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UniStar
NUCLEAR ENERGY

10 CFR 50.4
10 CFR 52.79

September 29, 2008

UN#08-037

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: UniStar Nuclear Energy, NRC Docket No. 52-016
Submittal of Response to Requests for Additional Information for the
Calvert Cliffs Nuclear Power Plant, Unit 3 – Supplemental Aquatic RAIs

References: (1) Thomas Fredrichs (NRC) to G. Wrobel (UniStar), "RAIs for Calvert Cliffs Environmental Report," dated May 13, 2008

(2) George Vanderheyden (UniStar) to NRC Document Control Desk, "Submittal of Response to Requests for Additional Information for the Calvert Cliffs Nuclear Power Plant Unit 3," dated June 12, 2008

(3) Thomas Fredrichs (NRC) to George Wrobel (UniStar), "Aquatic RAIs for Calvert Cliffs (RAIs resulting from RAI Responses)," dated August 29, 2008

The purpose of this letter is to respond to supplemental requests for additional information (RAIs) identified in the NRC e-mail correspondence to UniStar Nuclear, dated August 29, 2008 (Reference 3). These RAIs address aquatic ecology issues as discussed in portions of the Environmental Report as submitted in Part 3 of the CCNPP Unit 3 Combined License Application (COLA).

The enclosure and attachments provide responses to the supplemental RAIs.

If there are any questions regarding this transmittal, please contact me or Mr. George Wrobel at (585) 771-3535.

D079
HRO

I declare under penalty or perjury that the foreg oing is true and correct.

Executed on September 29, 2008

Greg Gibson

Enclosure: Response to RAIs

cc: U.S. NRC Region I
U.S. NRC Resident Inspector, Calvert Cliffs Nuclear Power Plant, Units 1 and 2
NRC Environmental Project Manager, U.S. EPR Combined License Application
NRC Project Manager, U.S. EPR Combined License Application
NRC Project Manager, U.S. EPR Design Certification Application (w/o enclosures)

Enclosure

Response to RAIs

ITEM NUMBER 1 SUPPLEMENTAL REQUEST REGARDING RAI #12

NRC Request:

This response references a 2006–2007 entrainment study: EA, 2007b. EA Engineering, Science, and Technology, Inc., Entrainment Characterization Data Report for Calvert Cliffs Nuclear Power Plant, Prepared for Constellation Generation Group, July, 2007.

Please provide a copy of the report.

UniStar Response:

Copies of these documents are included as an attachment to this submittal.

ER Impact:

No changes to the ER are required.

ITEM NUMBER 2 SUPPLEMENTAL REQUEST REGARDING RAI #12

NRC Request:

This response refers to a discussion with NMFS that states that it is not necessary to conduct an EFH evaluation for cobia, king mackerel, and Spanish mackerel. NMFS, 2008, Chiarella, L., Pers. comm. National Marine Fisheries Service, 2008.

Please provide written documentation of this information.

UniStar Response:

The National Marine Fisheries Service was contacted to determine whether an EFH evaluation is necessary for cobia, king mackerel, and Spanish mackerel. Mr. Lou Chiarella of the National Oceanic and Atmospheric Administration responded that an EFH evaluation is not necessary. A Telephone/Visit record documents the discussion of this issue with the National Oceanic and Atmospheric Administration National Marine Fisheries Service

A copy of this record is included as an attachment to this submittal.

ER Impact:

No changes to the ER are required.

ITEM NUMBER 3 SUPPLEMENTAL REQUEST REGARDING RAI AE-9

NRC Request:

Please provide a copy of the CCNPP Unit 3 Storm Water Management Plan, April 2008 that was referenced in this and other RAI responses.

UniStar Response:

Attachment 3 provides a copy of the report.

ER Impact:

No changes to the ER are required.

ITEM NUMBER 4 SUPPLEMENTAL REQUEST REGARDING RAI #16 / #17

NRC Request:

Most of the information presented in these updated sections may prove to be useful, but has not been documented well. Two examples are provided. Only one reference, a Smithsonian Institution website, is cited for the beaver (SI 2008); much of the information about the beaver in the RAI response is not documented on that website. One citation is provided for the Atlantic Loggerhead Turtle (NatureServe Website). The website does not document much of the information provided in the text, especially the Chesapeake-specific data. For example, the response states that 2,000–10,000 young loggerheads forage in the bay during the summer. No support for this "fact" is offered. Information about the white perch habitat in Chesapeake Bay is not found on the NatureServe (2007k) website that is the only citation listed for the Habitat Requirements section.

Please provide additional citations to document the facts presented in the RAI response.

UniStar Response:

Information on North American Beaver

Beavers are primarily aquatic animals and the largest rodents in North America. They have a waterproof, rich, glossy, reddish brown or blackish brown coat. The underhairs are much finer than the outer, protective, guard-hairs. The ears are short, round, and dark brown in coloration. A beaver's hind legs are longer than its front legs, thus making the rear end to be higher than the front end while walking (1998; Frazier, 1996; Hall and Kelson, 1959; Whitaker and Hamilton, 1998 as cited in ADW, 2008a).

Population Abundance and Distribution: Beavers are found throughout all of North America except for the northern regions of Canada and the deserts of the southern United States and Mexico (Frazier, 1996 as cited in ADW, 2008a).

Habitat Requirements: Beavers are essentially aquatic and require water in the form of a pond, stream, lake, or river for their well-being. Because of their skills in regulating water level and stream flow with dams, beavers are able to convert an otherwise unfavorable area into one that is habitable. Their ponds tend to fill up with sediment washed off the slopes above and in time become meadows, forcing the beavers to move to new sites. Large rivers and lakes offer suitable habitat in places where natural food and den or house sites are available, but the largest populations are on small bodies of water (TTU, 2008). Beavers build dams to slow down the flow of water in streams and rivers and then build stable lodges for shelter. The dams are engineered according to the speed of the water; in slow water the dam is built straight, but in fast water the dam is built with a curve in it. This provides stability so that the dam will not be washed away (Data: Species: Mammal: American Beaver- Castor canadensis, 1998; Frazier, 1996; Hall and Kelson, 1959 as cited in ADW, 2008a).

Beavers travel good distances from their homes to find food. If they find a good source, they build canals to the food source as a way to float the food back to their lodges. Logs and twigs are often stored underwater for winter feeding (Data: Species: Mammal:

American Beaver- Castor canadensis, 1998; Frazier, 1996; Hall and Kelson, 1959 as cited in ADW, 2008a).

Beavers cache and consume the inner bark of both deciduous and evergreen shrubs and trees, as well as terrestrial and aquatic plants (SI, 2008).

Beavers maintain wetlands that can slow the flow of floodwaters. They prevent erosion, and they raise the water table, which acts as a purifying system for the water. As ponds grow from water backed up by the dam, pond weeds and lilies take over. After beavers leave their homes, the dams decay, and meadows appear (Frazier, 1996 as cited in ADW, 2008a).

Life History: Beavers usually live in family groups of up to 8 related individuals called colonies. The younger siblings stay with their parents for up to 2 years, helping with infant care, food collection, and dam building. Beaver families are territorial and defend their territories against other families. One method is territory marking, which is done by making mud piles around the edges of a territory and then depositing anal and castoral secretions on these piles from the anal and castoral glands located at the base of the tail. Beavers will also warn others of danger by slapping their tails against the water, creating a powerful noise. This method, however, is not always effective, as older beavers will often ignore the warning slaps of younger members of the colony (Data: Species: Mammal: American Beaver- Castor canadensis, 1998; Frazier, 1996; Hall and Kelson, 1959; Whitaker and Hamilton, 1998 as cited in ADW, 2008a).

Male and female beavers are sexually mature at about 3 years of age. They mate between January and March in colder climates, and in late November or December in the south. Beavers give birth to one litter of kits per year, usually between April and June. The gestation period is about 3 months, or 105-107 days. During this time, the young develop inside the female's body. When they are born they are fully furred, have open eyes, and can swim within 24 hours. After several days they are also able to dive out of the lodge with their parents to explore the surrounding area (Frazier, 1996; Hall and Kelson, 1959 as cited in ADW, 2008a).

Beavers are instrumental in creating habitats for many aquatic organisms, maintaining the water table at an appropriate level and controlling flooding and erosion, all by building dams (Data: Species: Mammal: American Beaver- Castor canadensis, 1998 as cited in ADW, 2008a).

Population Dynamics: The conservation status differs with respect to source, but there have been significant threats to the survival of the beaver. Beavers have been hunted and trapped extensively in the past and by about 1900, the animals were almost gone in many of their original habitats. Pollution and habitat loss have also affected the survival of the beaver. In the last century, however, beavers have been successfully reintroduced to many of their former habitats (Data: Species: Mammal: American Beaver- Castor canadensis, 1998; Frazier, 1996 as cited in ADW, 2008a). The beaver is now common and widespread, even in areas it did not inhabit during pre-colonial times (SI, 2008).

Conservation status ranks are based on a one to five scale, ranging from critically imperiled (G1) to demonstrably secure (G5). Status is assessed and documented at three distinct geographic scales-global (G), national (N), and state/province (S). These status assessments are based on the best available information, and consider a variety of factors such as abundance, distribution, population trends, and threats. The beaver has a global status of G5 (secure – common; widespread and abundant), a national status of N5 (secure - common, widespread, and abundant in the nation or state/province), and a state status of S5 (secure - common, widespread, and abundant in the nation or state/province). The beaver has a large range in North America, is common, and has expanding populations (NatureServe, 2008a).

