United States Department of the Interior 50-286

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

In reply refer to:
ER 71/193

MAY 10 1973

Dear Mr. Muller:

This is in response to your letter of March 20, 1973, which transmitted Supplement Nos. 4 and 5 to the environmental report for Indian Point Nuclear Generating Station, Unit 3, Westchester County, New York.

The combination of fresh water and tidal flows in the vicinity of the plant site is a complex phenomenon which makes modeling and computation of expected thermal effects extremely difficult and open to doubt and manipulation. Only actual measurement of operational temperatures will determine if a different outfall design will be needed; however, based on the Atomic Energy Commission's staff position and this Department's position on the closed cycle method of cooling for Unit 2, we would strongly suggest that this unit also use a closed cycle cooling system, especially if additional units are contemplated at this site.

We hope these comments will be helpful to you in the preparation of the draft environmental statement.

Sincerely yours,

Assistant Secretary of the Interior

Mr. Daniel R. Muller
Assistant Director for
Environmental Projects
Directorate of Licensing
Atomic Energy Commission
Washington, D. C. 20545

2120

Regulatory File Cy.

Docket No. 50-286

COMMENTS ON THE ORNL ROUGH DRAFT OF INDIAN POINT UNIT NO. 3 FOR THE PRELIMINARY DES

I. General Comments

The ORNL team assembled a very rough first draft of the PDES the latter part of April. A second rough draft was assembled on May 11, 1973 and was reviewed by the ORNL Review Board on May 14-15, 1973. Extensive comments were received by the Review Board and the second draft is in the process of being revised. The same draft of May 11, 1973 was reviewed by Mr. Knighton and M. J. Oestmann at ORNL on May 22-23, 1973. Our comments follow.

The total document needs extensive reworking as it is in a very, very rough shape. I was astounded to see the lack of progress made in the preparation of the PDES at this point in time. Much of what was presented or what was missing should have been finished months ago. This includes Sections I, II, IV, VIII, IX which should have involved primarily a summary of what was presented in the FES for IP-2 plus a relatively minor amount of additional information regarding IP-3. This should have been a straight-forward effort with very little information required from Con Ed to complete the work. Nothing had been written in Sections VII and VIII.

Regarding Section III, I felt that a reasonably good job had been done on the thermal discharge section. However, we are still waiting to receive the revised section on the radwaste description from ETSB. The EPM has received a number of source terms on the radioactive releases from the three units because of the confusion regarding what really is the existing system as compared to what Con Ed has described in the FSAR and ER and supplements.

Section V, the most critical section which establishes the basis of the conclusions of the DES, was in the worst condition I have ever seen. Much of the information in the FES for IP-2 was all but ignored. The specific points of factual evidence developed by Goodyear should have been identified and the incremental impact on these issues from operation of IP-3 should have been evaluated and discussed. In the corresponding appendix, no computer codes should be presented; however, the mathematical

equations which are represented by the computer codes should be presented. It appeared that Van Winkle discounted much of the major concerns Goodyear presented in the FES. Yet extensive additional information developed by Goodyear on the various subjects in rebuttal testimony should have been brought into this presentation since much of it was not in the FES and should now be included in the DES for IP-3.

On the whole Section X - Need for Power was an interesting discussion of the applicant's service system, but the need and the timing of that need of IP-3 was not emphasized in this Section. Of primary concern at the IP-3 prehearing conference, was the need for power, the timing for the power from the plant and the consideration of reduced power, particularly during critical times of the year prior to the possible operation of the plant with a closed-cycle cooling system.

Some of the material presented in the text should be presented in an appendix and some of the material in the appendix should be deleted as not required in the DES. Only a sketchy listing of the references used was provided.

Specific details follow. However, extensive comments were written on the individual pages of the rough draft. On the whole, an extensive full time effort will have to be exerted by ORNL to prepare an acceptable document which I believe the AEC has a right to expect of ORNL. From what I can see, to accomplish the job of preparing an acceptable document, ORNL would require another two months starting the latter half of the month of May. To say the least, I was very disappointed with the status of this document at this point in time. Much of the work has already been done in connection with the FES, rebuttal testimony, etc. for IP-2. This should have been a relatively easy job to do using the FES as a guide along with the guides to prepare the environmental report and impact statement. The IP-3 PDES should generally follow the same format as was used for the IP-2 FES; however, the April Guide to prepare impact statements can be used wherever appropriate for this situation.

II. Specific Comments

Chapter I Introduction

A. Site Selection - Information of the factors for site selection such as closeness to load center, transmission facilities, availability of cooling water for once-through cooling etc. should be emphasized.

B. Applications - Cross reference the information from the FES and present information in the format used in the FES. Updated information is in the FES, not in the original ER from Con Ed. The major applications of importance still pending are the Sections 401 and 402 - water quality certificate and the operating discharge permit for both IP-2 and IP-3. No mention is made of the Hudson River Policy and Technical Committees or Fish Advisory Board or Hudson River Valley Commission.

Chapter II The Site

List in one sentence the subjects covered in FES- geology, etc. Details of the terrestrial ecosystem should be described in an appendix and should include the map showing the flora survey of the area around the site as provided by the applicant.

Chapter III The Plant

Some of the tables should be put in an appendix and some of the information on discharges can also be transferred to Chapter V.

Section A - In the section on transmission lines, information should be presented regarding the corridors along the east and west bank of the Hudson and the total output from the IP Station and interconnection through Millwood and Sprain Brook to New York City since most of the power from the station is to be used in NYC. Chapter X has some of this information and should be cross referenced or transferred to this Section.

Section D - Include in a sentence information on the number of condensers each unit has and the flow of water involved. See Section E.3 of the FES.

Section E - Reference to the January 17, 1973 letter on water quality standards should be made. Do the traveling screens on IP-3 operate periodically or continuously? On the whole it is a good section. However, is there any information that can be provided to show the extent of the thermal plume surface area which can give the reader an idea of the size of the plume? Is the capacity for thermal loading of the river been reached? The radwaste description will be revised. We are still waiting for a formal writeup from ETSB. No chlorine schedule for all 3 units is

provided. Chlorination of IP-1 and IP-2 alternate every other day. When is IP-3 chlorinated? Distinguish between continuous and batch discharges, normal and accidental releases.

Chapter IV. Plant Construction Effects

A summary of the basic information is needed particularly since IP-3 is still being constructed. Cross reference information from the FES and consider items under Section 4 of "April Guide to Prepare an EIS" if they have not been covered in the FES.

Chapter V

To aid in the preparation of this Chapter, utilize where possible the April Guide but cross reference material from the FES and include redirect testimony in the IP-2 hearings.

