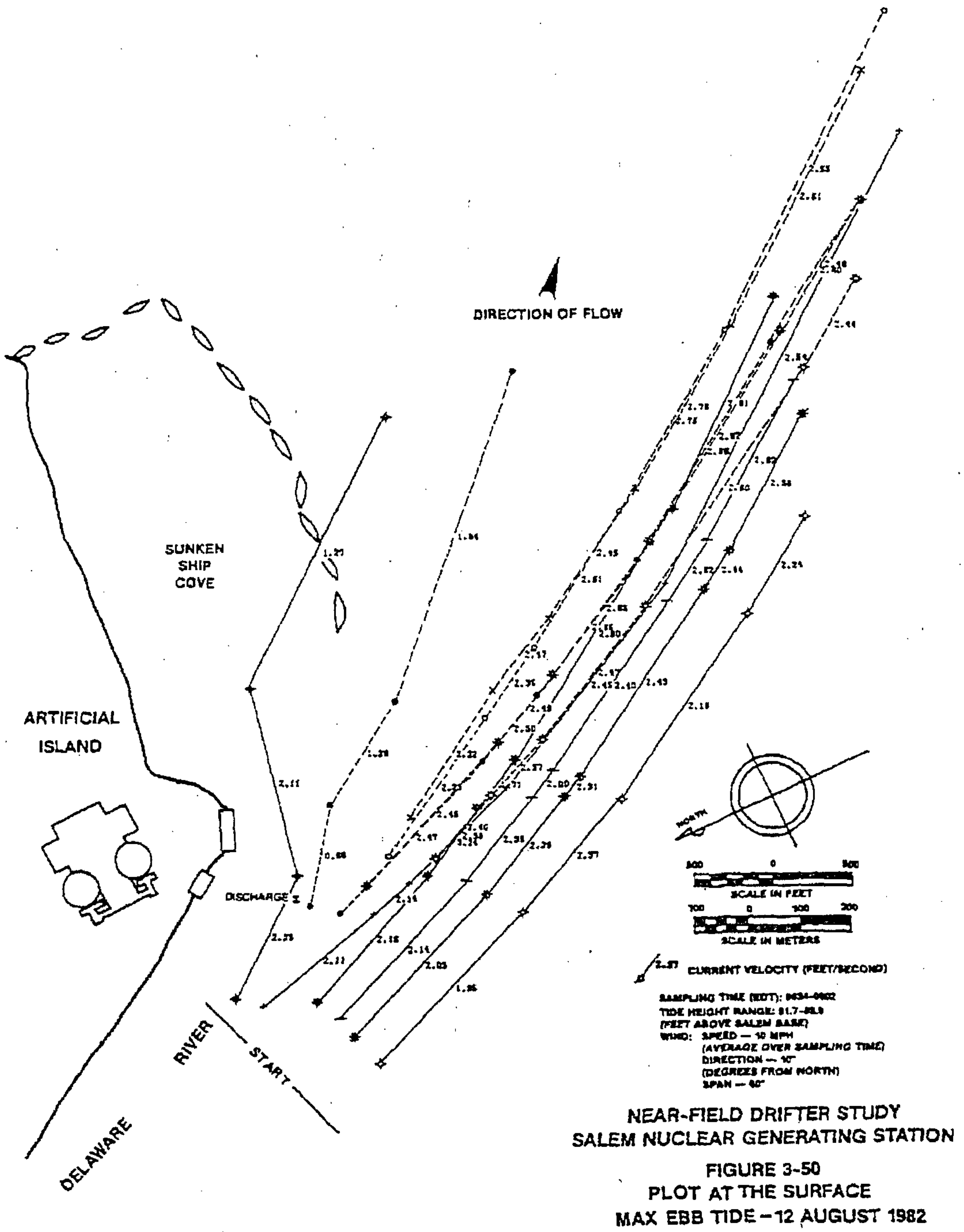

Figure IV-17. **Drifter/drogue tracks during ebb tide (Weston 1982).**

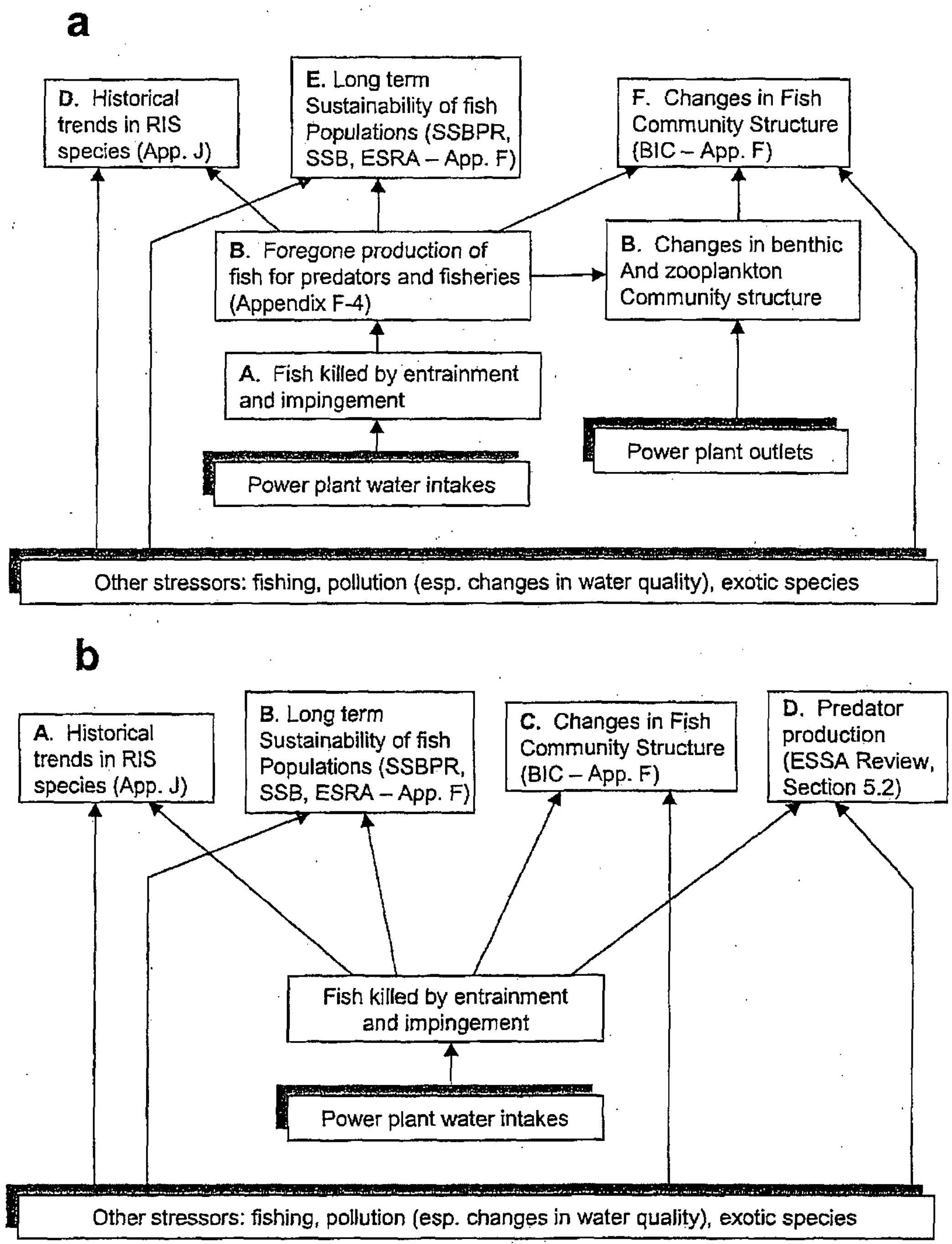

Figure VII-1. **Conceptual models of Station impacts. a. Model provided by ESSA as Figure 5.1 of its review. b. ESSA's model revised to focus in 316(b)-related impacts and to show correct relationship between station losses and potential assessment endpoints (EPA terminology) or benchmarks (PSEG terminology)**