Global Protection Needs: In situations where beaver protection is desired, it is necessary to protect both aquatic and riparian habitats. Generally beavers will modify the aquatic system to make it most suitable for them. Protection of an adequate amount of riparian habitat to meet the food and building needs of the beavers is critical; ideally the riparian habitat to be protected should extend at least 50 m from the water and should support young deciduous woody vegetation. Along streams, about 1 km of stream channel generally is sufficient to support one beaver family (NatureServe, 2008a).

Threats: Other than intensive, unregulated trapping, or extensive removal of deciduous woody plants near permanent water sources (except in circumstances where old growth is replaced by young growth), there are few threats to beaver populations. In fact, once established in an area (e.g., a watershed or drainage system), beavers often are difficult to eliminate (NatureServe, 2008a).

Important Estuarine Species

NUREG-1555 defines important species as: 1) species listed or proposed for listing as threatened, endangered, candidate, or of concern in 50 CFR 17.11 and 50 CFR 17.12, by the USFWS or the state in which the project is located; 2) commercially or recreationally valuable species; 3) species essential to the maintenance and survival of rare or commercially or recreationally valuable species; 4) species critical to the structure and function of local terrestrial ecosystems; or 5) species that could serve as biological indicators of effects on local terrestrial ecosystems. A single species may meet more than one of the five criteria. A sixth criterion, status as a potential nuisance to plant operation, is not discussed, as no nuisance aquatic species are expected to occur in the vicinity of the project area.

A list of species considered important in the project area was compiled based on these criteria and summarized in Table 16-1. Following the table, a brief summary of habitat requirements, life history, and population dynamics is provided for these species as well as for the following: summer flounder, red drum, weakfish, spotfin killifish, alewife, blueback herring, green turtle, leatherback turtle, and soft-shelled clam.

Table 16-1
Important Estuarine Species in the Chesapeake Bay near the CCNPP Site

Species (*Scientific Name*)	**Commercially Harvested**	**Recreational Target**	**Keystone Species**	**Indicator Species**
Threatened and Endangered Species				
Shortnose sturgeon * *Acipenser brevirostrum*				
Atlantic sturgeon *Acipenser oxyrhynchus oxyrhynchus*	X (Moratorium since 1997)			
Atlantic loggerhead turtle * *Caretta caretta*				
Kemps ridley turtle * *Lepidochelys kempii*				
Harvested Fish				
American shad *Alosa sapidissima*	X			
Bay anchovy *Anchoa mitchilli*	X		X	
Atlantic menhaden *Brevoortia tyrannus*	X		X	X
Atlantic croaker *Micropogonias undulatus*	X	X		
Striped bass *Morone saxatilis*	X	X		
Spot *Leiostomus xanthurus*	X	X		
White perch *Morone americana*	X	X		
Bluefish *Pomatomus saltatrix*	X	X		
American eel *Anguilla rostrata*	X	X		
Harvested Invertebrates				
Blue crab *Callinectes sapidus*	X	X		
American oyster *Crassostrea virginica*	X			X
Other Important Resources				
Submerged Aquatic Vegetation (SAV)			X	X
Plankton			X	X
Note: *Threatened and Endangered Species are not allowed to be taken in the Chesapeake Bay.				

The Chesapeake Bay is considered important estuarine habitat to most, if not all, of the estuarine species identified in the area. However, none of the important species in the vicinity of the project are endemic to the Chesapeake Bay. They range widely throughout the mid-Atlantic coast, and most occur in the Gulf of Mexico, as well. Each important species is described in terms of the following parameters, which provide a context within which site-related effects may be measured and interpreted:

- Critical life support (natural history) requirements, including spawning areas, nursery grounds, food habits, feeding areas, wintering areas, and migration routes (including maps)
- Temporal and three-dimensional spatial distribution and abundance, especially in the discharge area and receiving water body (including maps)
- Seasonal catch data (location, volume, and value) for commercially and recreationally important species
- Existing stressors and adverse effects not related to the proposed project

Description of Threatened or Endangered Species

Two fish and two sea turtle species in the project area are afforded special protection under the Endangered Species Act: the shortnose and Atlantic sturgeons, and the loggerhead and Kemp's ridley sea turtles.

Shortnose Sturgeon

The shortnose sturgeon (*Acipenser brevirostrum*) is an anadromous bony fish that was listed as federally endangered in 1967 and is considered extremely rare under Commonwealth of Maryland law.

Population Abundance and Distribution: The ancestral range of this species is believed to extend from the St. John River in New Brunswick, Canada to the St. Johns River in Florida. In 1979, Baltimore Gas and Electric researchers captured a shortnose sturgeon during trawl studies in the vicinity of the CCNPP site. Other isolated individuals may use the area intermittently; however, no shortnose sturgeon is known to have spawned in the Chesapeake in decades. In August, 2006, a female with eggs was captured as she swam up the Potomac River, supposedly to spawn. It is not known whether she spawned, but biologists consider it doubtful, since males are exceedingly rare in the area (Chesapeake Bay Journal, 2006). Intensive efforts by biologists to document the presence of this species in the Chesapeake Bay are ongoing.

Habitat Requirements: Shortnose sturgeons inhabit river mouths, lakes, estuaries, and bays (Scott, 1978 as cited in Froese and Pauly, 2007a). They prefer deep pools with soft substrates and vegetated bottoms (Seibel, 1991 as cited in NatureServe, 2008b). Shortnose sturgeons move up river channels to spawn in fresh water. Generally, they spawn in sand to boulder-sized substrate with low to medium water flow (NatureServe, 2008b).

Life History: The shortnose sturgeon spawns in April in Maryland, generally at intervals of a few to several years. Females sexually mature at 6 to 7 years while males sexually mature at 3 to 5 years. The first spawning may occur from 1 to 16 years after maturity (NatureServe, 2008b).

The lifespan of the shortnose sturgeon may reach 50 years in the northern part of its range (Dadswell et al, 1984 as cited in NatureServe, 2008b).

Population Dynamics: The shortnose sturgeon historically inhabited sluggish tidal rivers and near-shore marine waters of the western Atlantic coast, including Chesapeake Bay. Although this fish once supported an enormous international export business, the stock plummeted during the 1900s due to overharvesting. Deteriorating water quality (especially low dissolved oxygen) and placement of dams that restrict its access to historical spawning grounds have likely inhibited the strong comeback that could have been expected once legal protections were put in place.

Atlantic Sturgeon

A larger, longer-lived relative of the shortnose sturgeon, the Atlantic sturgeon (*Acipenser oxyrhynchus*) is currently on the candidate species list maintained by NOAA Fisheries because it is undergoing a status review under the Endangered Species Act.

Population Abundance and Distribution: The Atlantic sturgeon was formerly known to occur along the Atlantic coast and major estuarine drainages from Labrador to northeastern Florida (NatureServe, 2008c). The MDNR conducted a trial stocking experiment in 1996 to investigate the viability of juvenile hatchery fish that were released on the Eastern Shore. During the subsequent 5 years, 14% of the juveniles were recaptured (Atlantic Sturgeon Status Review Team, 2007), suggesting that habitat conditions were adequate to support growth and survival. Recent changes to the water quality goals in the Chesapeake Bay are expected to result in habitat improvements for both sturgeon species.

Habitat Requirements: Atlantic sturgeon is primarily a marine species and stays close to the shore when not breeding. They migrate to rivers for spawning and move downstream afterward. Juveniles spend winter and spring mainly in river mouths (NatureServe, 2008c). Some juveniles spend several years continuously in freshwater while others move downstream to brackish water when temperatures drop in the fall (Hoff, 1980 as cited in NatureServe, 2008c). Spawning habitat is fresh water, although sometimes tidal or brackish water, over substrates of hard clay, rubble, gravel, or shell (NatureServe, 2008c).

Life History: Adults migrate between fresh water spawning areas and salt water non-spawning areas. Atlantic sturgeons spawn from April to May in Chesapeake Bay tributaries at intervals of a few to several years. Their eggs hatch in approximately one week. The lifespan of the Atlantic sturgeon may be several decades long. (NatureServe, 2008c).

Population Dynamics: The Atlantic sturgeon once supported a robust fishery in the Chesapeake Bay. Prior to 1890, there were an estimated 20,000 in Chesapeake Bay (NatureServe, 2008c). The decline of the Atlantic sturgeon was not as sudden or steep as that of the shortnose sturgeon, but its populations are currently depleted. The sturgeon's dependence on both estuarine and freshwater habitat make it susceptible to harm from habitat degradation due to pollution, physical barriers to spawning areas, channelization or elimination of backwater habitats, de-watering of streams, and physical destruction of spawning grounds. In Chesapeake Bay and elsewhere in the range, hypoxic events have increased and may degrade nursery habitat for Atlantic sturgeon (NatureServe, 2008c). In late 1997, a moratorium on the harvest of wild Atlantic sturgeon was implemented and remains in effect until there are at least

20 protected year classes in each spawning stock, which may take up to 40 or more years (NMFS, 2008a).

Atlantic Loggerhead Turtle

Loggerheads (*Caretta caretta*) are large reddish-brown sea turtles that have disproportionately large heads (MDNR, 2006).

Population Abundance and Distribution: Loggerheads occur throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans. The loggerhead is the most abundant species of sea turtle found in U.S. coastal waters, including the Chesapeake Bay. Approximately 2,000 to 10,000 young loggerheads forage in the bay each summer for horseshoe crabs, jellyfish, and mollusks (Kimmel, Driscoll, and Brush, 2006 as cited in USEPA, 2007). In addition to the well-known juveniles, it has been reported that up to 5% of the loggerheads in Chesapeake Bay are adult females who are taking time off between nesting efforts.