Section A - Impact of transmission lines needs improvement to include information on Con Ed's plans to landscape corridors and Title VII requirements of the NYS Public Service Commission. Carter has a copy of this article. See p. 9 of the April Guide.

Section C - Provide basis for no contamination of nearby well water. Intake velocity through the screens is greater than 2 fps. See FES, Appendix A-III-1.

Section D - A list of the major points Goodyear made in the FES and redirect testimony should be provided in this section. This whole section needs complete reworking and should include the essentials in the FES and hearing. It appears that most of the basic information in the FES was required.

1) Radiation effects -

The effects should include IP-3 alone, initial and modified, and then another table to take into account all 3 units, initial and modified. Until the source term is finalized from ETSB, it is difficult to complete this subsection. Separate the radiological and nonradiological effects as per April Guide.

2) Dissolved oxygen -

A lot of material was submitted by Con Ed in response to comments in the DES for IP-2 and also was provided in testimony at the June 1972 hearing and other documents on October 30, 1972 etc. An evaluation of this information should be made. I would not rely on only the August 17, 1972 data collected. Keep in mind the range of DO during different seasons of the year and the importance of loss of DO in the thermal plume when all 3 units are in operation, particularly during the spawning season. The NYS DEC has a major interest in DO and the decrease in the levels when the air bubble curtains are not in operation during the summer time.

3) Chemical Discharges -

What about the reduction of retention time in the discharge canal when all 3 units are in operation? Also the total amount of chlorine will be doubled when IP-3 goes into operation. What will the effects be during sensitive life stages of fish eggs and larvae? This is going to be a major concern because of the total amount and concentration used. Con Ed wants to keep the level at 0.5 ppm because it is the State limit but do we want to recommend 0.1 ppm as is the position taken at other plants? What about the chlorine demand and chloramine formation? The frequency of chlorination should be discussed or mentioned in Chapter III under Chemical Discharges.

4) Thermal Discharges -

The impact of thermal discharges to the biota can be quite critical because of the large thermal plume from all 3 units, particularly during the time when the eggs and larvae are passing the plant. Although the plume may be on the surface, and the eggs during the day down at the bottom of the river, the potential for impact of the thermal plume should be discussed. Granted it is difficult to quantify ecological damage to biota but areas of concern should be addressed and the general magnitude or extent of potential damage

should be discussed. During different seasons of the year, what are the species most likely to be affected by the thermal plume? What about lethal and sublethal effects?

5) Entrainment -

The major points presented in the FES, etc. of the location of the fresh eggs and larvae, the life cycle, and biological behavior of different species should be addressed. The importance of the effect of the damage done to the eggs relative to the fishery resource of the river and the mid Atlantic area needs explanation. The entire section needs to be polished up and indirect as well as direct effects should be considered in terms of the extent of mortality of fish eggs.

6) Impingement -

I question the statement regarding the information collected on IP-1. The NYS DEC has provided additional data on the subject. How many fish can be impinged on the screens considering all 3 units will be in operation? The information presented by Con Ed is questionable since they only count a part of the time what is caught on the traveling screens in the IP-2 intake system after lifting up the fixed screens. These traveling screens are not continuously operated. The fish see the fixed screens first and that is where the fish kill is the greatest but Con Ed doesn't count them at that time; at IP-3, the fish see the traveling screens with 3/8-inch mesh first at an intake velocity over 2 fps. See the information from the DEC reports in this subject. I believe Con Ed will have more troubles at IP-3 than at IP-2 unless the traveling screens rotate horizontally rather than vertically as they do now. The thermal plume should attract more fish around the entire site with IP-3 in operation since the plume can travel north and be recirculated through the intake again.

No mention has been made of the relationship between sport and commercial fishing intensity versus damage to the fishery from station operation.

This section needs extensive rewriting to point out the importance of the entrainment effect on the fishery resource and the entire fish population of the river and the Atlantic Coast. It is a very weak presentation of the significance of damage to relay to the reader one of the major reasons to warrant a closed-cycle cooling system.

In reference to the Staff evaluation of the ecological study, this section needs a complete evaluation of the program as proposed by the applicant and can not be discounted since the applicant will be required to monitor discharges and study the effect of discharges under the Environmental Technical Specifications. The Applicant's ecological studies should be outlined. See Section 6, p. 12 of the April Guide.

Section E - Radiological Impact

Utilize the writeup in the FES, not Newbold Island since it is not applicable to the IP-3 situation. Collect all the radiological impacts together as the April Guide indicates. T. Clark has been working at a decided disadvantage because of the changing source term yet to be finalized by ETSB.

Section F - Transportation Section was provided on May 21, 1973. Include information on Social and Economic Effects as per April Guide.

Chapter VI. Transportation Accident

Section B was provided on May 21, 1973. See Section 7.2 of the April Guide for assistance.

Chapter VII, VIII - Nothing has been provided in these sections. Use Sections 10.1 and 10.2 to assist in the preparation of these sections.

Chapter IX - Commitments of Resources. Needs editing and polishing up. See Section 10.3 in the April guide to assist in the preparation of this section.

Chapter X Need for Power

On the whole, a good writeup but I got lost as to the role IP-3 played either at full power or partial power to meet the needs of the service area. What about the need for partial power operation and the timing for power? Is all the power really

needed all the time prior to closed-cycle cooling? These are points that will be brought up at the hearing.

Chapter XI - Alternatives and Benefit-Cost Analysis

This section is being extensively revised. In addition the section will be finalized after all the other sections are finished.

Appendices -

As stated above, no computer code description should be presented, but the mathematical equations are essential.

The meteorological information and atmospheric dispersion values prepared by SAB apparently were not used to calculate the radiological dose. The model used at ORNL differs from that used at the AEC. However, the basic information used should be the same as that SAB used. Any question about this should have been brought up earlier. I was unaware of the memo dated April 7, 1973 from Hamrick to Binford.

Population projections can be cross referenced with the applicant's ER or summarized on one page in the form of a circular distribution of zones at distances up to 50 miles from the plant.

Regarding multiplant operation no discussion was made on thermal discharges. The section on effects on biota needs polishing up and reworking.

The entire reference sections are essentially missing. Tables and graphs are in a very rough shape. Editorial changes are also necessary.

Enclosure 3

COMMENTS AND RECOMMENDATIONS ON

SECTION 4.10, ENVIRONMENTAL MONITORING SURVEY

PROPOSED INDIAN POINT TECHNICAL SPECIFICATIONS IN FFDSAR

Docket No. 50-286

1. A brief description should be given for each sampling media shown in Table 4.10-1. The description should include sampling location, collection technique (i.e., description of samplers, filter papers, liquid sample volumes, containers, etc.), preparation technique for analysis and the analyzing system and method to be employed. Information from Section 2, Site and Environs, Subsection 2.9 of the FFDSAR including a map for sampling location should be provided in Section 4.10 of the Technical Specifications.