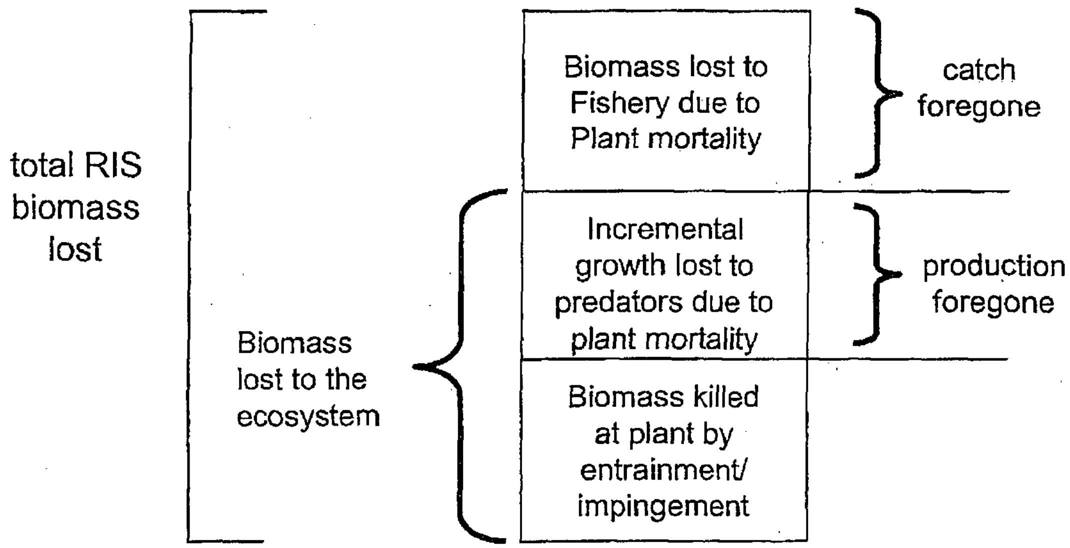

Figure VII-2. Components of ESSA's "Biomass Loss to the Ecosystem" indicator. (Figure 5.2 of the ESSA Report)

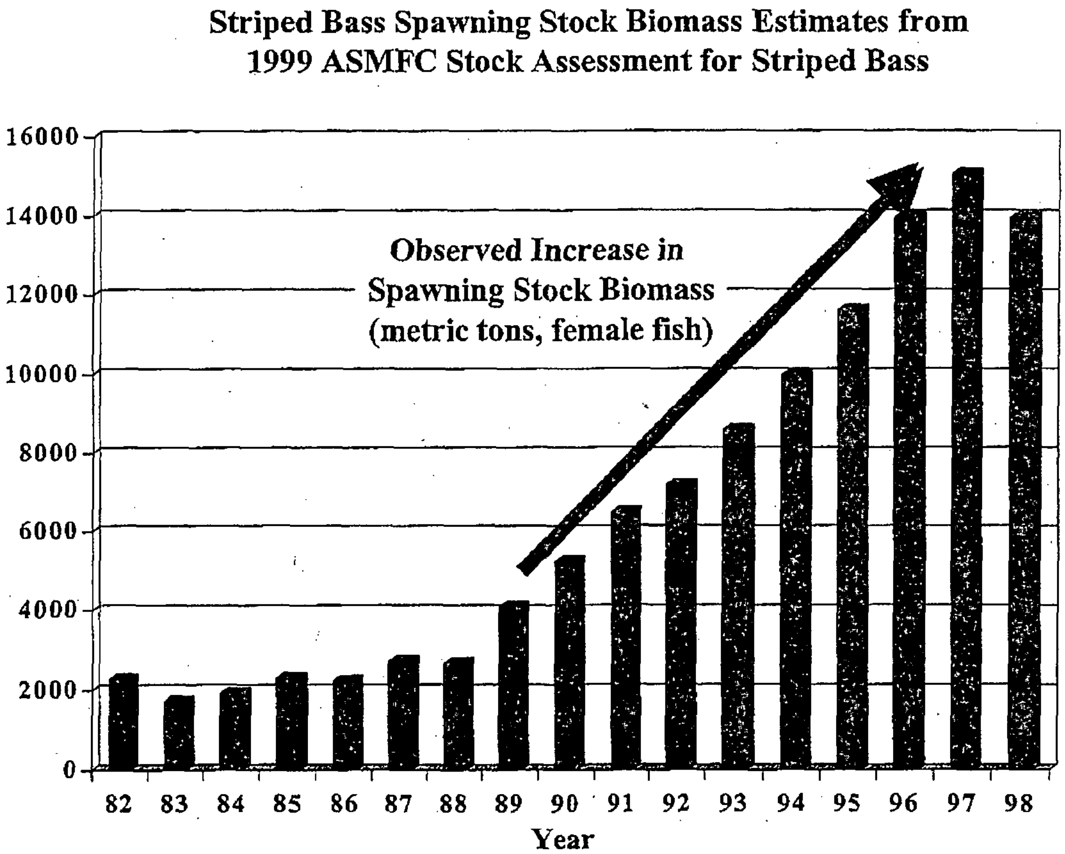

Figure VII-3. **Trend in spawning stock biomass of the east-coast stock of striped bass, showing increasing abundance since 1989. Data are from the Virtual Population Analysis presented in the August 1999 stock assessment report on striped bass prepared**

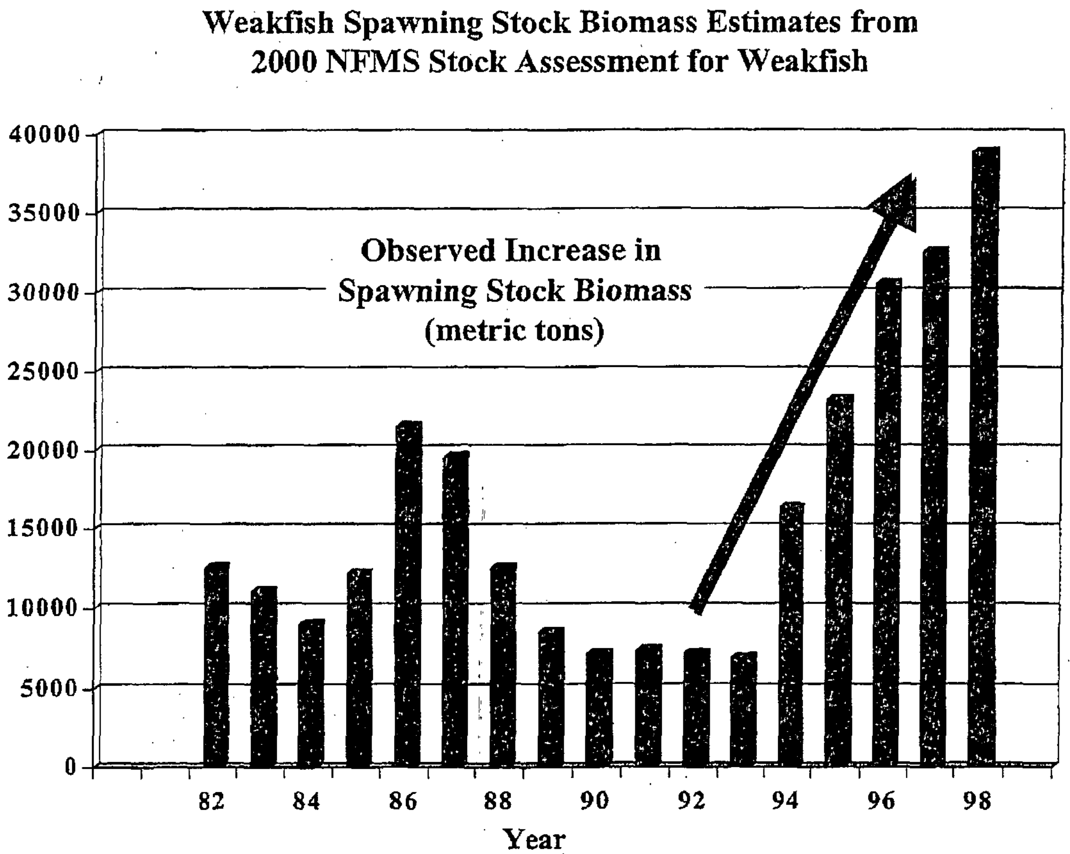

Figure VII-3b. **Trend in spawning stock biomass of the east-coast stock of weakfish, showing increasing abundance since the early 1990's. Data are from the Virtual Population Analysis presented in the 30th Stock Assessment Review Committee report (NMFS, 2000).**