Habitat Requirements: Loggerheads are most often seen near the mouths of rivers, in water greater than 13 ft (4 m) deep and are known to occur in open sea, mostly over the continental shelf, and in bays, estuaries, lagoons, and creeks in mainly warm temperate and subtropical regions not far from shorelines. Adults occupy various habitats, from turbid bays to clear waters of reefs. Subadults occur mainly in nearshore and estuarine waters. Hatchlings move directly to sea after hatching, and often float in masses of sea plants (*Sargassum*). These hatchlings may remain associated with the sargassum rafts for 3 to 5 years. In the Chesapeake Bay, loggerheads occur mainly in deeper channels, usually at river mouths or in the open bay (NatureServe, 2008d). Most sightings are in the Virginia portion of the bay, where salinity is higher.

Nesting occurs usually on open sandy beaches above the high-tide mark and seaward of well-developed dunes. Loggerheads nest primarily on high-energy beaches on barrier strands adjacent to continental land masses (NatureServe, 2008d). They prefer steeply sloped beaches with gradually sloped offshore approaches for nesting sites (CSTC, 1990 as cited in NatureServe, 2008d) and will generally return to the same area in subsequent years if the habitat remains suitable (NatureServe, 2008d). The loggerhead's nesting range in the U.S. is mainly the Atlantic coast from North Carolina to southern Florida (Shoop 1985, Dodd 1988 as cited in NatureServe, 2008d), Nesting also regularly in small numbers in Virginia and sometimes north to New Jersey. The Chesapeake Bay is an important habitat for subadults in summer (NatureServe 2008d). Juvenile loggerheads are not rare in the Chesapeake Bay, but it is unusual to find a nesting female loggerhead north of Cape Hatteras, North Carolina. Loggerheads use the bay as feeding habitat between nesting events, but nesting activities take place elsewhere along the Atlantic coast (VIMS, 2008a). There are no known nesting beaches for loggerheads in the Chesapeake Bay area (USEPA, 2007).

Life History: Loggerheads mate every 2 to 3 years from late March through early June. Nesting occurs mainly at night in late April through early September, and often at high tide. Eggs hatch in about 7 to 11 weeks. The sex of hatchlings is affected by incubation temperature, with warmer temperatures resulting in a preponderance of females and cooler temperatures producing mainly or only males. Hatchlings emerge from the nest a few days after hatching, typically during darkness. Females are sexually mature at an average age of about 15 to 30 years (NatureServe, 2008d) and are reproductively active over a period of about 30 years (CSTC, 1990 as cited in NatureServe, 2008d).

Population Dynamics: The stock structure of the U.S. population of loggerheads is poorly understood. Some evidence suggests that individuals nesting in Georgia represent a population distinct from the Florida nesters. If so, the northern population may be more severely threatened. NOAA Fisheries suggests that it may become necessary to consider listing them as endangered. Adult loggerheads are known to make extensive migrations between foraging areas and nesting beaches. The Virginia Institute of Marine Science Sea Turtle Program actively tracks individuals that nest on Virginia beaches in an effort to determine the migration routes of these turtles. At present, the place of origin of an individual turtle cannot be determined. Turtles feeding in the Chesapeake Bay may represent a number of nesting populations worldwide. At the global level, the primary threat to loggerhead turtle populations is incidental capture in fishing gear, especially in longlines and gillnets, but also in trawls, traps and pots, and dredges. NOAA Fisheries is currently implementing a program to evaluate the incidence of bycatch of sea turtles in various types of gear, including pound nets in the Chesapeake Bay. Egg mortality may result from predation, beach erosion, invasion of clutches by plant roots, crushing by off-road vehicles, or flooding by sea water overwash or excessive rainfall (NatureServe, 2008d).

Kemp's Ridley Turtle

The Kemp's ridley turtle (*Lepidochelys kempii*) is one of the smallest of the sea turtles, with adults reaching about 2 ft (0.6 m) in length and weighing up to 100 lbs (NMFS, 2008b). The Kemp's ridley turtle has been on the endangered species list since 1970.

Population Abundance and Distribution: Adult Kemp's ridley turtles are restricted to the Gulf of Mexico. Juvenile Kemp's ridley turtles inhabit the Gulf of Mexico and the U.S. Atlantic coast north to Nova Scotia (NatureServe, 2008e). A sizeable group of the Kemp's ridley turtle spends summers in the Chesapeake Bay, although most remain in the higher salinity waters of the Virginia portion of the bay.

Habitat Requirements: This turtle is a shallow water benthic feeder with a diet consisting primarily of crabs. Its preferred habitat is shallow, coastal, and estuarine waters, usually over sand or mud bottoms, where crabs are numerous. Nesting occurs on well-defined, elevated dune areas, especially on beaches backed up by large swamps or bodies of open water having seasonal, narrow, ocean connections (NatureServe, 2008e).

Life History: Females begin nesting at the age of 8 to 13 years (Schmid and Witzell, 1997 as cited in NatureServe, 2008e). Nesting occurs on Mexican beaches from April to July. Females lay one to four clutches of about 100 eggs at intervals of 10 to 28 days (NatureServe, 2008e). The eggs hatch in 50 to 55 days (CSTC, 1990 as cited in NatureServe, 2008e). After leaving the nesting beach, hatchlings are believed to become entrained in eddies within the Gulf of Mexico, where they are dispersed within the Gulf and Atlantic by oceanic surface currents. At two years of age, they enter coastal shallow water habitats. Individuals often nest in successive years. Large numbers of females may nest simultaneously on one beach. (NatureServe, 2008e). Individual adult females lay 1-4 clutches averaging about 100 eggs at intervals of 10-28 days, during daylight from April to July. Individuals often nest in successive years. Large numbers of females may nest simultaneously on one beach. Eggs hatch in average of 50-55 days (CSTC

1990). Females begin nesting at an estimated age of 8-13 years (Schmid and Witzell 1997).Individual adult females lay 1-4 clutches averaging about 100 eggs at intervals of 10-28 days, during daylight from April to July. Individuals often nest in successive years. Large numbers of females may nest simultaneously on one beach. Eggs hatch in average of 50-55 days (CSTC 1990). Females begin nesting at an estimated age of 8-13 years (Schmid and Witzell 1997).Individual adult females lay 1-4 clutches averaging about 100 eggs at intervals of 10-28 days, during daylight from April to July. Individuals often nest in successive years. Large numbers of females may nest simultaneously on one beach. Eggs hatch in average of 50-55 days (CSTC 1990). Females begin nesting at an estimated age of 8-13 years (Schmid and Witzell 1997).

Population Dynamics: Kemp's ridley has received protection in Mexico since the 1960's and was listed as endangered throughout its range December 2, 1970 under United States law. Less than fifty years ago, Kemp's ridley was a very abundant sea turtle in the Gulf of Mexico. The population was able to generate a synchronized reproductive effort of an estimated 40,000 females in one day on the single known nesting beach on the northeastern coast of Mexico (Carr 1963, Hildebrand 1963 as cited in USFWS and NMFS, 1992), and a much larger adult population may have existed. The population crash that occurred between 1947 and the early 1970's may have been the result of both intensive annual harvest of the eggs and mortality of juveniles and adults in trawl fisheries (Magnuson ei A. 1990 as cited in USFWS and NMFS, 1992). The recovery of the species has been forestalled primarily by incidental mortality in commercial shrimping, preventing adequate recruitment into the breeding population (USFWS and NMFS, 1992)

The Kemp's ridley is found throughout the Chesapeake Bay from the Potomac River south (VDGIF, 2008a). The Chesapeake Bay is a major summer foraging ground for Kemp's ridley sea turtles (VIMS, 2008b). Developmental habitat for juveniles has been identified in the Chesapeake Bay (USFWS and NMFS, 1992).

The principal threats to this species occur on the nesting beaches, where both deliberate and accidental disturbances interfere with nesting success and in accidental take by fisheries vessels. Kemp's ridley turtles have incurred high mortality due to predation on eggs (especially by coyote), hatchlings, and nesting adults. Restoration of the species requires protecting sub-adult and adult animals by the use of turtle excluder devices on shrimp trawls wherever turtles occur.

Harvested Fish: Nine species of fish that are harvested commercially or recreationally in the Chesapeake Bay are considered important in the project area, as shown in Table 2.4.2-5.

American Shad

The American shad (*Alosa sapidissima*) is one of six shad and herring species to occur in the Chesapeake Bay.

Population Abundance and Distribution: The American shad ranges along the Atlantic Coast from Labrador to the St. John's River in Florida. In addition, the American shad was introduced to the Sacramento River in California, from which it has spread north to eastern Asia and Alaska, and south to Mexico (NatureServe, 2008f). American shad stocks in the Chesapeake Bay are low compared to historic levels (Chesapeake Bay Program, 2008a).

Habitat Requirements: American shad is an anadromous, pelagic-schooling migratory species (Jenkins and Burkhead, 1993). They are found in nearshore marine waters except during the breeding season (NatureServe, 2008f). Spawning takes place in freshwater over shallow flats or in riffles (Bigelow and Welsh, 1925; Massmann, 1952; Barker, 1965 *in* Wang and Kernehan, 1979 as cited in Jenkins and Burkhead, 1993) and often in birthplace rivers and streams (Jenkins and Burkhead, 1993).

Life History: From January to June, shad older than approximately four years enter the Chesapeake Bay to spawn in fresh or near-fresh tributaries as far north as the Susquehanna River. Shad usually complete the spawning run without feeding and move far enough upstream for the eggs to drift downstream and hatch before reaching saltwater. After spawning, the adult either dies or resumes its long pelagic migration. Within a month, young fish begin feeding on zooplankton in the Chesapeake Bay. More than 70% of the young fish die before leaving the estuary (Chesapeake Bay Program, 2008b).