2. Table 4.10-1 should include benthos such as barnacles, clams, polychaete worms and amphipods species in the Hudson River sampling.

3. Table 4.10-1 should include precipitation sampling with all the information request in (1) above. Sampling sites would be desirable in the principal downwind directions and, at least, the plant boundaries.

4. Only five samples for air particulates and radioiodine are collected weekly. The recommended minimum level environmental monitoring program for airborne particulates should consist of, at least, seven samplers as shown in Table I of the Environmental Radioactivity Surveillance Guide issued by the Environmental Protection Agency. Five samplers to be used at the site boundary may be reasonable number for those locations. However, there is a need for samplers at exclusion areas and low population zones.

5. A more detailed description should be given on direct gamma monitoring. For example, which TLD's will be used, if any? Will they be read out by the utility or a commercial supplier? How will they be packaged? How many will be read out at each station during each readout period? (If less than two, explain). What is the limit of sensitivity? How will control dosimeters be handled? What statistical error will be assigned and how will the beta component of dose be recognized?

6. Sediments, water, soil samples should include ^{89}Sr and ^{90}Sr analysis.

7. Vegetation should include ^{3}H analysis.

8. Collection frequency for milk samples are not specified, nor does analysis include radioiodines. Weekly sampling is required for the nearest cow, with analysis within seven days for iodine. Sampling sensitivity should be at 0.5 pCi/liter at the time of sampling.

9. The applicant uses a monitoring program having two alternatives which depend on the past month's record. The staff would prefer that the applicant use a single monitoring program at the higher frequency. If a two-alternative program is to be used, then the staff recommends that the applicant change from Program I to Program II whenever the effluent monitors exceed a level that is 1% of the limit specified in Section 3.9.B.1 of the Technical Specifications.

Regulatory File Cy.

DEPARTMENT OF THE ARMY
COASTAL ENGINEERING RESEARCH CENTER
5201 LITTLE FALLS ROAD, N.W.
WASHINGTON, D.C. 20016

50-247
50-286

CEREN-DE

28 March 1973

Dr. J. M. Hendrie
Dep. Director for Technical Review
Directorate of Licensing
U. S. Atomic Energy Commission
Washington, D. C. 20545

Dear Dr. Hendrie:

Reference is made to your letters regarding Docket Nos. 50-247, 286, 342 and 343, Consolidated Edison Company of New York's Indian Point Nuclear Generating Units 2, 3, 4 and 5, and our letter dated 21 November 1969.

Pursuant to our arrangements, Mr. R. A. Jachowski of my staff has continued to review all information pertaining to the application for an operating license for Unit 3 (Docket No. 50-286) and to advise your staff on the acceptability of the applicant's implementation of the design bases still water level in which we have previously concurred in the referenced letter. Our review has included consideration of the storm surge associated with Probable Maximum and Standard Project Hurricanes, and wind-generated wave analyses associated with severe water levels.

We agree with your staff that wind-generated wave activity associated with severe water levels such as that resulting from the PMH surge could exceed plant grade in the vicinity of the intake structures by several feet, and that with appropriate emergency procedures should be developed so as to protect essential structures from flooding.

Sincerely yours,

THORNDIKE SAVILLE, JR
Acting Director

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ENVIRONMENTAL FILE

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F169

FROM: State of New York
Gov. Office.
Alton G. Marshall

TO: H. L. Price

CLASSIF: U

POST OFFICE REG. NO:

DESCRIPTION: (Must Be Unclassified)
Ltr re: our ltr on Nat. Enviro. Policy Act...& advising that the Dept of Enviro. Conservation, Albany, N.Y. headed by Comm. Henry L. Diamond is responsible for water pollution control & issuance of discharge permits..... in N.Y. State...

ENCLOSURES:

Orig ltr filed under docket 50-322
XXXXXXXXX

REMARKS:
DIST: (2) cys for Branc Chief & Enviro corres from state off. for info..

DATE OF DOCUMENT	DATE RECEIVED	NO.
7-1-70	~~70x~~ 7-6-70	2091

LTR: X MEMO: REPORT: OTHER:

ORIG.: 1 CC: OTHER:

ACTION NECESSARY ☐ CONCURRENCE ☐ DATE ANSWERED
NO ACTION NECESSARY ☐ COMMENT ☐ BY:

FILE CODE: 50-3-220-244-247-286-342-343-322-319-333

REFERRED TO	DATE	RECEIVED BY	DATE
Zieman 50-3	7-7-70		
Zieman 50-220			
Schemel 50-244			
Moller 50-247		DISTRIBUTION:	
Muller 50-286		Reg file cy(10)	
Muller 50-333		AEC PDR (10)	
Ireland 50-342		Henderson	
~~50-342~~		Felton	
Knuth 50-319		Shapar Rm-P-506-A	
		DiNunno Rm A-170 GT	
		Boyd	
		DeYoung	
			FEL

U.S. ATOMIC ENERGY COMMISSION **MAIL CONTROL FORM** FORM AEC-326S (8-60)

☆ U.S. GOVERNMENT PRINTING OFFICE: 348-016

DOCKETS 50-3-220-244-247-289-343-343-
322-319-333

Regulatory File Cy.

ALTON G. MARSHALL
EXECUTIVE OFFICER
TO THE GOVERNOR

STATE OF NEW YORK
EXECUTIVE CHAMBER
ALBANY 12224

July 1, 1970

Dear Mr. Price:

Governor Rockefeller has asked me to thank you for your informative letter and the enclosures regarding the Atomic Energy Commission's procedures under the National Environmental Policy Act.

The Department of Environmental Conservation, Albany, New York 12201, headed by Commissioner Henry L. Diamond, is responsible for water pollution control and the issuance of discharge permits.