**Production Foregone Due to Losses at Station
(consistent with ESSA presentation)**

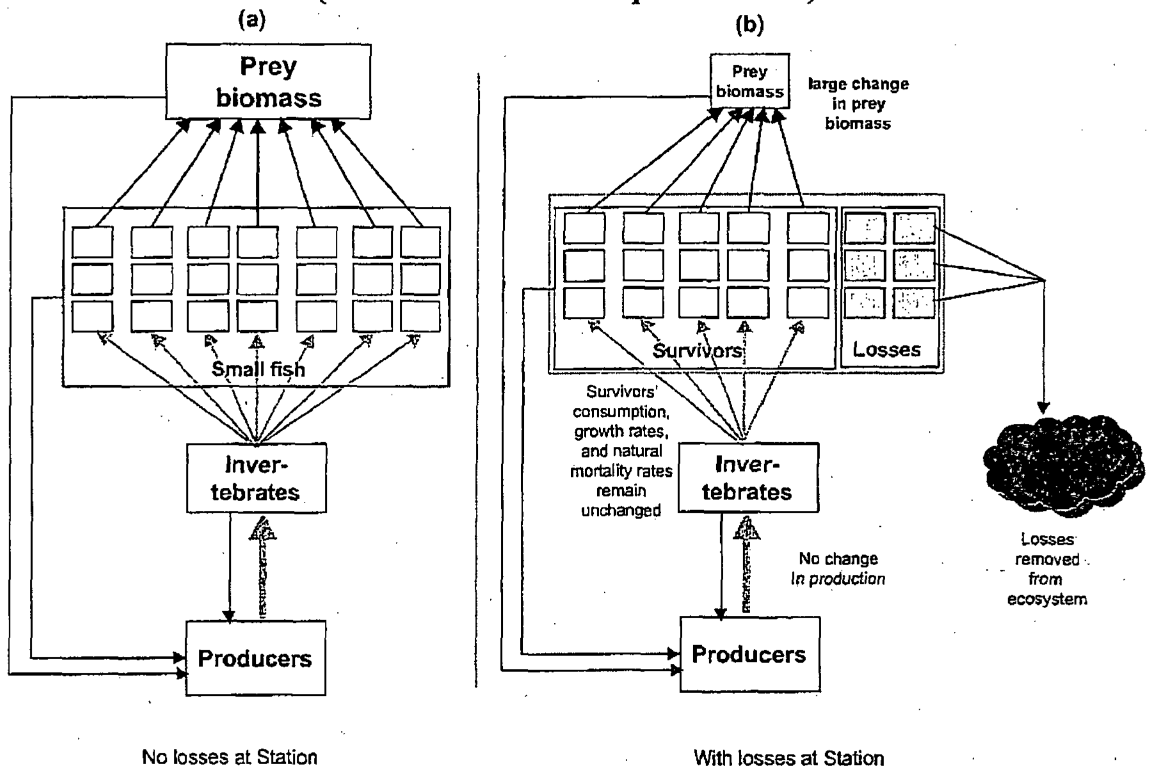

Figure VII-4a. (left-hand side). Simplified representation of an estuarine food web with small fish, that become prey to larger predatory fish, feeding on invertebrates that feed on primary production (e.g., plant material and decaying organic material). Arrows depict the flow of biomass through the food web.

Figure VII-4b. (right-hand side). Simplified representation of the food web with losses due to entrainment and impingement, and with the artificial condition of no recycling of the nutrients and energy from the lost biomass that is returned to the estuary, and with the artificial condition of no compensatory growth and survival due to the decrease in competition by small fish for available food items. Under the artificial conditions depicted in Figure 1b, the biomass of prey organisms available to larger predatory fish would be reduced due to the effects of entrainment and impingement.

Production foregone due to losses at Station reduced by compensation and recycling

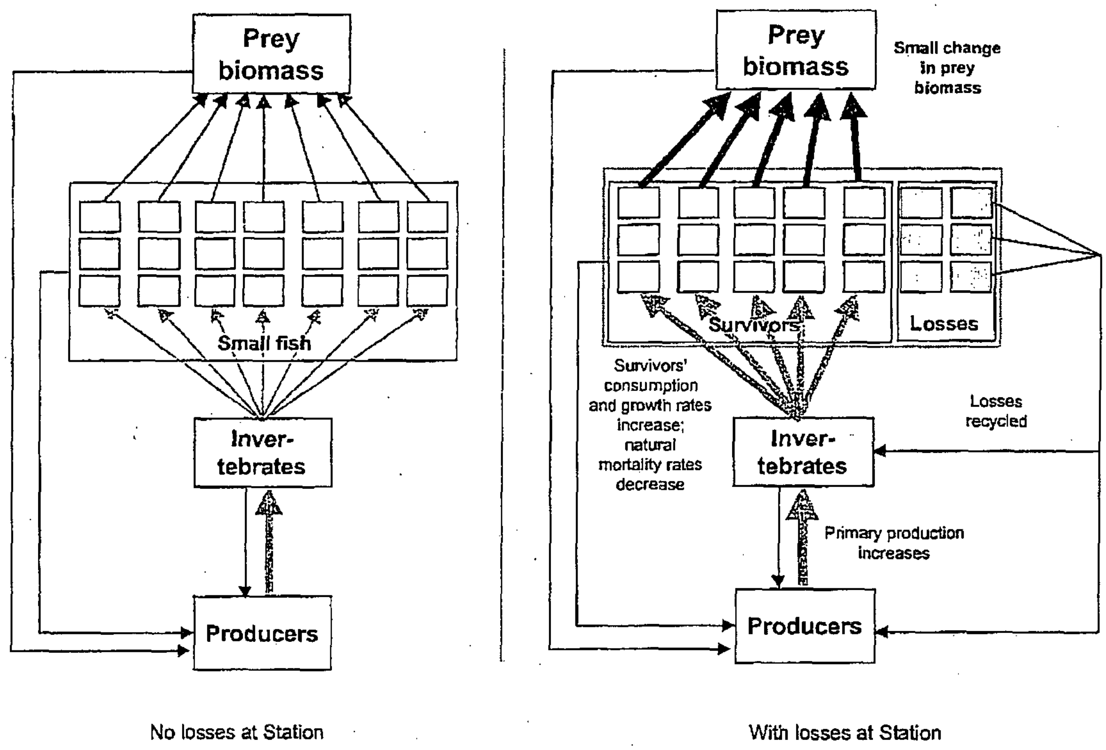

Figure VII-5a (left-hand side). Simplified representation of an estuarine food web with small fish, that become prey to larger predatory fish, feeding on invertebrates that feed on primary production (e.g., plant material and decaying organic material). Arrows depict the flow of biomass through the food web.

Figure VII-5b (right-hand side). Simplified representation of the food web with losses due to entrainment and impingement, and with natural recycling of the nutrients and energy from the lost biomass that is returned to the estuary, and with natural compensatory growth and survival due to the decrease in competition by small fish for available food items. Under the conditions depicted in Figure 2b, the biomass of prey organisms available to larger predatory fish would be reduced by only a small amount due to the effects of entrainment and impingement.

Table VII-6. Summary of Estimated Entrainment Losses for Historical Conditions

Year	White Perch Eggs	Weakfish Eggs
1991	0	0
1992	0	0
1993	0	380,347
1994	369,152	0
1995	0	1,366,532
1996	0	0
1998	566,785	15,047,333

Table VII-7. Summary of Estimated Impingement Losses for Age-1 White Perch for Historical and Base Case Conditions (historical loss estimates from Appendix L, and Base Case loss estimates from spreadsheet provided to ESSA for its review).