Population Dynamics: Historically, it is likely that American shad spawned in suitable waters across the Atlantic coast. Current spawning runs are limited by physical barriers as well as degraded water quality. These impediments to spawning, added to overharvesting, spurred Maryland to implement a fishing moratorium on American shad in 1980. Virginia concurred in 1994, making it illegal to harvest American shad anywhere in the Chesapeake Bay. Stocks are being enhanced in three ways: (1) restoring native spawning habitat by removing dams or building fishways; (2) supplementing wild stocks with hatchery fish; and (3) improving water quality.

A low of several hundred American shad per year was reported in the early 1980s. The most recent data available show an average of 101,140 per year between 2003 and 2005 (Wolflin, 2008). The increased abundance falls short of the long term restoration goal of two million fish per year. The Atlantic States Marine Fisheries Commission has identified habitat areas of particular concern for the American shad, including spawning sites; nursery areas; inlets that provide access to coastal bays, estuaries and riverine habitat upstream to spawning grounds; and sub-adult and adult nearshore ocean habitat.

The abundance of the closely related hickory shad (*Alosa mediocris*) dropped so low in the Chesapeake Bay in the late 1970s that a moratorium on commercial and recreational capture in Maryland's portion of the Chesapeake Bay was implemented in 1981. Although the population is increasing, the moratorium remains in place. Ocean landings of hickory shad are still allowed and Maryland recorded landings less than 4000 lb (1800 kg) in 2004.

Bay Anchovy

The bay anchovy (*Anchoa mitchilli*) is a small, schooling fish that is a key species in the food web of the Chesapeake Bay (CBEF, 2008).

Population Abundance and Distribution: The bay anchovy ranges along the western Atlantic and Gulf of Mexico coasts, from Maine to Yucatan (NatureServe, 2008g). It is the most abundant fish in the Chesapeake Bay (Chesapeake Bay Journal, 2002).

Habitat Requirements: The bay anchovy prefers the lower freshwater and estuarine reaches of coastal rivers, bays, sounds, and high salinity near-shore marine waters (NatureServe, 2008g). The bay anchovy is commonly found in shallow tidal areas with muddy bottoms and brackish waters and tolerates a wide range of salinities (Froese and Pauly, 2007b). Bay anchovies spawn in estuarine waters where temperatures are above 12°C and salinity is greater than 10 percent (Morton, 1989). The bay anchovy spawns throughout the Chesapeake Bay.

Life History: Bay anchovies spawn from May to September in the Chesapeake Bay. Their eggs hatch in approximately 24 hours. Those that hatch early in the season become sexually mature during their first summer (Morton, 1989). The life span of the bay anchovy is approximately three years (CBEF, 2008).

Population Dynamics: Through predator-prey relationships, the bay anchovy forms a link between zooplankton and top game fish. Striped bass, bluefish, and other sport fish, as well as some birds and mammals, depend on the abundance of bay anchovy to sustain them. In one study, bay anchovy accounted for up to 65% of the biomass consumed by striped bass in the Bay. In summer months from 1995 to 2000, bay anchovy eggs comprised more than 94% of the fish eggs in the plankton of the Middle Bay portion of the Chesapeake Bay. More than 75% of all larval fish collected in ichthyoplankton tows were bay anchovy. The bay anchovy is not commercially harvested. However, bay anchovy populations in the Chesapeake Bay fluctuate annually. Since 1994, the bay anchovy population in the Chesapeake Bay has been on a long term decline, the first ever recorded for the species. In recent years, recruitment of bay anchovy has been lower than expected, based on the various trawl surveys. Although the specific causes of the decline are not well understood, it is known that oxygen levels below 3.0 mg/L can be lethal to eggs and larvae. Dissolved oxygen greater than 2.0 mg/ L is critical for adult survival.

Atlantic Menhaden

Like the bay anchovy, the Atlantic menhaden (*Brevoortia tyrannus*) is a key component of the estuarine food web, consuming plankton and small fish while being consumed by larger predatory fish.

Population Abundance and Distribution: The Atlantic menhaden occurs along the western Atlantic from Nova Scotia south to the Indian River in Florida (Froese and Pauly, 2007c). Adults are present in near proximity to the CCNPP site year round. In the Middle Bay, spring egg collections were comprised of more than 80% menhaden.

Habitat Requirements: The Atlantic menhaden is found inshore in summer, but some move into deeper water in winter (Froese and Pauly, 2007c). Adults are found in near-surface waters (June, 1961 as cited in Froese and Pauly, 2007c), usually in shallow areas overlying continental shelf (Froese and Pauly, 2007c). The Atlantic menhaden is found in greatest abundance immediately adjacent to major estuaries (Jones et al, 1978 as cited in Froese and Pauly, 2007c). Juveniles are generally pelagic, with the smallest size groups occurring farthest up river. Estuaries are the preferred nursery habitat (Froese and Pauly, 2007c).

Life History: Atlantic menhaden spawn throughout the entire year in inshore waters over most of the continental shelf. Their eggs are buoyant and hatch within 2 to 3 days depending on water temperature. Larvae are pelagic and probably spend between one and three months in waters over the continental shelf. In Maryland, larval fish enter the Chesapeake Bay in late winter and early summer and move into lower salinity waters in estuarine tributaries where they are found in great numbers. These juveniles remain in the Bay until the fall when most migrate to the ocean. The following spring they migrate northward as adults to the Chesapeake Bay area and into New England waters (MDNR, 2007a).

Population Dynamics: Unlike the bay anchovy, the Atlantic menhaden is directly targeted by commercial harvesters. In 2004, more than 3 million lb (1.4 million kg) were landed in Maryland. Atlantic menhaden stocks across the Atlantic coast are stable. However, reduced abundance in the Chesapeake Bay, a key nursery area, has been reported. Due to the concern over the steady decline in recruitment in the Chesapeake Bay, fisheries managers have recently (starting in 2006) capped the commercial harvest of Atlantic menhaden for 5 years (ASMFC, 2005). The limits on harvest of Atlantic menhaden are based on the importance of Atlantic menhaden to predatory fish, including the striped bass and bluefish.

Atlantic Croaker

The Atlantic croaker (*Micropogonias undulatus*) is one of the top ten recreational finfish in the Chesapeake Bay.

Population Abundance and Distribution: The Atlantic croaker ranges along the Atlantic coast from Massachusetts to Florida, and from the northern Gulf of Mexico to Mexico (NatureServe, 2008h). Adults are abundant in the Chesapeake Bay from March to October. They move offshore and south along the Atlantic coast in the fall. Juveniles are present in the Bay year round.

Habitat Requirements: The Atlantic croaker is a bottom-feeding generalist, consuming benthic invertebrates and some fish. It prefers coastal waters and estuaries (Froese and Pauly, 2007d) and is associated with muddy substrates in depths less than 400 ft (120 m), in a wide range of salinity and temperature conditions. Spawning occurs offshore over the continental shelf (SCDNR, 2006). Nurseries and feeding grounds are typically located in estuaries (Froese and Pauly, 2007d).

Life History: The Atlantic croaker spawns offshore in August. Their eggs are pelagic (NatureServe 2007g). Larvae are carried into the coastal inlets by tidal currents (SCDNR, 2006). Young-of-the-year move into the Chesapeake Bay and into low salinity and freshwater creeks during autumn (Chesapeake Bay Program, 2008c). They overwinter farther upstream and then leave the Bay the following autumn with the adults (Chesapeake Bay Program, 2008c). Juveniles become sexually mature in two years (NatureServe, 2008h).

Population Dynamics: All of the major predatory fish in the Chesapeake Bay, including striped bass, flounder, shark, spotted seatrout, other species of croaker, bluefish and weakfish, include Atlantic croaker in their diet. The Atlantic croaker is a perennial favorite of the human population, as well, ranking within the top 10 species caught by anglers. Historically, the Chesapeake Bay region accounted for the majority of Atlantic coast croaker landings.

Recreational landings in the region have been declining since 1986. After a sharp decline in commercial landings during the 1970s and 1980s, Atlantic croaker landings in Maryland increased to close to 1 million lb (454,000 kg) per year for most of the 1990s. In fact, commercial landings in 2001 were higher than at any time since 1956, indicating a rebound of the Atlantic croaker fishery in the Chesapeake Bay.

Striped Bass

The striped bass (*Morone saxatilis*) is the dominant predator in the Chesapeake Bay (Walter III and Austin, 2003).

Population Abundance and Distribution: The striped bass is native to the Atlantic slope drainages from the St. Lawrence River in Canada to the St. John's River in Florida and in Gulf slope drainages from western Florida to Lake Pontchartrain in Louisiana. It was introduced widely in inland areas of the U.S. and the Pacific coast and has spread north to British Columbia and south to Baja California (NatureServe, 2008i). Juveniles and adults occur in the Chesapeake Bay year round. The abundance and distribution of the striped bass affect countless other species, including the Atlantic menhaden.

Habitat Requirements: The striped bass is a marine and estuarine coastal species that moves far upstream in channels of medium to large rivers during spawning migrations. Rivers, tidally influenced freshwaters, and estuaries are used for spawning and nurseries. (NatureServe, 2008i).

Life History: Upriver migration and spawning of the Chesapeake populations occur between April and early June (Jenkins and Burkhead, 1993). The striped bass spawns in aggregations (NatureServe, 2008i). Eggs hatch in 2 to 3 days and larvae become free swimming in 4 to 10 days (Hardy, 1978a as cited in Jenkins and Burkhead, 1993). Males become sexually mature in 1 to 3 years, females in 4 to 6 years (NatureServe, 2008i). In the Chesapeake basin, both sexes stay in nurseries for at least two years either in the Bay or in their birthplace rivers, and first leave the Bay at age 3 to 4. The life span of the striped bass is approximately ten years (Jenkins and Burkhead, 1993).