Sincerely,

Alton G. Marshall

Mr. Harold L. Price
Director of Regulation
United States Atomic
Energy Commission
Washington, D. C. 20545

DU 2091

File

15 cys - frank

FROM: Dept of Army Coastal Engring Research Center Washington, D.C.	DATE OF DOCUMENT: 11-21-69	DATE RECEIVED: 11-25-69	NO.: 3677
	LTR.: X	MEMO:	REPORT:	OTHER:
TO: R.S. Boyd	ORIG.: 1	CC:	OTHER:
	ACTION NECESSARY ☐ NO ACTION NECESSARY ☐	CONCURRENCE ☐ COMMENT ☐	DATE ANSWERED BY:
CLASSIF.: U	POST OFFICE REG. NO:	FILE CODE: 50-247-50-286.....50-342-343	

DESCRIPTION: (Must Be Unclassified)
Ltr furnishing comments on design water level....& storm surge associated with probable Maximum Hurricane & wind wave analysis.....for Con. Edison, Indian Point Units 2-3-4-5

ENCLOSURES:

REFERRED TO	DATE	RECEIVED BY	DATE
A. Dromerick W/ 6 cys for action	11-21-69		
DISTRIBUTION:			
Reg file cy (4) OGC (506-A)			
H. Price & Staff Morris/Schroeder			
Boyd Levine			
Mason/Ireland W/3 cys for Units 4-5-(50-342-343			
Blunt/Muller W/3 cys for Unit 3 (50-286)			
Blunt/Muller W/orig ltr & 3 cys...Orig ltr to be returned to room 016....50-247 3677			

REMARKS:
Note: Orig ltr sent to N.Blunt upon return to file room file in docket 50-247

U.S. ATOMIC ENERGY COMMISSION **MAIL CONTROL FORM** FORM AEC-326S (8-60)

☆ U.S. GOVERNMENT PRINTING OFFICE: 946-016

DEPARTMENT OF THE ARMY
COASTAL ENGINEERING RESEARCH CENTER
5201 LITTLE FALLS ROAD, N.W.
WASHINGTON, D.C. 20016

CEREN

21 November 1969

Mr. Roger S. Boyd
Asst. Director for Reactor Projects
Division of Reactor Licensing
U. S. Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Boyd:

Reference is made to your letters regarding Docket Nos. 50-247, 50-286, 50-342, and 50-343, Consolidated Edison Company of New York's proposed Indian Point Nuclear Generating Units No. 2 and No. 3, and Units No. 4 and No. 5 which are contiguous to Indian Point plant site.

Pursuant with our arrangements, Mr. R. A. Jachowski and Mr. B. R. Bodine of CERC have reviewed all pertinent information contained in the reports from the standpoint of establishment of a design water level. This included the review of the storm surge associated with the Probable Maximum Hurricane (PMH) and wind wave analysis.

We concur with the applicant's finding that the design water level should be 14.5 feet above the mean sea level datum for Units, Nos. 2, 3, 4 and 5. Although this value is acceptable, there are compensating errors in routing procedure employed.

If you have any further questions regarding this matter please let us know.

Sincerely yours,

Edward M. Willis

EDWARD M. WILLIS
Lieutenant Colonel, CE
Director

3677

Carl L. Newman
Vice President

Consolidated Edison Company of New York, Inc.
4 Irving Place, New York, N. Y. 10003
Telephone (212) 460-5133

October 28, 1974

Mr. George W. Knighton, Chief
Environmental Projects Branch No. 1
Directorate of Licensing
U.S. Atomic Energy Commission
Washington, D.C. 20545

50-3/247/286

Dear Mr. Knighton:

This is in reply to your letter dated October 3, 1974 to Mr. William J. Cahill, Jr. of Con Edison, which we received on October 7, 1974.

Attached is a list of ecological reports which gives the status of the documents which you listed in attachment I to your letter.

You also inquired as to the availability of certain other documents. The report of Quirk, Lawler & Matusky entitled "First Annual Report on the Impact of the Bowline Generating Station on the Hudson River Aquatic Ecology - 1973 Program" has not yet been published and is expected to be available in about 2-3 months, as was reported to you in the letter dated September 25, 1974 of Mr. William J. Cahill, Jr.

The report entitled "Aquatic Ecology Studies - 1973 Roseton/Danskammer" is enclosed herewith.

The report entitled "Impingement and Entrainment Studies - 1973 Danskammer" has not yet been received. The data are still being analyzed and Con Edison has not been furnished a firm date of submittal.

The report of Quirk, Lawler & Matusky entitled "Compensation" is enclosed herewith.

The document prepared by Con Edison entitled "The Contribution of the Hudson River Striped Bass to the Mid-Atlantic Fishery" is enclosed herewith.

Supplement 11 of the Environmental Report has not yet

11366

been filed because the analyses required to respond to Question 6 have not been completed. This supplement is expected to be completed before the end of November.

In accordance with your request, we submit three signed and seven additional copies of this letter together with ten copies of the attachments. Two of these copies of the letter and attachments have been sent directly to Dr. Richard Rush.

Sincerely,

Carl L. Newman

Carl L. Newman
Vice President

Encs.

cc: Dr. Richard Rush (2)

LIST OF ECOLOGICAL REPORTS AND DOCUMENTS

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

1. Cooling Tower Bioassay Report - The final preparation of this report has been delayed because of the Cornwall FPC hearings. It is now scheduled for the end of October.

2. Thermal Plume Progress Report - The report requested was that submitted on July 31, 1974 in a letter from Mr. William J. Cahill, Jr., to the Director, Directorate of Licensing of the AEC. Follow up reports will be submitted in accordance with the reporting requirement section of the ETSR.

3. Progress Reports - Results of D.O. - The report requested was that submitted on July 31, 1974 in a letter from Mr. William J. Cahill, Jr., to the Director, Directorate of Licensing of the AEC. Follow up reports will be submitted in accordance with the reporting requirement section of the ETSR.

4. Chlorine Residual - In accordance with para. 2.3.1 of the ETSR for Units No. 1 and No. 2, a program of one year duration (subsequent to August 1973) is required to be undertaken to determine the feasibility of reducing the concentration of total residual chlorine at the confluence, consistent with plant operation. Due to the limited service of Unit No. 2 during the months of August through November 1973 (Unit No. 1 out of service in 1973) and the onset of winter when no chlorinations are performed, we had not yet experienced by August 1974 a sufficient period of chlorination to produce a meaningful report. We anticipate that the current chlorination season will end sometime in December (river water temperature 45°F). A report on the results of our program will subsequently be submitted as required by the ETSR.

5. Impingement-Danskammer - The data are still being analyzed and Con Edison has not been furnished a firm date of submittal.

6. 1972-1973 Indian Point Fish Impingement Study - [TI] - The final preparation of this report has been delayed because of the Cornwall FPC hearings. It is now scheduled for the end of November.

7. NYU Effects of Entrainment by the Indian Point Power Plant and Appendix Tables - This report was submitted to the AEC by letter dated September 25, 1974 from Mr. William J. Cahill, Jr. to Mr. George W. Knighton. There are no separate appendix tables to this report.

8. NYU Supplement (Transect and Intake Data) - This report is now in final preparation and is scheduled for submission to the AEC before the middle of November.

9. Application by QLM to Revised IP-3 f Factors with Analysis and QLM Computer Run Results - The final preparation of this report has been delayed because of the Cornwall FPC hearings. It is now scheduled for the end of October.

10. Volume IV Hudson River Fishery - The final preparation of this report has been delayed because of the Cornwall FPC hearings. It is now scheduled for the end of October.

11. Discharge Canal, Bass Length/Frequency (Special NYU Report) - Data has been reduced and the analyses are being prepared. This is now scheduled to be submitted by the end of October.