Year	Age-1 White Perch Impingement Loss Estimates	
	Historical	Base Case
1991	167,672	27,237
1992	269,266	43,721
1993	124,735	36,083
1994	55,243	25,735
1995	48,666	17,207
1996	4,960	19,579
1997	19,910	53,780
1998	17,141	30,978
Mean	88,449	31,790

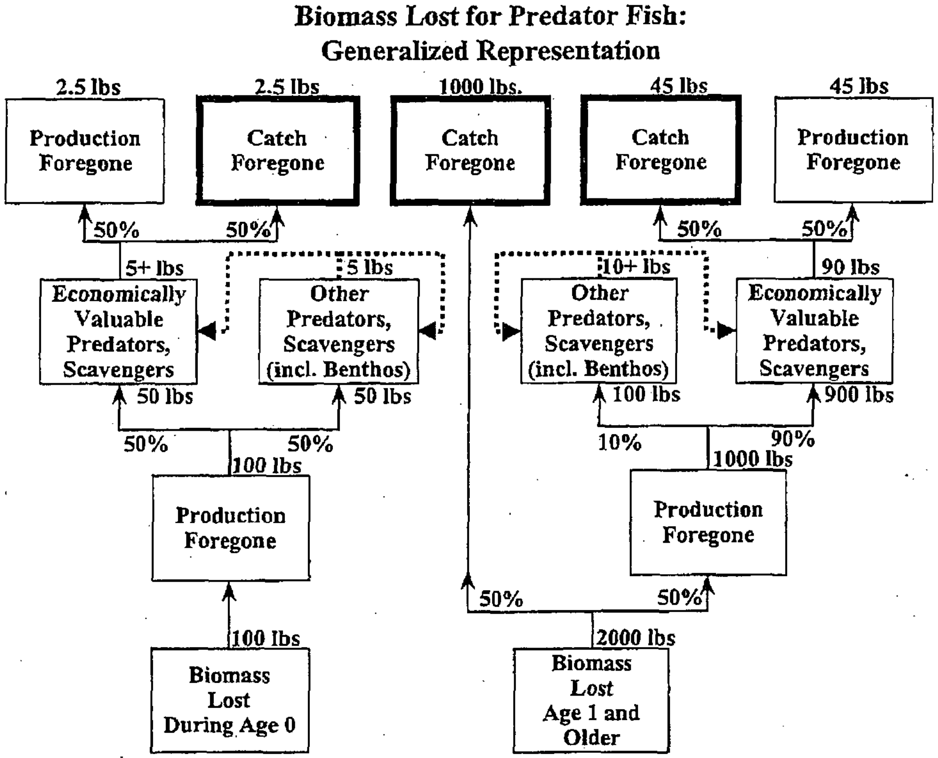

Figure VII-8. **Hypothetical example of biomass lost due to entrainment and impingement of predator fish showing catch foregone components used for Cost-benefit analyses (boxes with heavy outlines) in relation to other components of biomass lost. In this example, the total catch foregone is 1,047.5 pounds (the sum of 2.5 pounds, 1,000 pounds and 45 pounds). This catch foregone is derived from an initial total biomass lost of 2,100 pounds (the sum of 100 pounds biomass lost during Age-0 and 2,000 pounds of biomass lost subsequently). The difference between the pounds of catch foregone and the pounds of total biomass lost is due to transfers that occur through the food web.**

For this example, the following assumptions are made: 1) For Age-0 fish, 50% of natural mortality is assumed to be due to predation by economically valuable species, 2) For older fish, 90% of natural mortality is assumed to be due to predation by economically valuable species, 3) For fish at risk to the fishery (i.e., Age-1 recruits and older), the fishing mortality rate is assumed to be equal to the natural mortality rate so that 50% of mortality is due to fishing and 50% is due to natural mortality, 4) A 10% trophic transfer efficiency is assumed for this example so that 900 pounds of production consumed by predator fish produces 90 pounds of additional predator biomass, and 5) Transfer of production from "Other Predators" (dashed lines) does not materially contribute to catch foregone.

**Biomass Lost for Predator Fish:
ESSA's Spreadsheet**

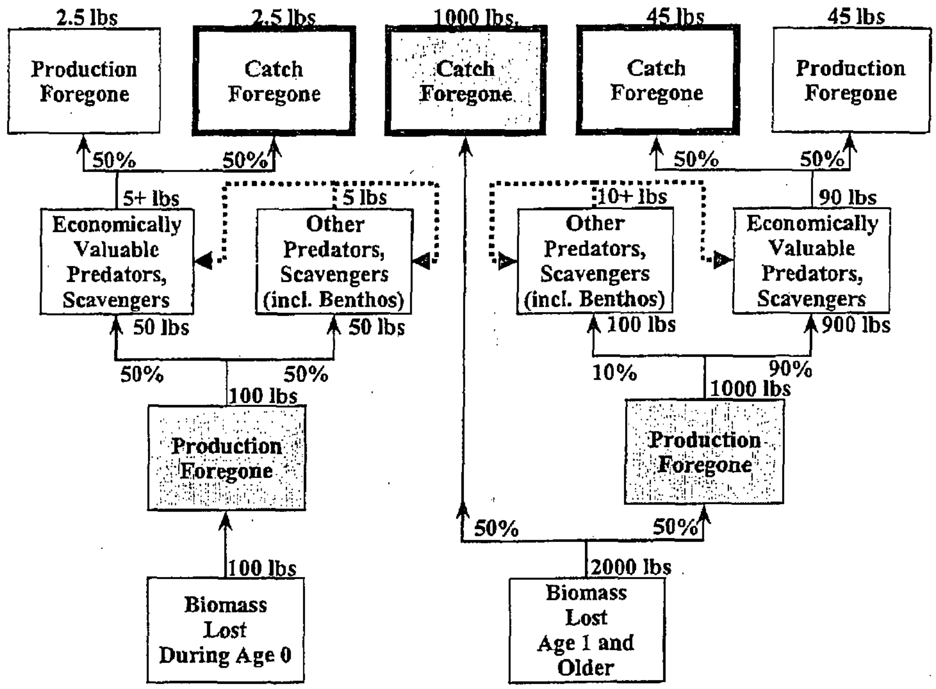

Figure VII-9. **Hypothetical example of biomass lost due to entrainment and impingement of predator fish from Figure 3 showing the components of biomass lost included in ESSA's Estimates of Total Biomass Lost (dark shaded boxes), in comparison to the catch foregone components required for the Cost-benefit analyses (boxes with heavy outlines). The biomass lost components depicted in ESSA's graph would sum to 2,100 pounds (100 + 1,000 +1,000), whereas the catch foregone components sum to only 1,047.5 pounds (2.5 + 1,000 + 45).**

For this example, the following assumptions are made: 1) For Age-0 fish, 50% of natural mortality is assumed to be due to predation by economically valuable species, 2) For older fish, 90% of natural mortality is assumed to be due to predation by economically valuable species, 3) For fish at risk to the fishery (i.e., Age-1 recruits and older), the fishing mortality rate is assumed to be equal to the natural mortality rate so that 50% of mortality is due to fishing and 50% is due to natural mortality, 4) A 10% trophic transfer efficiency is assumed for this example so that 900 pounds of production consumed by predator fish produces 90 pounds of additional predator biomass, and 5) Transfer of production from "Other Predators" (dashed lines) does not materially contribute to catch foregone.