Population Dynamics: Juvenile striped bass feed on zooplankton and benthic invertebrates. Adults eat a variety of other important fish, including bay anchovy, Atlantic menhaden, spot, Atlantic croaker, and white perch.

This large anadromous species has a complex life history that centers on the Chesapeake Bay, where historically, about 90% of the Atlantic population spawned (Chesapeake Bay Journal, 1994). Distribution patterns are influenced by the age, sex, degree of maturity and the river in which they were born. Successful completion of the striped bass life cycle requires a variety of habitats including spawning sites, nursery areas, passages between inland spawning and estuarine nursery habitats, and offshore wintering grounds.

Commercial and recreational landings in the Chesapeake Bay generally increased from the 1930s through the mid-1970s then declined sharply through the mid-1980s. Aside from direct overfishing, it is thought that low dissolved oxygen increased stress on the fish, making them susceptible to disease. A moratorium on all striped bass fishing in Maryland in 1985, and in Virginia in 1989, allowed the population to rebound. According to the Maryland Department of

Natural Resources (MDNR), 602,506 lb (273,292 kg) of striped bass were harvested from the south central area of the Chesapeake Bay near the CCNPP site in 2004. This was one of the top 10 years of greatest harvest since data collection began in 1944. Concerns about the future of this fishery remain. A large percentage of striped bass appear to be malnourished and up to 70% of the population is infected with mycobacteriosis, a type of wasting disease (Wolflin, 2008). The impact of this disease of sustainability of the stock is not well understood at this time.

Spot

Spot (*Leiostomus xanthurus*), like the Atlantic croaker, occupies a middle position in the Chesapeake Bay food web, as a consumer of benthic invertebrates and as prey for striped bass, bluefish, weakfish, shark and flounder.

Population Abundance and Distribution: Spot can be found in estuarine and coastal waters from Cape Cod to the Bay of Campeche in Mexico (NatureServe, 2008j). Spot ranges throughout the Chesapeake Bay from April through October.

Habitat Requirements: Spot is a generalized omnivorous bottom feeder that prefers shallow coastal waters and estuaries with mud or sand bottoms (NatureServe, 2008j). It is broadly tolerant of temperature and salinity fluctuations. Spawning takes place offshore over the outer continental shelf (NatureServe, 2008j).

Life History: Spawning occurs offshore in the months of September through November in the Chesapeake Bay (NatureServe, 2008j), then the young move into the estuary for rearing. They become sexually mature in two years and have a typical life span of three years (NatureServe, 2008j).

Population Dynamics: In addition to their central role in the food web, spot are important to both commercial harvesters and recreational anglers. Inter-annual variability in spawning conditions leads to unpredictable landings. No long term declines, however, have been noted. Commercial landings are highest during the fall migration out of the Chesapeake Bay, when they are taken as by-catch from the pound net fishery in the lower Bay. According to MDNR, commercial catches in Maryland have exceeded 100,000 lb (45,000 kg) annually since 1998.

White Perch

White perch (*Morone americana*) are semi-anadromous predaceous fishes that spend their entire lives in the Chesapeake Bay (MDNR, 2007b).

Population Abundance and Distribution: The range of the white perch encompasses Atlantic slope drainages from the St. Lawrence – Lake Ontario drainage in Quebec to the Pee Dee River in South Carolina (NatureServe, 2008k). The white perch is abundant in the Chesapeake Bay (MDNR, 2007b).

Habitat Requirements: White perch migrate from the open Chesapeake Bay into the tidal-fresh portions of the bay to spawn over the sandy bottoms of brackish or tidal-fresh rivers (Pat Panther Fishing, 2008). They never move into the open ocean (Pat Panther Fishing, 2008) and are common in quiet water (NatureServe, 2008k).

Life History: Spawning occurs from April to June (MDNR, 2007b), and eggs hatch in about 4 days (NatureServe, 2008k). Young white perch remain near shore downstream from their hatching areas for several months, foraging for insect larvae and crustaceans. Adult white perch overwinter in the deeper channels of the Chesapeake Bay. The lifespan of the white perch is approximately 10 years (MDNR, 2007b).

Population Dynamics: White perch are heavy consumers of fish eggs, including those of striped bass. The white perch is considered a delicious table fish, and supports an important recreational fishery in the Chesapeake Bay. It is also commonly taken as by-catch by commercial harvesters. Large schools of white perch are vulnerable to capture when they aggregate in large schools to feed on herring. According to MDNR, commercial catches in Maryland have exceeded 1 million lb (453,000 kg) annually since 1995.

Bluefish

The bluefish (*Pomatomus saltatrix*) is a migratory pelagic species that primarily travels in schools (Murdy et al, 1997).

Population Abundance and Distribution: In the western Atlantic, the bluefish ranges from Nova Scotia to Brazil but is rare in the Caribbean Sea (Murdy et al, 1997). The migratory bluefish visits the Chesapeake Bay area from spring to fall. It is abundant in the lower bay and common in the upper bay (Murdy et al, 1997).

Habitat Requirements: Bluefish occur in oceanic and coastal waters (Claro, 1994 as cited in Froese and Pauly, 2007e) and are most common along surf beaches and rock headlands in clean, high energy waters (Froese and Pauly, 2007e). Bluefish spawn offshore over outer continental shelf (Murdy et al, 1997) in the Chesapeake region. Larger juveniles and adult bluefish have broad habitat tolerances and range throughout the Chesapeake Bay in search of forage fish. The bluefish diet is varied, consisting of fish species from all depths, including Atlantic menhaden, weakfish, and croaker. As a large, mobile predator, it competes with the striped bass for food.

Life History: Bluefish spawn offshore in the Chesapeake region in July. Eggs are pelagic and hatching is temperature dependent (NMFS, 2008c). Transformation from larva to juvenile occurs after approximately 18 to 25 days (NMFS, 2008c). Juvenile bluefish move into the bay during late summer. Most bluefish mature by age 2 (MDNR, 2007c). Their lifespan is approximately 12 years (NMFS, 2008c).

Population Dynamics: About 20% of the bluefish caught commercially in the U.S. are landed in the Chesapeake Bay, making bluefish a significant fishery in the area. The majority of the catch is in the Virginia portion of the Chesapeake Bay. Historic highs and lows in the harvest have occurred during the last 70 years. Until about 1992, commercial landings of bluefish in Maryland routinely exceeded 200,000 lb (90,000 kg) annually. Although overall stocks of bluefish in the Atlantic are increasing, landings in the Chesapeake Bay are on the decline, possibly due to over harvesting. According to MDNR, about 52,000 lb (23,000 kg) of bluefish were landed by commercial fishermen in 2004.

The bluefish ranked first in number and weight among sportfish in the Chesapeake Bay for nearly 20 years, until the current decline began in 1990. Recreational landings outnumber commercial landings by at least 5 times. MDNR implemented a management plan in 1990 in response to concerns about declining regional bluefish stocks.

American Eel

The American, or common, eel (*Anguilla rostrata*) is a widely distributed catadromous species.

Population Abundance and Distribution: American eels range along the Atlantic coast of North America, throughout the Gulf of Mexico and the Caribbean, and along the east coast of Central America to Venezuela (Murdy et al, 1997). The American eel is abundant year-round in all tributaries to the Chesapeake Bay.

Habitat Requirements: American eels live predominately in rivers, lakes and estuaries, but migrate into the center of the Atlantic Ocean to spawn. They are most commonly found in permanent streams with continuous flow, hiding during the day in undercut banks and in deep pools near logs and boulders (Froese and Pauly, 2007f). During the 5 to 20 years the American eel spends in the Chesapeake Bay (NOAA, 2008), it feeds at night on insects, mollusks, crustaceans, worms, and other fish.

Life History: American eels spawn in winter and early spring (NatureServe, 2008l). Larvae drift in ocean currents before entering coastal waters where they metamorphose (Murdy et al, 1997). American eels go through phases of pigmentation beginning with the transparent glass eel stage as they migrate upstream. Most of their life is spent in the yellow phase, in which they are nocturnally active omnivores (Murdy et al, 1997). In the Chesapeake Bay, American eels reach maturity in 8 to 24 years and populations are dominated by females (NatureServe, 2008l). Sexual maturity is delayed until just prior to the reproductive migration in which eels migrate to the ocean to spawn. Adults die after spawning (Murdy et al, 1997).

Population Dynamics: In all its life stages, the American eel is an important prey species, as it is consumed by a variety of fish, aquatic mammals, and birds. The American eel is caught in commercial eelpots. Most eels landed in the Chesapeake Bay area are juveniles, or "glass eels," which are exported to Europe and Asia. Recreational anglers do not typically target the eel for consumption, although they are often bought for use as bait for striped bass and other sport fish.

In 2005, the Atlantic States Marine Fisheries Commission determined that eel abundance had fallen since the late 1970s to mid-1980s and was at or near historic lows along the entire Atlantic coast. The decline was not attributed to any particular cause although several possible factors such as harvest, habitat loss, predation, hydroturbine mortality, disease, parasitism, and reduced fecundity resulting from pollution were noted. The commercial catch in 1981 was more than 700,000 lb (317,000 kg) in both Maryland and
Virginia but has been declining ever since (Chesapeake Bay Program, 2008d).

The American eel was considered for special protection under the Endangered Species Act. The U.S. Fish and Wildlife Service on January 30, 2007 announced the completion of an extensive status review of the American eel, concluding that protecting the eel as an endangered or threatened species under the Endangered Species Act is not warranted. The

American eels mature slowly (reproducing at age 8 to 24 years) and are vulnerable to targeted harvest during seasonal migrations, which occur before the first spawning of new adults.