12. QLM Plant Impingement Ratios - This report is enclosed herewith.

13. Length-Frequency Distribution - Longitudinal River Survey - The raw data are now available on magnetic tape. A printout of these data can be furnished upon request. Con Edison intends to submit an analysis of these data in the 1974 Annual Report of TI.

APPENDIX B.

Rec w/ ltr d+d 10-28-74

50-3/247/286

Report of Quirk, Lawler & Matusky Engineers
to H.G. Woodbury, Executive Vice President,
Con Edison - March 15, 1974

11366

COMPENSATION

The following is addressed to the notion of compensation in biological systems. Briefly stated, what we mean by compensation is that any persistent biological population will, when perturbed or impacted by some external influence, act to offset the change induced by that perturbation. In other words, rather than the perturbation introducing a continuous one-way change in the system, such as either a continuous decline in a fishery population or a continuous increase in that population, the tendency to decline or increase, as the case may be, is offset by a reaction in the opposite direction.

1. Support for Compensation in the Biological Literature

This notion is expressed articulately by A. J. Nicholson in his classic paper entitled "The Self-Adjustment of Populations to Change." (1)

Mr. Nicholson introduces his subject, saying:

> "... *abundant evidence is provided by both field and laboratory studies showing that the populations of many different kinds of animals possess the ability to adjust themselves to great changes in their environments. These studies, together with logical deduction from certain well-established facts* (and here Mr. Nicholson refers to a paper of his written in 1954 entitled "An Outline of the Dynamics of Animal Populations," Aust. J. Zool. 2:9-65) *strongly suggest that this ability is possessed by all persistent populations.*"

(1) Nicholson, A. J., "The Self-Adjustment of Populations to Change", : Cold Spring Harbor Symposium, 1957, quant. biol. 22:153-172

Mr. Nicholson goes on to say that the experiments to be discussed in his current paper were done simply to show in some detail how this adjustment is achieved by one particular kind of animal. Furthermore, to illustrate to the reader the difficulty of identifying the compensatory effects in field studies, Nicholson states :

> *"An inherent difficulty with field studies is that the observable events in natural populations consist largely of end results, and the situation in the field is generally so complex that it is difficult to identify with certainty the underlying causes of many of the observed events."*

Mr. Nicholson then indicates that, although the experiments he describes have been done in the laboratory, the conclusions that he makes are general in nature and, in his judgement, certainly apply to all persistent populations.

His conclusion is as follows:

> *"In brief, it is the innate ability of animals to produce a surplus of offspring which enables populations to persist in spite of adverse environmental factors which cause heavy mortality, or which seriously interfere with reproduction, provided these are not so severe that they cause the number of mature offspring to be less than the number of parents, when averaged over a long period. When adverse factors are less severe than this a population will tend to increase progressively, but increasing density induces adverse effects which oppose population growth with progressively greater severity, so preventing further growth when the intensity of this induced opposition, combined with that of the inherent environmental resistance, just counteracts the innate ability of the animals to multiply. Consequently any species automatically adjusts its density in different places, and in the same place at different times, in relation to the prevailing environmental conditions; and it maintains a state of stability*

under all conditions which are not inherently intolerable. This mechanism may enable populations to remain in being in spite of great changes in the environment, without any necessity for the development of new adaptations."

It is our contention that the modeling effort done to date by QL&M shows that the adverse effects due to once-through circulating water systems, at thermal-electric generating stations as well as at the subject pumped storage station, are not so great as to require significant levels of compensation to offset these effects. This proposition is discussed in detail in Dr. Lawler's responses to the questions of the Atomic Safety and Licensing Board on 3/7/73[(2)], at the Indian Point 2 initial operating license hearing.

Some of the complexities of compensation are discussed by Nicholson in the description of his experiments with L. cuprina, the Australian sheep-blowfly. Nicholson, in describing one of his many experiments, states:

> *"Figure 5 illustrates a particularly interesting example of compensatory reaction to destruction. The two cultures compared were maintained under identical conditions except that in (B) 50 per cent of the total population of adults was destroyed every second day (see Nicholson, 1954b p.24). Each culture was provided with 50 grams of larval food, to which the adults had access, and adequate supplies of water and sugar were available to the adults. Comparison of (B)*

(2) Transcript 9806-9815

with (A) in Figure 5 shows that the imposed destruction had the expected effect of markedly reducing the average life of the individuals flies, so increasing the proportion of immature flies incapable of laying eggs - for adults of L. cuprina only begin to lay eggs about three days after emergence. The immediate effect of this was approximately to halve the number of eggs produced in the total population, so reducing the larval competition and permitting a greater number of larvae to pupate. Thus destruction of adults led to an increase in the number of individuals subsequently reaching the adult stage. The mortality due to the relaxed larval competition, combined with the imposed destruction of adults removed exactly the surplus of off-spring produced.

Destruction at the rate of 50 per cent of the adult population every second day actually resulted in the destruction of 79 per cent of the adults, for the flies which escaped destruction on one occasion were exposed to it again after two days. In spite of this it will be seen from Figure 5 that automatic compensatory reaction caused the mean adult population to remain virtually the same as in the control culture in which there was no imposed destruction."

Mr. Nicholson then continues to describe the fact that even though compensation has been demonstrated as discussed above, the situation is not nearly so simple. He says:

"In contrast to this lack of change in adult numbers, the histogram shows that the age-structure of the population was altered markedly. This experiment illustrates the important fact that it is misleading to confine attention to the numbers, or densities, of animals; the age- and stage-structures of the populations must also be considered, for these are important characteristics of populations. They are often outstandingly important, for example, when we are concerned with the abundance of the destructive stage of an insect pest, rather than that of its population as a whole."

With respect to this comment of Nicholson's on the change in the age structure in the adults, it should not be automatically inferred that should compensation be operative in the Hudson River striped bass population, for example, that

similar adult population age structures would change. Furthermore, should such a change in the adult age structure occur, it should not be inferred that this would be necessarily an adverse affect.

It appears quite possible, particularly since the striped bass adults reproduce over a long number of years, that the effect as far as reproduction is concerned, were an age structure change to occur, would simply be to provide the offsetting compensatory effect that should exist. It should be noted, however, that McFadden, in his testimony before the Atomic Safety and Licensing Board on the Indian Point Unit 2 operating license hearing, has testified that it is his belief that the compensatory effect will occur most probably in the first year of life, rather than in the adult population.[3]

(3) McFadden on Entrainment & Impingement, Oct. 30, 1972, p.10, Transcript 9488

2. Mathematical Basis for Compensation

All real world systems operate in a non-linear fashion; i.e., the components of any physical system are ordered in such a way that changes or perturbations imposed on these components are offset in proportion to the products of the magnitudes of the components in question. In biological systems, one such mechanism is referred to as density-dependent activity. This means that a biological population cannot grow without bound because; as it grows, its rate of growth becomes more and more dependent on the magnitude of the population itself; in other words, as the population size increases, the rate of growth of that population begins to decrease until the population reaches some stable level or what is sometimes called a "saturation" level.