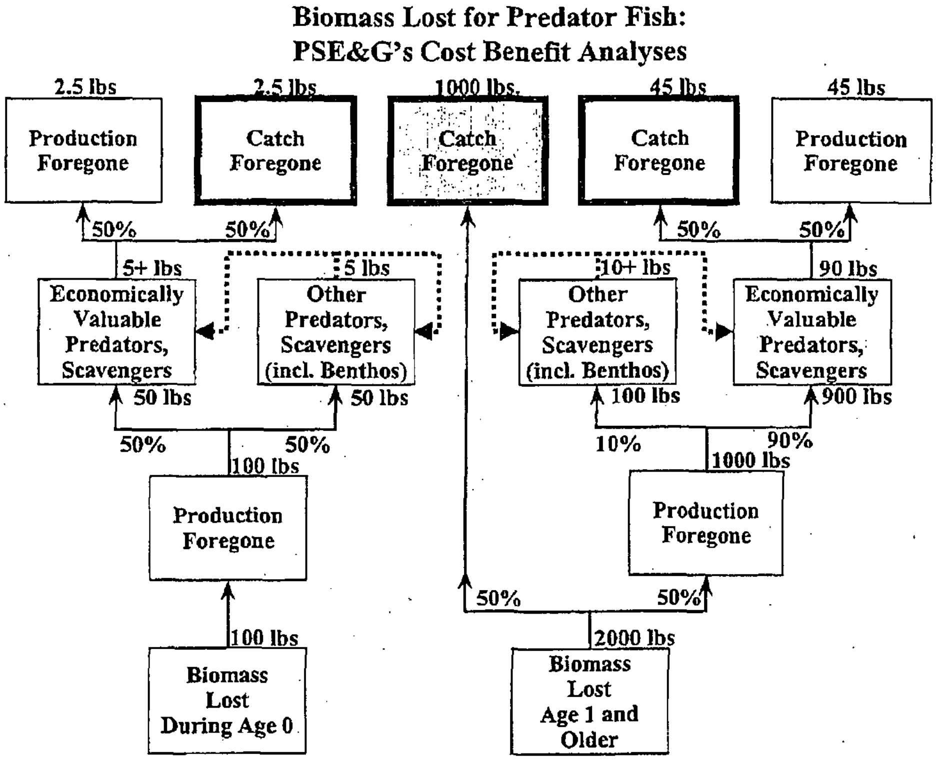

Figure VII-10. **Hypothetical example of biomass lost due to entrainment and impingement of predator fish from Figure 3 showing the components of biomass lost included in PSE&G's Cost-benefit analyses presented in the Application (dark shaded boxes), in comparison to the total catch foregone (boxes with heavy outlines). The catch foregone included in PSE&G's Application would be 1,000 pounds for this example, whereas the total catch foregone sums to 1,047.5 pounds (2.5 + 1,000 + 45). The methods used in the Application would have underestimated catch foregone by less than 5%.**

For this example, the following assumptions are made: 1) For Age-0 fish, 50% of natural mortality is assumed to be due to predation by economically valuable species, 2) For older fish, 90% of natural mortality is assumed to be due to predation by economically valuable species, 3) For fish at risk to the fishery (i.e., Age-1 recruits and older) the fishing mortality rate is assumed to be equal to the natural mortality rate so that 50% of mortality is due to fishing and 50% is due to natural mortality, 4) A 10% trophic transfer efficiency is assumed for this example so that 900 pounds of production consumed by predator fish produces 90 pounds of additional predator biomass, and 5) Transfer of production from "Other Predators" (dashed lines) does not materially contribute to catch foregone.

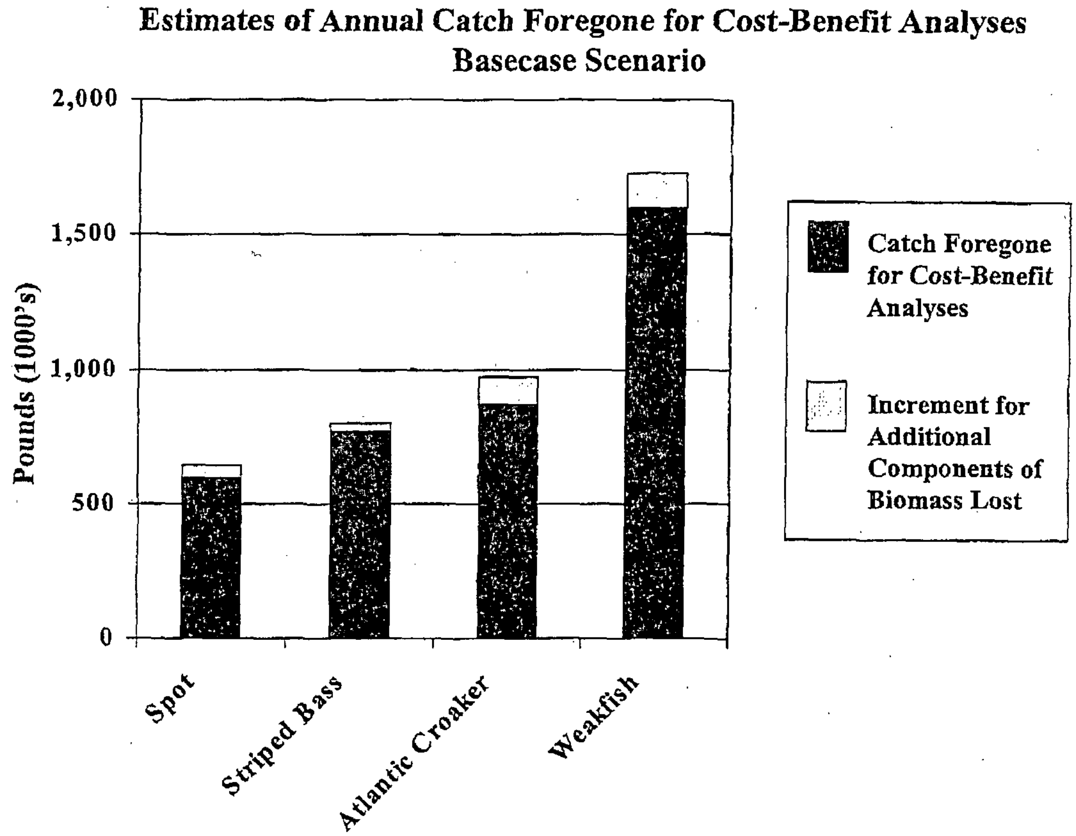

Figure VII-11. **Estimates of catch foregone for the Basecase scenario defined in the Application for the species with highest catch foregone estimates. Including all components of biomass lost in the estimates presented in the Cost-benefit analyses of the Application would increase the total catch foregone estimates slightly. For the estimates depicted in this graph, 90% of natural mortality was assumed to be due to predation by economically important species.**

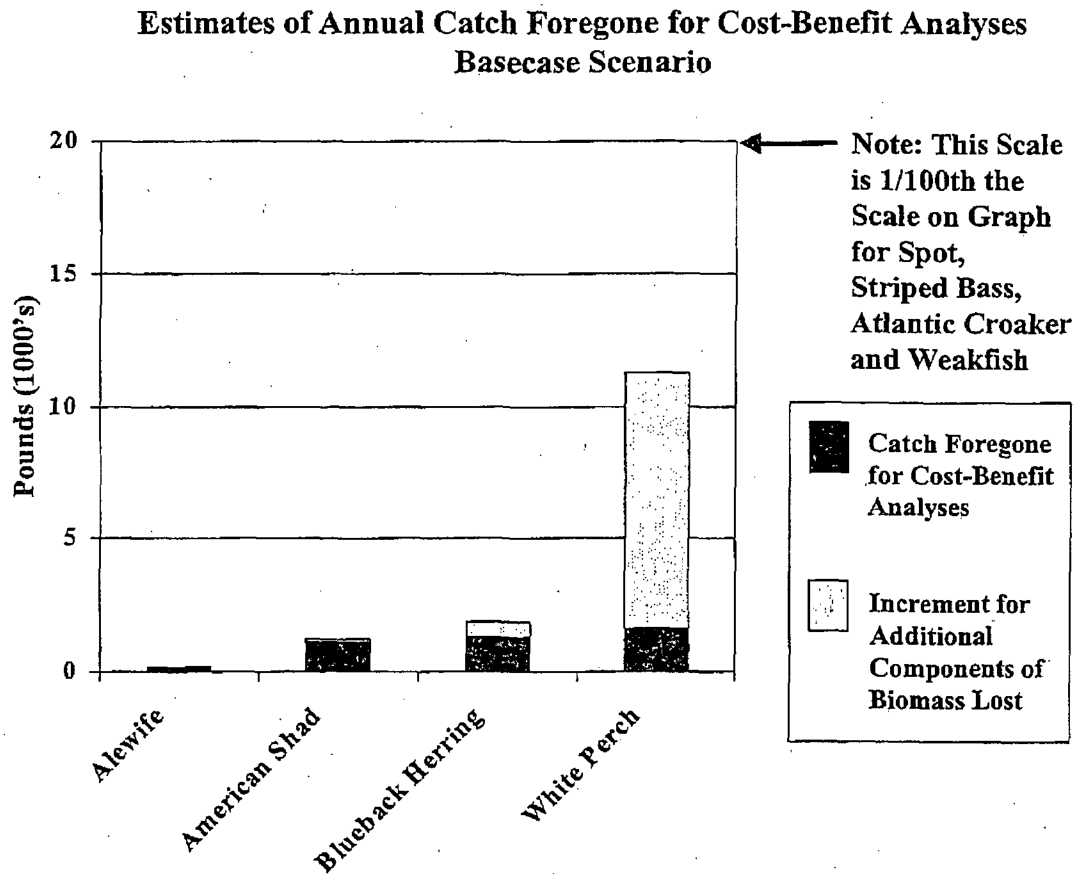

Figure VII-12. Estimates of catch foregone for the Basecase scenario defined in the Application for the four commercial and recreational species with lowest catch foregone estimates. Including the natural mortality, foregone components of production foregone in the estimates presented in the Cost-benefit analyses of the Application would increase the total harvest foregone estimates slightly. For the estimates depicted in this graph, 90% of natural mortality was conservatively assumed to be due to predation by economically important species. Note that the incremental increase for white perch is roughly 10,000 pounds, which would be barely visible if plotted on the graph of harvest-foregone estimates for the major species, and therefore would not materially affect the Cost-benefit assessment, which considers all RIS collectively.