Harvested Invertebrates

Two species of invertebrates have been historically important to commercial and recreational harvesters near the CCNPP site, and throughout the Chesapeake Bay: the blue crab and the American oyster. Both species are now severely depleted, and under strict management provisions.

Blue Crab

The blue crab (*Callinectes sapidus*) plays a vital role in the Chesapeake Bay region as both predator and prey.

Population Abundance and Distribution: Blue crabs are known to occur in the western Atlantic from Nova Scotia to northern Argentina and were introduced in the eastern Atlantic, the northern and eastern Mediterranean, and in Japan (FAO, 2008a). Blue crabs range from the upper Chesapeake Bay near freshwater tributaries down to the mouth of the Chesapeake Bay. Although mating occurs in the areas near the CCNPP site, the females typically migrate down-bay to a spawning and hatching area approximately 70 mi (110 km) south of the CCNPP site, where an appropriate salinity of approximately 23 to 28 parts per thousand occurs.

Habitat Requirements: Blue crabs use all the available habitats within the Chesapeake Bay, preferring shallower areas during warm weather and deeper areas during winter. While males move up into the Bay and tributaries, females tend to congregate in saltier waters. Blue crabs are bottom-dwellers and utilize bay grass beds for mating, shelter, and nurseries (Chesapeake Bay Program, 2008e).

Life History: Blue crab mating takes place from May to October. Females migrate to the saltier lower bay to spawn where they release larvae, called zoea, after two weeks. The zoea are transported to the ocean by currents and back to the Bay by winds. The larvae molt several times before reaching a post larval form called megalops. Megalops travel farther up into the Bay and metamorphose into the first crab stage. They molt several more times before becoming adults at 12 to 18 months (Chesapeake Bay Program, 2008e). The lifespan of the blue crab is 3 years (Van Den Avyle, 1984).

Population Dynamics: The Chesapeake Bay is the largest producer of crabs in the country, supporting major commercial and recreational fisheries. In most years, at least 30% of the nation's blue crabs come from Chesapeake Bay waters. According to the CBP, annual commercial harvests can approach 100 million lb (45.4 million kg) of crab.

The number of mature female Chesapeake Bay blue crabs, or spawning stock, remains below the long term average. The 2006 winter survey conducted by MDNR showed that the total number of crabs in the Chesapeake Bay was low compared with historical averages but stable. In 2006, the Chesapeake Bay Foundation issued a Chesapeake Bay score of 38%, or grade C for the blue crab. Reasons for the observed reduction in harvest are complex but may include over-harvesting, loss of habitat, and degradation of water quality. Juvenile crabs are closely tied to submerged aquatic vegetation and may suffer a decline when submerged aquatic vegetation is unavailable for use as habitat and nursery grounds. Crabs are bottom feeders, and can be sensitive to low dissolved oxygen near the substrate.

American Oyster

The American oyster (*Crassostrea virginica*) is a filter feeding bivalve mollusk (Chesapeake Bay Program, 2008f).

Population Abundance and Distribution: The American oyster ranges from Canada's Gulf of St. Lawrence to the Gulf of Mexico, the Caribbean Sea, and the coasts of Brazil and Argentina. It has been introduced to British Columbia, the west coast of the United States, Hawaii, Australia, Japan, and the United Kingdom (FAO, 2008b). Oyster breeding and nursery areas occur near the CCNPP site. New beds were created during construction of CCNPP Units 1 and 2 to mitigate habitat loss. However, oysters have not occurred in sufficient numbers for commercial fishery near the CCNPP site since at least 1971.

Habitat Requirements: The American oyster thrives in estuaries, but also lives in marine coastal environments (FAO, 2008b). American oysters are often found concentrated in areas with shell, hard sand or firm mud bottoms (Chesapeake Bay Program, 2008f).

Life History: The American oyster discharges gametes into the water column in response to a variety of stimuli, including warmer temperatures, pheromones, and the presence of appropriate phytoplankton (FAO, 2008b). Fertilized eggs develop into larvae after about 24 hours (Chesapeake Bay Program, 2008f). After 2 to 3 weeks in the plankton, larval oysters attach to the Chesapeake Bay substrate in a place where they will become permanently attached as adults. Upon being stimulated to settle, the oyster cements its left valve to the substrate and metamorphoses into a juvenile oyster, or spat, by discarding its velum, reabsorbing its foot, and enlarging its gills (FAO, 2008b).

Population Dynamics: The American oyster is highly valued in the Chesapeake Bay but has been declining since the late 1800s due to over-harvesting, parasites, and poor water quality. A healthy oyster provides many services to the Chesapeake Bay ecosystem, including filtering the water, producing planktonic larvae that feed a variety of larval fish, and creating a physical structure with its shell that many other animals use for shelter and foraging. Efforts to restore the oyster fishery include expanding the amount of clean, hard surfaces for oyster spat to settle, increasing the number of breeding adult oysters, and developing methods for controlling oyster diseases.

Description of Additional Species

ASMFC Stock Status Overview

The Atlantic States Marine Fisheries Commission (ASMFC) collects and publishes stock status data for 22 managed species or species groups. From the "important" species addressed above, these include Atlantic striped bass, Atlantic menhaden, Atlantic croaker, Atlantic sturgeon, American shad, American eel, bluefish and spot. From the additional list addressed below, summer flounder, red drum and weakfish are included in the stack status assessments.

Essential Fish Habitat: NMFS Mid-Atlantic RMC, which is responsible for managing EFH in Maryland, has established EFH for various life stages of nine species of fish in the northern Chesapeake Bay, where CCNPP is located. These fish species are butterfish, cobia, king mackerel, Spanish mackerel, red drum, bluefish, black sea bass, windowpane flounder, and summer flounder. The EFH for these species includes the entire northern Chesapeake Bay and are depicted on Figure 11.1-1 in relation to the area proposed to be impacted during additional CWIS, discharge, and barge facility construction.

Summer Flounder

EFH has been designated in the vicinity of the project area for larval, juvenile, and adult summer flounder (*Paralichthys dentatus*).

Population Abundance and Distribution: Summer flounder are found in estuarine and coastal waters from Nova Scotia to Florida. They are most abundant from Cape Cod, Massachusetts to Cape Fear, North Carolina. Within Chesapeake Bay, summer flounder are largely restricted to waters south of Annapolis, but they can be found occasionally in the upper Bay (MDNR, 2007d).

Habitat Requirements: Summer flounder spawn offshore, and larvae enter the Chesapeake Bay from October to May, entering inshore coastal and estuarine areas to complete transformation. After metamorphosis, the larvae settle from the water column to the substrate, where they may start to exhibit burial behavior (NOAA, 1999). Juvenile summer flounder utilize eelgrass beds as nursery habitats in the Chesapeake Bay. Summer flounder bury themselves in sandy substrates, which comprise approximately 93 percent of the substrate in the vicinity of the proposed construction activities (EA, 2007a). Most adult summer flounder migrate into the Chesapeake Bay from spring to autumn and then migrate offshore during the winter months; however, some are year-round residents. The summer flounder is more common in the lower bay than in the upper bay, extending as far north as the Gunpowder River. Adult summer flounder typically occur in deep channels, ridges, or sandbars. Summer flounder greater than 3 years in age primarily inhabit coastal waters. Adults have often been reported as preferring sandy habitats (NOAA, 1999; Murdy, 1997).

Life History: Winter spawning migrations in Chesapeake Bay begin in October, moving offshore to depths of 100 to 600 feet during the winter. Their migration is presumably brought on by decreasing water temperatures and declining photoperiods in the fall. Spawning begins at about age 2 and generally occurs in the fall and winter during offshore migrations and/or at the wintering grounds. Fish spawning north of Chesapeake Bay continues through December, while fish spawning south of Chesapeake Bay begins in November and ends in February (MDNR, 2007d).

Population Dynamics: MDNR provides the following: summer flounder are managed as one stock extending from North Carolina to Maine. Since 1980, 70% of the commercial landings have come from the Exclusive Economic Zone (EEZ: greater than 3 miles from shore). Large variability in landings has occurred within and among the states and over time. Summer flounder exist in Maryland in all waters where the salinity is above 10 parts per thousand. This includes the Maryland Coastal Bays, near shore Atlantic Ocean, and the Chesapeake Bay up to the Bay Bridge (Doctor, 2000).

The coastal stocks underwent a collapse in 1989 and 1990, but since then strict regulation has allowed a slow recovery in spawning stock biomass, age structure, and overall stock abundance. The council Plan Amendment 12 total biomass target (B MSY) required to produce maximum sustainable yield for the stock is B MSY =106,400 metric ton (mt), and the threshold for a recovered fishery is one-half B MSY =53,200 mt. The peak biomass from 1982 to 1998 was 48,500 mt. 1983, and the low was 16,000 mt. in 1989. The 1998 estimate of biomass was 38,600 mt. The 1999 biomass was estimated at 41,400 mt, or 23% below the threshold target (Doctor, 2000).

Spawning stock biomass has increased (age 0 and older) since 1989 (5,247 mt) to 17,400 mt. in 1996, to 25,000 mt in 1998. There is an 80% chance that the 1998 spawning stock biomass was between 22,500 mt and 28,500 mt which is a medium level of historical abundance. The age structure of the SSB has expanded recently. In 1995 only 12% of the SSB was ages 2 and older. In 1998, 70% of the SSB was ages 2 and older. Under equilibrium conditions at FMAX, at least 88% of the spawning stock biomass would be expected to be age 2 and older (Doctor, 2000).