The mathematical representation of such activity is to describe the rate of growth as proportional to density of the population raised to a power greater than one. Very often, this is simply the second power or the product of the density multiplied by itself.

Similar non-linear mechanisms occur in the interaction between two or more components in a system, such as two species competing for the same source of

food. Here, the mathematical expression for the rates of increase or decline of either population is expressed as the product of the two or more populations involved. This is a measure of density dependence in a multi-component system.

The mathematical expressions described above are called non-linear, i.e., the rates of change of the substance in question are not directly proportional to the density of the substance alone, but rather are proportional to some product of the density of the given substance and other substances in the reaction, or the product of the density of the given substance times itself.

The physical effect of such non-linearty is to suppress or offset the effect of an external perturbation which initially caused the system to depart from a prior stable or equilibrium position in either a positive or negative direction.

Precise modeling of such systems requires the introduction of these non-linear terms. Particuarly when the system is complex, however, and many dependent variables are involved, the resultant equation becomes so difficult to solve that a variety of approximation techniques are often applied by the modeler to

obtain a solution. A favorite approximation technique, because it makes the underlying mathematics so much more tractable, is to linearize the non-linear terms. This simply means that all of the non-linear terms are replaced by equivalent linear terms, that is, expressions that only involve the concentration or density in question raised to the first power. All products of densities are removed.

This procedure is usually valid provided that it is done over a limited range of operation of the system, for which the numerical behavior of the system in that range is known and can be approximated in a linear fashion. Simply stated, this means that the curvilinear behavior of the rate of growth of a substance with respect to its population, is replaced by linear or straightline approximations over small segments of the curve.

The "sine qua non" of this approximation technique is that the investigator must first ask whether the linearization eliminates or overlooks any important elements of the question being looked at. If the modeler can show that the linearization does not distort the very element of the physical system that he is

trying to model, then the approach is generally acceptable. If, however, the very question that is being asked becomes lost or misdirected due to the linearization, such linearization obviously is improper.

In modeling the movement and behavior of striped bass in the Hudson River and the potential impact of power plant activity on this specie, we have found the latter to be precisely the case, i.e., the basic non-linear or compensatory behavior, inherent in any persistent population as described above, cannot be ignored in modeling the impact of plant operation on striped bass population. The reason for this is that the models developed by Con Edison and its consultants are addressed to the long term impact of continued plant operation of the fishery. This includes the potential reduction of year class recruitment to the adult population, with additional reduction in subsequent years progeny due to these earlier losses.

This cycling effect, if all non-linearity in the system is removed, eventually results in extinction of the population. It is important to note that this extinction will result when any negative perturbation is placed on whatever initial conditions are chosen to operate the model, i.e., if the model is

operated at a particular level of fishing activity in the river and fishing activity increases, such fishing activity will eventually eliminate the striped bass population. Furthermore, in the same manner, if the perturbation is in the other direction, i.e., the fishing activity were to decrease, the model, over a period of years, would then produce an unlimited population.

Obviously, either of these results is clearly unrealistic and only occurs because of the elimination of all system non-linearity.

On the other hand, modeling efforts by the Hudson River Fisherman's Association and the Oak Ridge National Laboratory to date have been clearly non-compensatory. Oak Ridge argues, for example, that compensatory mechanisms should not be included in the model until such specific mechanisms are demonstrated to exist in a particular manner in the Hudson. From the standpoint of the purist, this might be viewed as a conservative and therefore appropriate approach. However, the trouble with it is that it is clearly unrealistic for the reasons stated above, i.e., the results of such modeling effort, were it extended into the cycling of the adult population, will result in extinction of the population. This was clearly indicated by Dr. Goodyear in the final Environmental Statement on

Indian Point Unit 2[4].

The foregoing exposition on the underlying non-linear mathematics in biological systems and its application to Hudson River striped bass modeling has been discussed in detail by the Applicant in the aforementioned Indian Point hearing. (5), (6), (7), (8)

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(4) FES, page V - 55-61

(5) April 5, 1972, Lawler on Entrainment

(6) October 30, 1972, Lawler on Entrainment and Impingement

(7) Transcript 7422 - 7426

(8) " 9806 - 9815

3. Possible Mechanisms of Compensation in the Hudson River

To date, the clear demonstration of a particular type of compensation in the Hudson River has not occurred. As indicated by Mr. Nicholson in the quote above, the demonstration of such in any natural system is an exceedingly difficult thing because what one is viewing in the natural system are end results rather than the compensation mechanism itself.

Several possibilities exist, however. Some of these are outlined below.

1. Dr. McFadden, in the Indian Point Unit 2 hearing, discussed the notions of compensation and its operation in natural fish populations at length. The following is excerpted from his testimony of February 5, 1973 on "Effects of Indian Point Units #1 & #2 on Hudson River Fish Populations."

at page 6, paragraph IIb

> "*IIb. Growth Rates of Hudson River Striped Bass and White Perch*
>
> *Data collection during 1972 in the Indian Point Ecological Study clearly demonstrate that striped bass in the vicinity of Indian Point (Table 2) and white perch in the vicinity of Indian Point (Table 3) grow at substantially slower rates than the same species in other waters for which published data are available. The most plausible explanation for these relative growth data is that the populations of striped bass and white perch in the Hudson River are fairly abundant in relation to their food supply, with the result that growth is slower than average. From this, it can be argued that these fish possess a substantial growth*

potential which could well be realized through a growth rate increase in response to reduced population density. This potential represents one type of compensatory reserve. Compensatory growth responses are not limited to fish populations in closed systems such as small lakes or ponds. An example of the occurrence of compensatory growth response in a marine fish population is presented in the work of Beverton and Hold (1957)."

In addition to this document, Dr. McFadden discussed compensation processes at length, in answering Board Questions on this document (Transcription pages 9482-9491).

2. Cannibalism has been demonstrated as a mechanism of compensation in West Coast striped bass populations. Dr. Goodyear, at the Indian Point Unit 2 hearing, argued that the greater survival rate of young striped bass in the Hudson, by comparison to that in the San Joaquin, being twice as much as that of the San Joaquin, was indicative of the lack of compensation occurring in the Hudson; we consider this to be clearly a spurious argument. In the same hearing, Dr. McFadden has indicated that striped bass young of the year recruitment varies from four to six fold from year to year in a given area. When one considers that the two estuaries being compared by Dr. Goodyear are some 3,000 miles apart and the years of comparison

may not be the same, it becomes rather clear that such arguments cannot be sound as a rebuttal of the notion of cannibalism occurring in the Hudson River.[9]

Current study effort include analysis of stomachs of older striped bass to determine whether cannibalism exists in the Hudson River striped bass population.