**Biomass Lost for Forage Fish:
Generalized Representation**

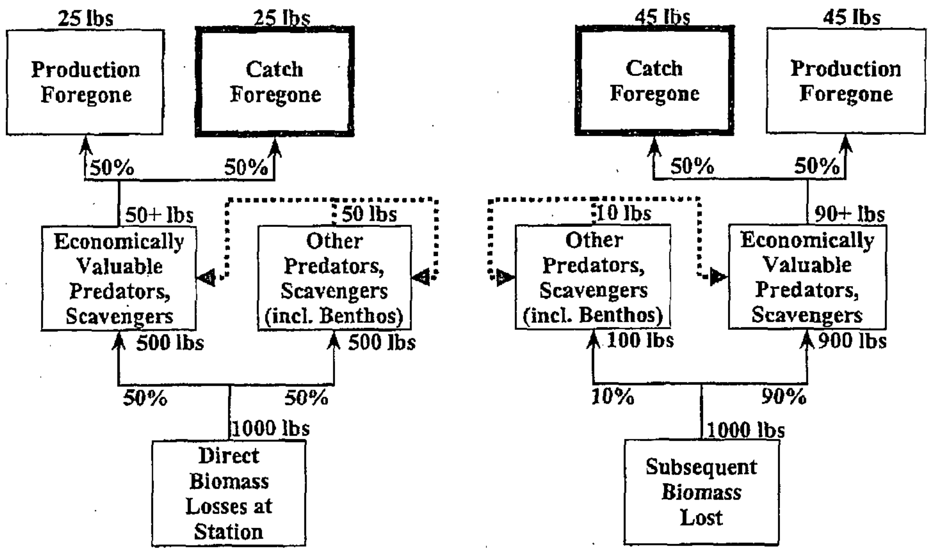

Figure VII-13. **Hypothetical example of biomass lost due to entrainment and impingement of forage fish showing catch foregone components used for Cost-benefit analyses (boxes with heavy outlines) in relation to other components of biomass lost. In this example, the total catch foregone is 70 pounds (the sum of 25 pounds and 45 pounds). This catch foregone is derived from an initial total biomass lost of 2,000 pounds (the sum of 1,000 pounds of direct biomass lost at the Station and 1,000 pounds of subsequent biomass lost). The difference between the pounds of catch foregone and the pounds of total biomass lost is due to transfers that occur through the food web.**

For this example, the following assumptions are made: 1) For direct biomass lost at the Station, 50% of natural mortality is assumed to be due to predation by economically valuable species, 2) For subsequent biomass lost, 90% of natural mortality is assumed to be due to predation by economically valuable species, 3) For fish at risk to the fishery, the fishing mortality rate is assumed to be equal to the natural mortality rate so that 50% of mortality is due to fishing and 50% is due to natural mortality, 4) A 10% trophic transfer efficiency is assumed for this example so that 1,000 pounds of production consumed by predator fish produces 100 pounds of additional predator biomass, and 5) Transfer of production from "Other Predators" (dashed lines) does not materially contribute to catch foregone.

**Biomass Lost for Forage Fish:
ESSA's Spreadsheet**

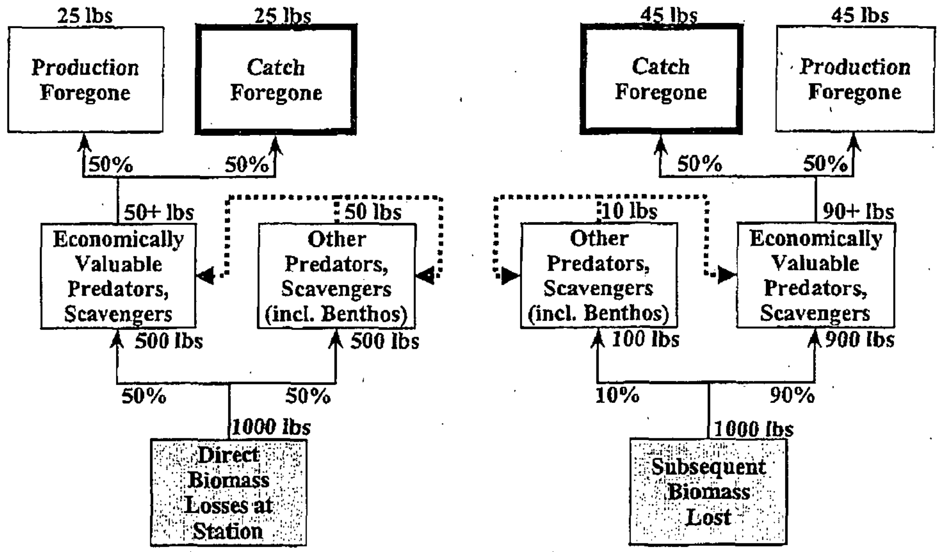

Figure VII-14. Hypothetical example of biomass lost due to entrainment and impingement of forage fish from Figure 7 showing the components of biomass lost included in ESSA's Estimates of Total Biomass Lost (dark shaded boxes), in comparison to the catch foregone components required for the Cost-benefit analyses (boxes with heavy outlines). The biomass lost components from ESSA's spreadsheet would sum to 2,000 pounds (1,000 +1,000), whereas the catch foregone components sum to only 70 pounds (25 + 45).

For this example, the following assumptions are made: 1) For direct biomass lost at the Station, 50% of natural mortality is assumed to be due to predation by economically valuable species, 2) For subsequent biomass lost, 90% of natural mortality is assumed to be due to predation by economically valuable species, 3) For fish at risk to the fishery, the fishing mortality rate is assumed to be equal to the natural mortality rate so that 50% of mortality is due to fishing and 50% is due to natural mortality, 4) A 10% trophic transfer efficiency is assumed for this example so that 1000 pounds of production consumed by predator fish produces 100 pounds of additional predator biomass, and 5) Transfer of production from "Other Predators" (dashed lines) does not materially contribute to catch foregone.