The fishing mortality rate on summer flounder is high, peaking at 2.1 (82% exploitation) in 1992, and was estimated to be 1.5 (72% exploitation) in 1995. The estimated mortality for 1995 was above the target mortality rate [FTGT = 0.53 (38% exploitation)]. The fishing mortality rate for 1996 was estimated to be 1.0 (58% exploitation), still above the management target rate of FTGT 0.41 in 1996. The fishing mortality rate in 1998 was estimated at 0.52. There is an 80% chance the 1998 F was between 0.46 and 0.58. Projections made at the 2000 SARC estimated that by January 1, 2001 F would be 0.26, if quotas were not exceeded in 2000. The overfishing definition is (FMAX =0.24). While the fishing mortality rate is declining, it is still above the overfishing definition (Doctor, 2000).

Stock status reports from ASMFC showed continuous growth of summer flounder stocks from 2000 through 2005, with achievement of the Spawning Stock Biomass Threshold (SSB) target of 100 million pounds as of 2003. However, SSB fell below the threshold to 93.3 million pounds in 2006. ASMFC currently describes summer flounder stocks as "depleted, overfished and overfishing is occurring." Fishing mortality is currently F=0.35 (FMAX=0.24).

Red Drum

Red drum (*Sciaenops ocellatus*) is one of nine species for which the Chesapeake Bay has been designated as EFH. The Chesapeake Bay has been designated as EFH for egg, larva, juvenile, and adult red drum life stages. Red drum is a euryhaline fish species that supports a healthy recreational sportfishery throughout most of its range (FAO, 2008c).

Population Abundance and Distribution: The historic distribution of red drum on the Atlantic coast is from the Gulf of Maine to northern Mexico. This species has become uncommon north of New Jersey.

Red drum are more abundant in the Gulf of Mexico than along the Atlantic coast (MDNR, 2007e). Adult red drum occur in the Chesapeake Bay from May to November and are most abundant in the spring and fall near the bay mouth in salinities above 15 parts per thousand. The species ranges as far north as the Patuxent River (Murdy, 1997).

Habitat Requirements: Adults occupy coastal and estuarine waters; are most common over sandy bottoms and are often captured in the surf zone. Some individuals may enter fresh water (e.g., St. Johns River, Florida). Juveniles use estuaries as nursery areas for 6-8 months. Red drum juveniles are generally found in shallow estuarine areas with little tidal influence and grassy or muddy bottoms (Buckley, 1984). Juveniles are most abundant in estuarine waters and inlets, while fish older than age-5 primarily inhabit coastal and offshore waters, often in large schools (MDNR, 2007e). Spawning occurs in coastal waters near passes, inlets, and bays (Manooch, 1984).

Life History: Red drum spawn in nearshore coastal waters from late summer through fall, and the eggs drift until they hatch (Murdy, 1997). Red drum larvae (approximately 6-8 mm SL) are transported via currents into estuaries, where they utilize seagrass beds and SAV as nursery habitats (FAO, 2008c).

Red drum are benthic feeders. Juveniles eat mostly copepods, amphipods, and tiny shrimps; adults eat fishes, crabs, shrimps, and sand dollars (Manooch, 1984).

Prey items selected by adult red drum vary by season but include moderate-sized crustaceans (e.g., blue crab and white shrimp [*Penaeus* spp.]) and fishes (e.g., clupeids) (Murdy, 1997).

Population Dynamics: Red drum are one of the most recreationally sought-after fish throughout the South Atlantic. Since the 1980s recreational fishing has accounted for about 90 percent of all red drum landings. Over the past decade, anglers have generally harvested between 250,000 and 500,000 fish per year. Red drum are landed commercially in only a few states. Small trip limits (generally the same as each state's recreational creel limit) have kept the commercial harvest between 50,000 and 300,000 pounds in most years of the last two decades (ASMFC, 2008a).

Through successful joint management by the Atlantic States Marine Fisheries Commission and the South Atlantic Fishery Management Council, red drum populations have shown significant increases. Spawning potential ratio (SPR), a measure of the fecundity of the population, is used to assess the stock. The last red drum assessment in 2000 demonstrated increases in SPR along the coast from 0.5-1.3 percent in 1987-1991 to 15-18 percent in 1992-1998. The next assessment for red drum will be in 2009, and will look to see if SPR has reached the current target of 40 percent (ASMFC, 2008a).

The Commission approved Amendment 2 to the Red Drum Fishery Management Plan in 2002. The Amendment required states to implement recreational creel and size limits to achieve the stock status goal of 40 percent SPR, including a maximum size limit of 27", and maintain existing commercial regulations. The management of red drum presents two particular challenges. First, the fishery removes mostly juvenile fish in state waters, which has significantly reduced recruitment to the spawning stock. Second, data on the adult population are limited, which makes assessing stock status difficult (ASMFC, 2008a).

Weakfish

Population Abundance and Distribution: Weakfish (*Cynoscion regalis*) are a migratory species occurring along the Atlantic coast of North America from Nova Scotia to southeastern Florida, although they are more common between New York and North Carolina. Important wintering grounds for the stock are located in offshore waters from Chesapeake Bay to Cape Lookout (ASMFC, 2007).

Habitat Requirements: Feeding on microscopic animals, larval weakfish journey from inshore spawning areas to coastal nursery areas, located in deeper portions of coastal rivers, bays, sounds, and estuaries. Growing into juveniles, they stay in the nursery areas until October to December of their first year, after which they migrate to the coast. As adults, inshore weakfish are often found near the periphery of eelgrass beds, perhaps because weakfish feed primarily on shrimp, other crustaceans, and small fish that are found near these grass beds (ASMFC, 2007).

Life History: When water temperatures rise in the spring, the mature fish migrate north and inshore to the spawning grounds. In these nearshore and estuarine areas between March and September, mature females produce large quantities of eggs that are fertilized by mature males as they are released into the water. Females continuously produce eggs during the spawning season and release them over a period of time rather than once. In the fall, an offshore and southerly migration of adults, coinciding with declining water temperatures, brings the mature weakfish back to the wintering grounds (ASMFC, 2007).

Growth in weakfish is especially rapid in the first year and they mature at a young age. 90 percent are mature at age one, 100 per cent by age two. Size at age one is variable but most fish are ten to eleven inches long (ASMFC, 2007).

Population Dynamics: In 2006, total weakfish harvest reached an all time low of less than 2 million pounds. For comparison, total weakfish harvest was greater than 31 million pounds in 1986. The apparent decline in abundance was supported by the results of the 2006 weakfish stock assessment. However, the assessment found that, concurrent with the decline in abundance, fishing mortality had not increased. Instead, total mortality—fishing mortality plus natural mortality—had increased. The leading theory suggests that increased predation on weakfish and reduced forage fish for weakfish have caused natural mortality to increase, although other hypotheses may not have been fully examined (ASMFC, 2008b).

Weakfish are currently managed under Amendment 4, and its addenda, to the Interstate Fishery Management Plan. States in the management unit have implemented regulations to achieve the biological reference points established in Amendment 4. State commercial regulations include a minimum size limit, corresponding mesh size limits, seasonal closures, bycatch reduction devices, and a bycatch limit. Recreational regulations include creel and size limits. Responding to the recent decline in abundance, the Commission also approved an addendum in 2007 to implement more conservative recreational creel limits, a reduced bycatch allowance, and two management triggers to initiate management action when the stock begins to recover (ASMFC, 2008b).

Weakfish are found throughout the Bay during spring and summer, when the coastal weakfish population migrates northward. In autumn they leave the Bay for their southward migration (Chesapeake Bay Program, 2008g). Larger fish (year 2 and older) appear in the lower Chesapeake Bay in April – May, with age-1 fish becoming abundant in summer (Murdy, 1997).

Weakfish landings by pound nets, gill nets, and haul seines constitute an important fishery in the lower Chesapeake Bay, but the fishery has been in decline since the 1940s. Maryland reported bayside landings of 700,000 pounds in 1948, but the catch has averaged less than 200,000 pounds in the 1980s and 1990s. In Virginia, the bay catch peaked at 16 million pounds in 1946 but has not exceeded 6 million pounds since 1948. Recent Virginia landings have rarely exceeded 2.5 million pounds. Weakfish are a major recreational species in the bay, with the 1985 estimated catch exceeding 1 million pounds (Murdy, 1997).

Spotfin Killifish

Population Abundance and Distribution: The spotfin killifish, *Fundulus luciae*, has been reported infrequently in brackish coastal habitats from Long Island, New York (Butner, 1960) to Georgia (Jorgenson, 1969). Spotfin killifish was considered rare (Hildebrand, 1928; Nichols, 1927; Richards, 1967) prior to focused studies which documented local abundance and distribution patterns of this species in New Jersey, Georgia, and Virginia (Able, 1983; Kneib, 1984; Yozzo, 1994). Recent reports indicate that the northern limit for spotfin killifish is southern Massachusetts, where they have been collected in tidal tributaries of Narragansett Bay (Hartel, 2002).

Habitat Requirements: Recent collections in salt marshes of the lower Housatonic River, at Milford, CT, indicate that spotfin killifish may be common in habitats dominated by both common reed, *Phragmites australis* (Cav.) Trin. ex Steud., and saltmarsh cordgrass, *Spartina alterniflora* Loisel (Osgood, 2003). Spotfin killfish occur in high intertidal areas in brackish, sometimes oxygen - deficient shallow ditches, mudholes, and tidal rivulets in stands of smooth cordgrass (Byrne, 1978). It has been recorded from freshwater ponds in Virginia and Maryland (Lee, 1980).