3. Furthermore, a number of other national compensatory mechanisms exist in aquatic ecosystems.

Predation, disease and parasitism are examples of natural impacts on the fish population which may often act in density dependent (i.e., compensatory) manner. Recent studies conducted by Texas Instruments on the Hudson River suggest that the striped bass are preyed upon by several other species, including white perch, blue fish and tom cod. Tom cod, for one, are also known to be a striped bass food source. Such cross-predation of adults of one specie on juveniles of a second and vice-versa, will result in oscillatory (and thus compensatory) behavior.

4. Recent analysis of data collected by QL&M at several electric generation sites along the Hudson River in the years 1971 through 1973, coupled with analysis of the data of other Hudson River investigators, suggest the possibility of food limiting mechanisms in larval fish activity on the Hudson River. Phytoplankton maximum concentrations are shown to take place in early spring and to be substantially reduced in the presence of increasing zooplankton populations.

Subsequently, zooplankton populations, which reach their maximum concentration during the time of early larval fish development stages, are shown to disappear during the latter stages of the larval fish development stage. Subsequent adult stages of these zooplankters are not very much in evidence.

At this time, these analyses are very preliminary in nature but they do suggest the fact that the larval activity of striped bass and white perch in June and July may be limited by food availability. Should this be the case, the cropping of fish larvae via other mechanisms, such as

(9) Applicant's Comments to Citations to the Record Submitted by HRFA on January 18, 1974, pg. 2-3, AEC Docket No. 50-247

losses by entrainment through power plants, would be offset by a reduced competition and therefore increased survival percentage among those larvae not vulnerable or lost via entrainment.

5. The striped bass population on the East Coast is characterized by rather wide fluctuations in year class recruitment to the population. In the presence of such wide fluctuations, however, this specie has been clearly shown to survive and persist; in fact, all of the evidence over the past 40 years has pointed to a substantive growth in the population of the middle Atlantic striped bass. The ability to survive and grow in the presence of such wide fluctuations in year class recruitment suggests a strong ability to absorb environmental shocks of any type. This would suggest that even relatively severe man-made impacts can be absorbed by the striped bass population. Such absorption of shock is an indication of compensation in population.

6. In the Indian Point 2 hearing, Dr. Goodyear suggested that man's fishing activity operated as a compensatory mechanism in adult populations of striped bass and, in so doing, regulated the Hudson River striped bass population. He suggested that fishing regulations in the Chesapeake area influenced the adult population of striped bass in that region and that fishing was a density dependent phenomenon.

ORNL's interpretation of man's fishing activity as a compensatory mechanism suggests that they recognize that a completely linear model is unrealistic. However, they leave unanswered the question: "What compensatory mechanisms would be operative in the absence of man's activity?"

Memorandum
For the Record of the Hearings
on the Cornwall Pumped Storage
Project held by the Subcommittee
on Fisheries and Wildlife Conser-
vation and the Environment of the
House Committee on Merchant Marine
and Fisheries -
February 19 and 20, 1974.

From Deborah N. Wallace
Study Manager - Cornwall
Consolidated Edison Company
of New York, Inc.

Re The Contribution of the Hudson River Striped Bass to the Mid-Atlantic Fishery

Date March 21, 1974

Introduction: The origin of the striped bass found in the mid-Atlantic region has long been a question in the minds of both fishermen and biologists. As long ago as 1934, Daniel Merriman of Yale University conducted tag-recapture studies to determine the movement of the fish. The following are more recent studies with the same objective.

1) Raney, Wolcott, and Mehring (1954)

Along the Atlantic Coast from Massachusetts to Chesapeake Bay, 9320 striped bass were tagged in the interval of four years (1948-1952). The great majority of specimens tagged in Western Long Island Sound and subsequently recovered were captured in the Hudson River. The majority

of the remainder were retaken in Western Long Island during the marine period of the anadromous cycle. The distribution of recoveries indicated "a summer population which does not move far from the western quarter of Long Island Sound."[1]

Adult and near-adult juveniles taken from the Hudson River and New York Bay were also tagged and released. Nearly all of these were recaptured the following two springs in the Hudson and Hackensack Rivers. The others were recaptured in New Jersey rivers within 50 miles of the Narrows where they had been tagged. Nearly all fish tagged in Upper New York Bay were recaptured in the Hudson the following spring, with a few recaptures in fall, an indication of overwintering in the lower Hudson. All but three stripers out of 133 tagged in Lower New York Bay and recaptured were taken in the Hudson.

About half of the recovered fish which were tagged in Southwestern Long Island Sound were taken in the Hudson either in spring or in fall. The majority of the other half were taken in the Sound. Six were recaptured at distant points (New Jersey, Delaware, and the Chesapeake).

Bass tagged along the northeast New Jersey coast were recovered in overwintering areas of New Jersey (Toms River, Barnegat Bay, Great Bay) or southward (Delaware Bay,

Chesapeake Bay). Bass tagged in the Delaware Bay were recovered at Salem Cove, Salem, New Jersey and in Delaware Bay. Fish tagged at Salem Cove were recovered in Chesapeake Bay, Delaware Bay, and Elk River near the C & D canal. Fish tagged along the Massachusetts coast were recovered in Delaware Bay, Long Island, New Jersey, Rhode Island and Connecticut, but none in the Hudson.

2) Alperin (1966 a and b)

Nearly 2000 juvenile striped bass were seined and tagged on the shore of Great South Bay, southern shore of Long Island. The great majority were taken from eastern Long Island waters and only 2.1 percent were taken from the Hudson. Other consistent locations of recapture were the Maine-Massachusetts coast, Rhode Island, and the New Jersey - Maryland coast. Usually very few striped bass juveniles have been collected in Great South Bay; when they did appear in large numbers, nearly all were from spawning grounds other than the Hudson. The tagged fish seemed to overwinter in the New Jersey - Delaware region although some were recovered in Maryland and Virginia. In spring, recoveries pointed to a northward movement into New England. Summer brought a concentration of recaptures at Long Island (south shore).

3) Schaefer (1968)

Two tagging sites on the south shore outer barrier beach of Long Island were used: Westhampton Beach and Great South Beach (Fire Island). Of the fish tagged at Westhampton, only 10 percent of those recovered were taken in New England, 34 percent from waters south of New York and more than 50 percent from New York waters. Those recaptured in the Hudson constituted the majority of New York recaptures.