**Biomass Lost for Forage Fish:
PSE&G's Cost-Benefit Analyses
(Not Adjusted for Exploitation Rate)**

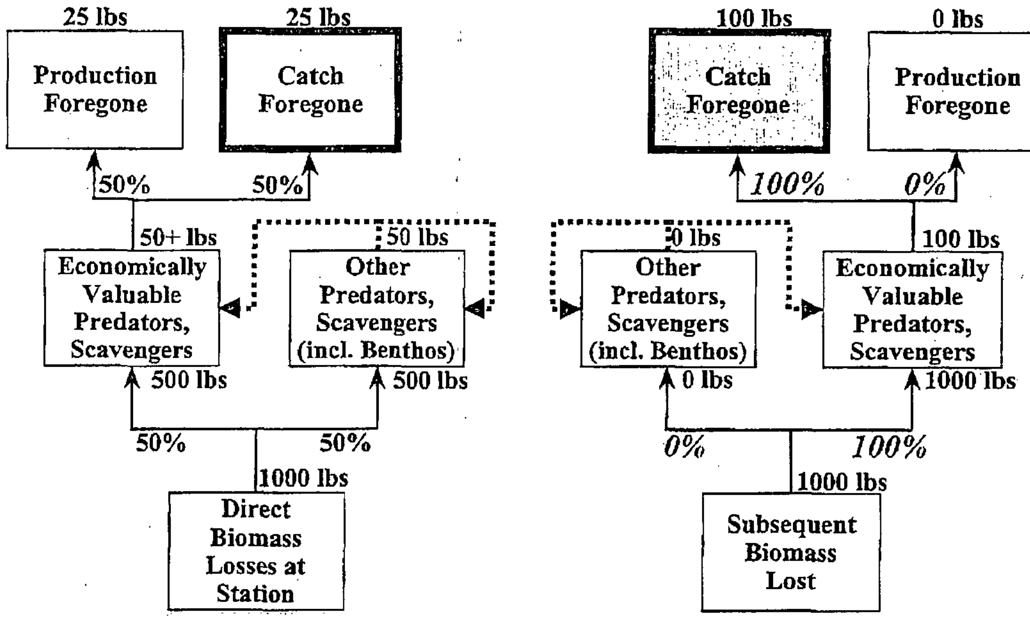

Figure VII-15 **Hypothetical example of biomass lost due to entrainment and impingement of predator fish from Figure 7 showing the components of biomass lost included in PSE&G's Cost-benefit analyses presented in the Application (dark shaded boxes), in comparison to the total catch foregone (boxes with heavy outlines). The method used in the Application would overestimate the catch foregone due to assumptions regarding exploitation rates and trophic pathways, and produce an estimate of 100 pounds of catch foregone (rather than the correct value, for this example, of 70 pounds shown in Figure 7). In the Application, it was assumed that economically valuable predators would have consumed all production foregone subsequent to the loss at the station. Furthermore, it was assumed that all of the resulting production of predators would be harvested by the fishery (i.e., exploitation rate = 100%). Again, a 10% trophic transfer efficiency was assumed so that 1,000 pounds of production consumed by predator fish produced 100 pounds of additional predator biomass.**

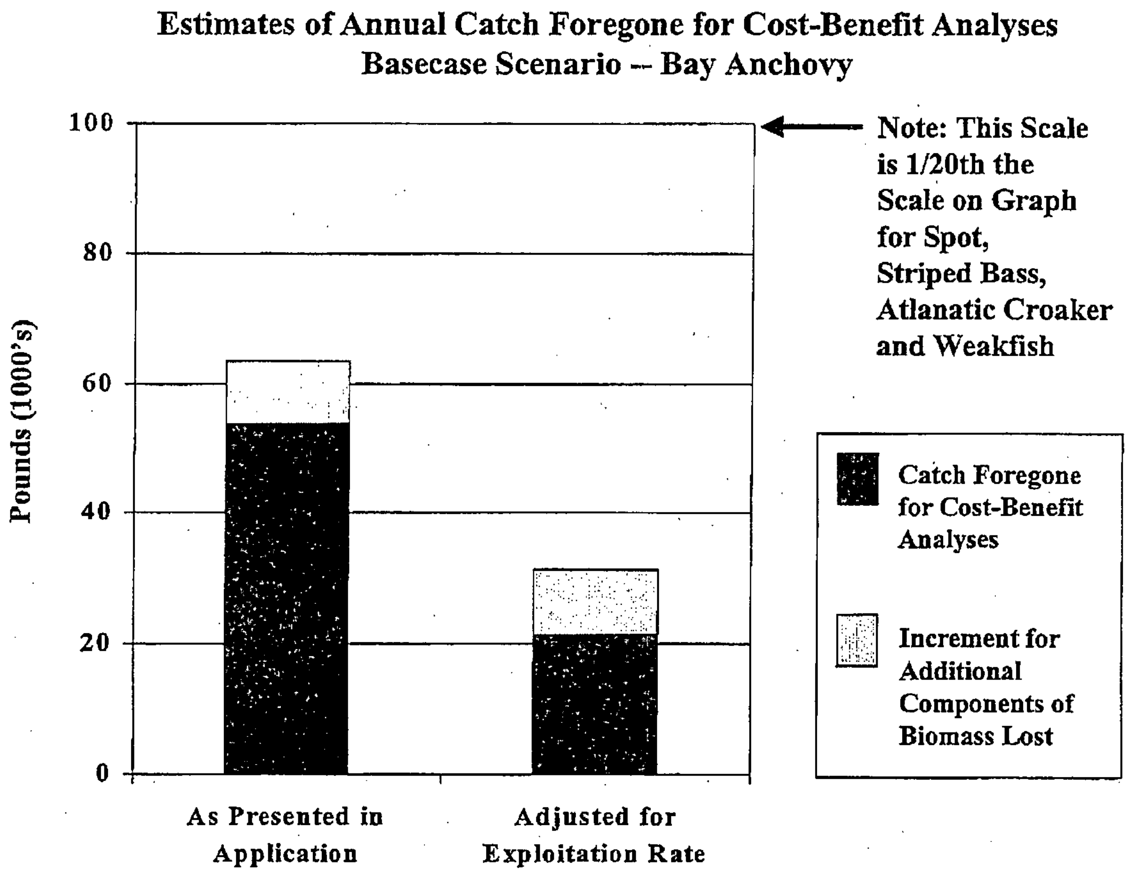

Figure VII-16. Estimates of catch foregone for bay anchovy for the Basecase scenario defined in the Application. Including the direct biomass lost component in the estimates presented in the Cost-Benefit analyses of the Application would increase the total catch foregone estimate for bay anchovy by roughly 10,000 pounds. However, when the method is adjusted to properly account for the exploitation rate being less than 100% (based on fishing mortality rates for the major predator species as described in the Application), and to account for some predation being by non-economically valuable species (as in Figure 7), then the total catch foregone (including the components associated with biomass lost to entrainment and impingement) is almost 20,000 pounds less than the amount reported in the Application.