In winter, the greater number of recoveries were from southern waters (Delaware and Chesapeake), but 72 percent of the spring recoveries were from the Hudson. This was a period of generally low numbers of striper.

Fish tagged at Fire Island were divided into large and small size categories (6 lbs. or more, or 600 mm or more = large). More than 75 percent of the recaptures were in New York waters, but <u>not in the Hudson</u>. All winter recoveries were from Delaware Bay. Spring recoveries ranged from the Chesapeake to the south shore of Long Island. Most of the summer and fall recoveries came from the south shore of Long Island.

Of the large fish recaptured, only one was taken in the Hudson. The large fish also overwinter south of New York. In spring, they were recaptured between Virginia

and Cape Cod. Most of the summer recaptures came from the south shore of Long Island. These years (1961 - 1963) were a period of large numbers of stripers along the southern coast of Long Island.

4) Clark (1968)

This paper was a report on the recovery of stripers tagged along the northeast Atlantic coast 1959 - 1963. Three groups were noted: one in the Hudson - West Long Island Sound area, a second in the Hudson Estuary, and a third in the Hudson - Atlantic area. Spring to fall, other strains also visited the area. The first contingent is a migrating strain, spawning in the Hudson, and then moving out to the Sound vua the Harlem River, East River, or around Manhattan and up the East River. The second contingent is a resident group which moves within the Hudson and does not reach beyond southwest Jamaica Bay and Northeast New Jersey. The Hudson - Atlantic contingent only visits there in winter and is southern in origin. They may occasionally spawn in the Hudson.

5) Murawski (1969)

The egg and larval distribution of striped bass in the Delaware River is reported in this paper. The year reported on, 1964, was a period of serious drought; yet eggs

and larvae were collected from river mile 58 to river mile 79 and larvae from river mile 118 to river mile 125. Substantial spawning appears to occur in the Delaware and its tributaries.

6) Koo (1970)

Koo analyzed commercial landings of striped bass on the Atlantic coast from 1930 - 1966. Annual landings in poundage increased ninefold from the 1934 level. The Chesapeake region landed two-thirds of the total catch. Flunctuations in the Chesapeake landings were followed by similar fluctuations in the landings of the Middle Atlantic and New England regions, whereas the South Atlantic had a fluctuation pattern completely distinct from the other three. Koo attributed the similarity of the three patterns to the Middle-Atlantic and New England fisheries being mainly of Chesapeake origin.

7) Homer (1971)

Homer studied the Maurice River, a tributary to Delaware Bay, and reported on a strong spawning run, fair production of bass, and Delaware Bay as a nursery and feeding area for young stripers.

8) Schaefer (1972)

Schaefer analyzed Commercial and sport landings

of Long Island from the nineteenth century to the present. From the latter half of the nineteenth century until 1933, the decline in landings was fairly steady. In 1934, a reversal of decline was noted. The upswing has been fairly steady (one-half million pounds in 1944, one million in 1966, an expected 1.6 million in 1974). This increase along the Atlantic coast of striped bass was attributed to sporadic strong year classes from the Chesapeake. The fishery is now feeling the effects of the strong 1970 Chesapeake year class.

9) Raney (1972)

An analysis of movements of fish tagged or recaptured in New York waters since 1967 was reported.

Fish tagged in the Hudson were recaptured either in western Long Island Sound or in New York Bay. only two fish were taken outside these areas. A third was taken in the Hudson.

Fish tagged along New Jersey, Staten Island, Brooklyn, Queens, and the southern shore of Long Island appear to follow the same migration pattern: overwinter in southern waters of Virginia, Maryland, and Delaware; come north in spring and occupy areas north of New Jersey during summer; move south in fall.

The majority of fish tagged within Long Island Sound do not perform this pattern of migration. Most remain in the Sound or in the waters of the New York areas.

Six hundred adult stripers were tagged in spring 1972 in the Chaptank River, a tributary of the Chesapeake. Recaptures were made off New Jersey, off Long Island, off Massachusetts, off Rhode Island, and off Maine. This study confirms the data from all the previous tagging studies.

Conclusion: The greater part of the Atlantic coast subpopulation - which performs seasonal migration along the coast is of Delaware-Chesapeake origin. Only a small portion of stripers which spawn in the Hudson perform this wide-ranging migration, and these constitute a very small portion of the New England, North New Jersey, Delaware, Maryland, and Virginia fisheries. The majority of Hudson stripers migrate to Western Long Island Sound, to northern New Jersey, and to Upper and Lower New York Bays.

1) Raney, Edward C., William S. Woolcott and Albert G. Mehring. 1954. "Migratory Pattern and Racial Structure of Atlantic Coast Striped Bass." Trans 19th N.A. Wildlife Conf., 376 - 396.

2) Alperin, I.M. 1966 a. "Dispersal, Migration, and Origin of Striped Bass from Great South Bay, Long Island." N.Y. Fish & Game J., 13 (1) : 79 - 112.

- 1966 b. "Occurrence of Yearling Striped Bass along the South Shore of Long Island. NY Fish & Game J., 13 (1) : 113-120.

3) Schaefer, Richard H. 1968. "Size, Age Composition, and Migration of Striped Bass from the Surf Waters of Long Island." N.Y. Fish & Game J., 15 (1) : 1 - 51.

4) Clark, John. 1968. "Seasonal Movements of Striped Bass Contingents of Long Island Sound and the New York-Bight." Trans Amer. Fish. Soc., 97 (4) : 320 - 343.

5) Murawski, Walter S. 1969 "The Distribution of Striped Bass, Roccus Saxatilis, Eggs and Larvae in the Lower Delaware River." N.J. Dept. of Conservation and Economics Development, Div. Fish & Game, Nacote Creek Res. Stat. Miscellaneous Report No. 1 u.

6) Koo, Ted S.Y. 1970 "The Striped Bass Fishery in the Atlantic States." Chesapeake Science, II (2) : 73 - 93.

7) Hamer, P. E. 1971 "Miagratory Patterns of Some New Jersey Striped Bass, Morone Saxatilis." Ecological Considerations for Ocean Sites Off New Jersey for Proposed Nuclear Generating Stations, Vol. 2, Part 3, Ichthyological Associates, Ithaca, New York.

8) Schaefer, Richard H. 1972 "Striped Bass." The Conservationist. N.Y. State Dept. of Environmental Conservation, 27 (1) : 27 - 46.

9) Raney, E.C. 1972. "The Striped Bass, Morone Saxatilis, of the Atlantic Coast of the United States with Particular Reference to the Population Found in the Hudson River." Testimony before AEC Safety and Licensing Board for Indian Point, Unit No. 2. (October 30) : 69 - 88.

10) Raney, E.C. 1972. Testimony before AEC. Dec. 1972 p. 7633 of transcript.