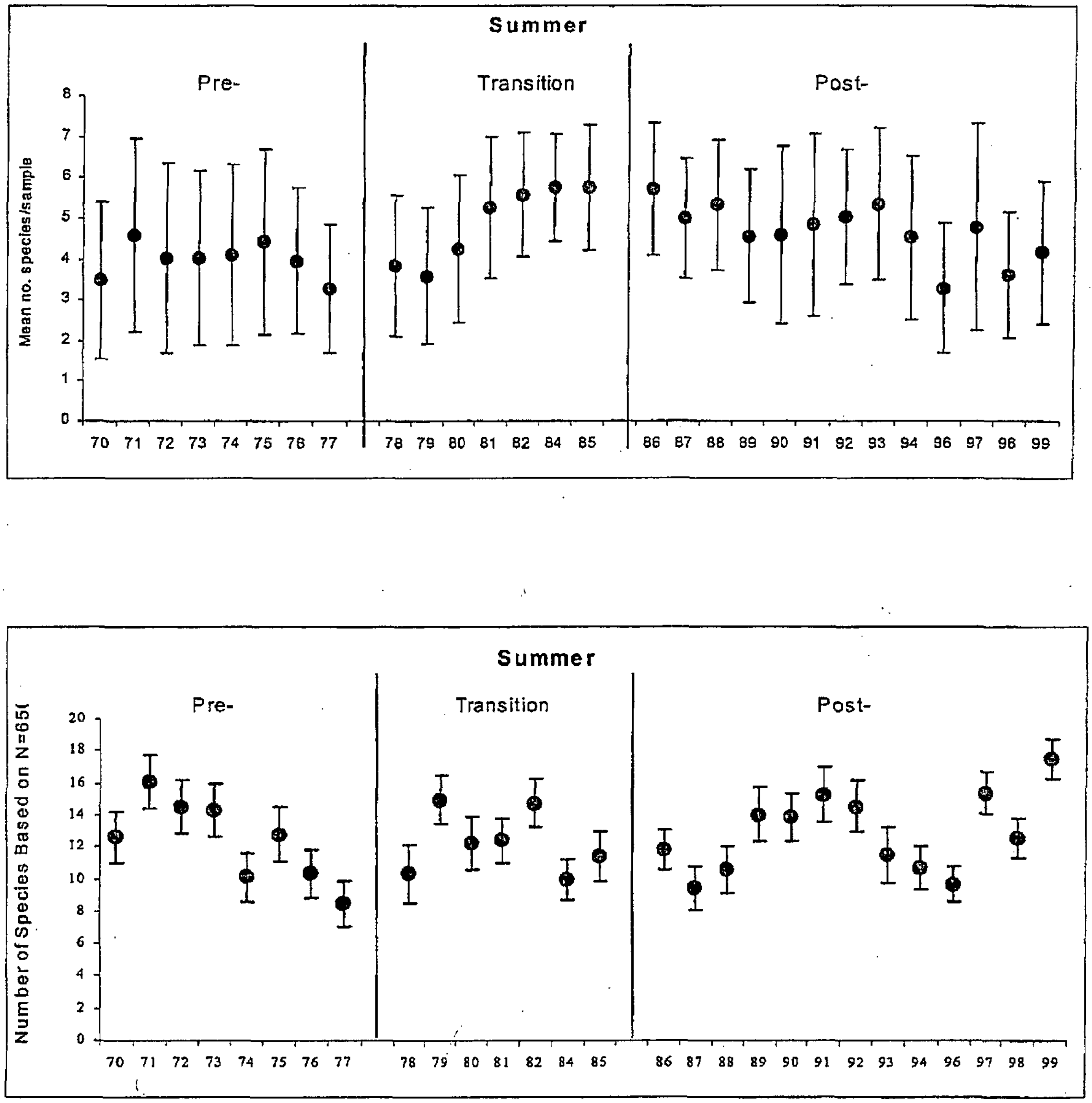

Figure VII-17. **Species richness (upper panel) and species density (lower panel) in the nearfield region, 1970 through 1999. No response to the 1996-1997 shutdown is apparent. Only the summer season is shown; results for spring and fall are similar.**

Table VII-18. **Average catch per haul values from Table 2 of Weisberg, et.al. (1996).**

Year	CPH
1986	58.23
1987	73.27
1988	61.37
1989	106.38
1990	43.55
1991	74.59
1992	29.94
1993	186.27

Table VII-19. Summary of sample sizes (i.e., total number of hauls) for tests of trends and differences.

Species	Sampling Program		
	DNREC Juvenile Trawl Survey	**NJDEP Beach Seine Survey**	**PSEG Nearfield Trawl Survey**
Atlantic croaker	617	1,317	203
American shad		892	
Alewife	858	593	203
Bay anchovy	4,143	1,317	1,458
Blueback herring	858	892	
Striped bass	1,634	1,317	1,464
Spot	3,109	917	1,201
Weakfish	1,876	425	743
White perch	667	892	203

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Weisberg, S. B.; H.T. Wilson; P. Himchak; T. Baum, and R. Allen. Temporal trends in abundance of fish in the tidal Delaware River. Estuaries. 1996; 19(3):723-729.

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Attachments

List of Attachments to PSEG's Comments on Draft NJPDES Permit No. NJ0005622
March 14, 2001

I. Responses to DNREC Report

A. Rebuttal to Accusations and Response to Technical Criticisms raised in "Comments on Appendix F of the PSE&G Permit Application for Salem 4 March 1999", Letter to D. Hart from R.E. Selover, February 18, 2000.

B. Response to the DNREC's Assessment of the impact of Entrainment and Impingement by the Salem Nuclear Generating Station on Delaware River Striped Bass, Letter to D. Hammond, Chief from J.H. Balletto, August 25, 2000.

C. PSEG Response to Memorandum to Andrew Manus from Desmond Kahn, Ph.D., December 15, 2000.

II. Supplemental Information Provided to NJDEP

A. Response to Request for Supplemental Analyses – Letter to Assistant Commissioners Hart and Wild from R.E. Selover, Analysis of Cost and Benefits to a Revised Fueling Schedule for Salem Generating Station, July 28, 2000.

B. Supplemental Response to Request for Information – Letter to Assistant Commissioners Hart and Wild, from R.E. Selover, September 14, 2000, transmitting three attachments:

Attachment I:	Potential Biases in Benefit Estimates Associated with the Week 21 Refueling Outage Schedule.
Attachment II:	Effect of Shifting Salem Outage on Electric Supply System Reliability
Attachment III:	Impacts of Revised Salem Refueling Schedules on Wholesale and Retail Electric Markets

C. Letter to S.T. Rosenwinkel from M.F. Vaskis, Response to ESSA's Presentation of Preliminary Findings from Its Review of PSE&G's March 1999 Permit Renewal Application for Salem Generating Station. May 17, 2000.

D. 1999 Site Status Report for Submission to the NJDEP - Land Use Regulation Program Alloway Creek Watershed Phragmites–Dominated Wetland Restoration Site, Salem County, NJ. June 30, 2000.

E. 1999 Site Status Report for Submission to the NJDEP - Land Use Regulation Program Cohansey River Watershed Phragmites-Dominated Wetland Restoration Site, Cumberland County, NJ. June 30, 2000.

F. 1999 Site Status Report for Submission to the NJDEP - Land Use Regulation Program Dennis Township Salt Hay Farm, Cape May County, NJ. June 30, 2000

G. 1999 Site Status Report for Submission to the NJDEP - Land Use Regulation Program Commercial Township Salt Hay Farm, Cumberland County, NJ, June 30, 2000

H. 1999 Site Status Report for Submission to the NJDEP - Land Use Regulation Program Maurice River Township Salt Hay Farm, Cumberland County, NJ, June 30, 2000

I. Salem Generating Station Proposed Biological Monitoring Plan Presentation: Monitoring Advisory Committee, June 22, 2000

III. Supplemental Information Provided to ESSA

A. Technical Review of Salem Permit Application Kick-off Meeting – PSE&G's Role, November 8, 1999.

B. Letter to S. T. Rosenwinkel from J.H. Balletto, SAS Code and Data sets used to Estimate CMR's in EEIM and ETM Models, December 22, 1999

C. Letter to S. T. Rosenwinkel from J.H. Balletto, Video of Flume Tests, December 23, 1999

IV. Miscellaneous Wetlands Reports

A. Horseshoe Crab Habitat Use at the Maurice River Township Salt Hay Restoration Site in Delaware Bay, New Jersey. October 27, 2000.

B. Toxicological Hazard and Risk Assessment of Glyphosate and LI700 ® in Association with Marsh Restoration in the Delaware Estuary. Keith R. Solomon and Leonard Ritter, March 2001.

V. Technology Alternative

A. Preliminary Engineering Evaluation of Dry Cooling Options for Salem Generating Station, James M. Nicholson. Stone & Webster Engineering Corporation, March 2001.

VI. PSEG Response to Third Party Comments

Salem/ Hope Creek Environmental Audit – Post-Audit Information

Question #: ENV-101 **Category:** Ecology

Statement of Question: Please provide the following documents that were made available during the Salem and HCGS License Renewal Environmental Audit:

A 1999 Salem NJPDES Permit Application, Vols 10-13, Appendix E

B 1999 Salem NJPDES Permit Application, Vols 14-15, Appendix F

Response: The documents requested are being provided.

List Attachments Provided:

A PSE&G. *Salem Generating Station Permit No. NJ0005622 Renewal Application*, Volume 10, "Appendix E, §316(a) Demonstration." March 4, 1999.

PSE&G. *Salem Generating Station Permit No. NJ0005622 Renewal Application*, Volume 11, Appendix E, Exhibits 1 and 2. March 4, 1999.

PSE&G. *Salem Generating Station Permit No. NJ0005622 Renewal Application*, Volume 12, Appendix E, Exhibits 3, 4, and 5. March 4, 1999.

PSE&G. *Salem Generating Station Permit No. NJ0005622 Renewal Application*, Volume 13, Appendix E, Attachments E-2, E-3, and E-4. March 4, 1999.

B PSE&G. *Salem Generating Station Permit No. NJ0005622 Renewal Application*, Volume 14, Appendix F and Appendix F Attachments 1 through 4. March 4, 1999.

PSE&G. *Salem Generating Station Permit No. NJ0005622 Renewal Application*, Volume 15, Appendix F Attachments 5 through 16, and Appendix G. March 4, 1999.