Life History: Members of the killifish genus are renowned for their survival skills in habitats most fishes find inhospitable. The spotfin killifish is found in salt marshes on the Atlantic coast from Georgia to Massachusetts. Spotfins thrive in an environment extreme even for a *Fundulus*; their preferred niche is in salt marshes among the *Spartina* grasses along the high tide line in waters that might average 2 or 3 cm deep. This environment is subject to large swings of temperature, oxygen, and water cover. At low tide spotfins can often be found in shallow muddy troughs, or even wrapped around the bases of clumps of *Spartina.* The only other fish commonly encountered in this strip between dry land and stable water is another killifish, *F. heteroclitu,s* commonly known as the mummichog (Stallsmith, 2008).

Spotfins are small fish never larger than 5 cm. They're named after a dorsal ocellus carried by males. Wild spotfins are so well adapted to their muddy environment that they don't glisten out of water like most fishes, but rather have a flat gunmetal gray base color. No other fish must complete its life cycle on the salt marsh as does the spotfin; mummichogs are often found in marsh creeks or in bays, but spotfins of any age are rarely found outside their narrow strip of upper marsh. An apparent advantage of this specific niche is safety from predatory fishes unable to navigate the watery muds of the upper marsh; but the spotfin must still contend with wading birds. Adults feed on medium-sized zooplankton and emergent insects, while juveniles search out smaller zooplankters such as rotifers and nematode worms (Stallsmith, 2008).

Spotfins spawn from spring to early fall, mostly in spring and are sexually mature 2-3 months after hatching. Their life span is probably about 1 year (Byrne, 1978; Kneib, 1978; NatureServe, 2008m). Spawning habitat includes herbaceous wetland, and tidal flat/shore. Spotfin killfish eat mainly detritus, diatoms, ostracods, dipterans, copepods, and other small organisms (Byrne, 1978).

Population Dynamics: NatureServe describes the Rounded Global Status as G4 -Apparently Secure. The species has an apparently spotty distribution from Massachusetts or Long Island to North Carolina or Georgia, is common in many areas, and is not very threatened. The National Status for the US is N3N4 (N3: Vulnerable - vulnerable in the nation or state/province due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors making it vulnerable to extirpation, N4: Apparently Secure - uncommon but not rare; some cause for long-term concern due to declines or other factors). The Global Short Term Trend is stable (unchanged or within +/- 10% fluctuation in population, range, area occupied, and/or number or condition of occurrences). The Maryland Status is S2 (Imperiled - imperiled in the nation or state/province because of rarity due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation from the nation or state/province). The spotfin killfish distribution in Maryland includes Somerset (24039), St. Marys (24037), and Worcester (24047) counties. Threats include alteration of saline, coastal marshes (i.e., lagoon development). The spotfin killfish is currently unthreatened in New Jersey as development in saline marshes has been controlled over the past 20 years. It is dependent on high salt wetlands that are inundated during spring tides; these areas are protected in New Jersey and many other areas (NatureServe, 2008m).

Relatively little is known about the life history and habitat preferences of spotfin killifish. Unlike mummichogs, adult and juvenile spotfin killifish tend to remain on the intertidal marsh during all stages of the lunar tidal cycle, seeking refuge in shallow icrodepressions, which retain standing water at low tide (Able, 1983). Although not widely distributed among marsh habitats, spotfin killifish are environmentally tolerant and adaptable, and are found in waters of varying temperature, salinity, and dissolved oxygen content (Byrne, 1978; Talbot, 1984). Byrne studied habitat preferences, food habits, and reproduction in a Virginia population of spotfin killifish; this is the most intensive study of the species to date. He found the species' preferred habitat to be *S. alterniflora* marsh with shallow, water-filled depressions and small, seasonal pools in saltmeadow hay, *S. patens* (Ait.) Muhl., marsh. Byrne observed adults throughout the year, with greatest abundance in spring and summer months. In a North Carolina study, spotfin killifish was collected using pit traps and found to be common in irregularly flooded black needlerush, *Juncus roemerianus* Scheele, marsh (Shields, 1983).

Likelihood of Project Impacts: Although primarily associated with intertidal marsh and brackish coastal habitats, references also note its environmental tolerance and adaptability to waters of varying temperature, salinity, and dissolved oxygen content (Byrne, 1978; Talbot, 1984). At least one reference notes that it has been recorded from freshwater ponds in Virginia and Maryland (Lee, 1980). However, the Aquatic Field Studies Report found no specimens of any *Fundulus* in fish surveys conducted in ponds and streams within the project area (EA, 2007b). Based on these criteria, the ponds and freshwater marsh wetlands identified in the wetlands delineation report (TTNUS, 2007a) could be interpreted as potential habitat with a low probability of occurrence.

With respect to the preferred salt or brackish habitats, none of the survey reports describe any habitat in the project area that would be suitable for spotfin killifish. The wetlands delineation report describes all of the wetlands within the project area as freshwater and nontidal (TTNUS, 2007a). The rare plant survey states that there is no fresh-to-brackish tidal shore habitat within the proposed project area (TTNUS, 2007b).

Alewife

Population Abundance and Distribution: The alewife, *Alosa pseudoharengus*, is an anadromous species, native to the Atlantic Ocean and the lakes and streams that drain to it from Newfoundland to North Carolina (Scott, 1998). This includes the Gulf of St. Lawrence, the outer coast of Nova Scotia, the Bay of Fundy, and the Gulf of Maine (Scott, 1988). It is also present, although non-native, in all of the Great Lakes (USA), and many lakes in northern New York.

Habitat Requirements: Much is known about the alewife's freshwater spawning habits, but little is known about its movements within the ocean. Alewives spend most of their time in coastal waters and most are caught in water 56-100 m deep at about 4°C. Light sensitive, they tend to be in deeper waters during daylight hours. They also follow diel movements of zooplankton in the water column. Adults can withstand temperatures up to 25°C and young of the year can live in waters up to 30°C (Scott, 1988).

Life History: Alewives spawn in the spring. In the Chesapeake Bay, alewife spawning peaks in late March and April (Murdy, 1997). The young swim to sea in anadromous populations or to deeper water in lake populations in the fall (Grosvenor, 1965). For anadromous populations, the temperature of the river water determines the timing of spawning migrations upstream, so spawning happens first in lower latitudes. Spawning generally starts in April in the south and lasts until the end of May in upper latitudes (Scott, 1998).

In all populations, females reach the spawning grounds first and older fish are the first to spawn. The oldest fish recorded at spawning sites were 9-10 years old. Spawning occurs in groups of 3 or in pairs (Grosvenor, 1965; Scott, 1998).

Females broadcast their eggs simultaneously with males broadcasting sperm (USDA, 2004). Although the eggs are adhesive at first and may stick to plants or rocks, they loose their adhesive qualities after a few hours and settle to the substrate. Alewives deposit their eggs over any type of substrate (USDA, 2004). The number of eggs per female may be 10,000 to 12,000 (Scott, 1998) or 48,000-360,000 (Scott, 1988).

In anadromous populations, adult alewives spend most of their lives at sea but spawn in streams above the influence of the tide. Although they cannot jump obstacles such as dams, they surmount rapids and fish runs, migrating farther upstream than the closely related American shad (Scott, 1998). Anadromous fish reach maturity at 3 years for males and 4 years for females (Scott, 1998).

Population Dynamics: Young alewives have a very high mortality rate. Less than 1% survive to migrate into the sea (USDA, 2004). Annual mortality for adult alewives is on the order of 70% per year. Most die during or shortly after the spawning season (USDA, 2004). Few land-locked alewives live longer than 5 years (Smith, 1970). Alewives are an important link in estuarine and marine food webs, between zooplankton and top piscivores. They may be highly utilized by gulls and terns (Fay, 1983). Lake populations often experience massive summer die-offs.

Alewives represent an important commercial fishery in the Atlantic Ocean. They are packaged fresh, smoked, salted, or pickled for human consumption and are often sold as "river herring." Alewives have other uses, including pet food, lobster and snow crab bait, and processing into fishmeal and fish oil (Scott, 1988).

In last two decades the alewife has gained in recognition and interest as source of fish meal, fish oil, and fish protein, especially for the animal food industries (Fay, 1983). However, the species has declined in commercial importance in South Atlantic region in recent decades (NatureServe, 2008n).

Alewife are found in the Chesapeake Bay and in virtually all its' tributaries (MDNR, 2007f). The anadromous alewife enters the Chesapeake Bay in the spring to spawn. Young alewives remain in fresh or brackish waters through the summer before migrating to the sea in early fall, although some individuals apparently overwinter in the bay. More typically, both adults and juveniles overwinter in deeper water offshore (Murdy, 1997).

The North American Fisheries Organization statistical bulletin includes blueback herring and alewives in the "other fish" category so no catch data are available (Scott, 1988). The generic term of "river herring" includes both species; which are very similar. Information about population dynamics based on historic harvest patterns applies generically to either species. In sheer numbers, river herring greatly outnumbered shad. In the 1830s, as many as 750 million herring were taken during an eight-week spawning season on the Potomac River, compared with 22.5 million for shad. While shad are rebounding — helped in large part by major hatchery-based stocking efforts in all of the Bay states — river herring abundances remain low. "As much as we've been encouraged by statistically significant increased abundances for American shad and hickory shad in the James, the bottom has just dropped out for the blueback herring and the alewife," said Greg Garman, head of Virginia Commonwealth University's Center for Environmental Studies (Chesapeake Bay Journal, 2000). In fact, a 1991 Bay Program report stated, "Of all the anadromous fish species harvested in the Chesapeake Bay, the river herrings experienced the most drastic decline in commercial landings" (Chesapeake Bay Journal, 2000).

More than 25 million pounds of river herring were harvested in the Bay in 1931, making them second in quantity and fifth in value of all Chesapeake finfish (Chesapeake Bay Journal, 2000). In 1969 alone, the foreign fishery is estimated to have taken 74 million pounds of river herring — on top of the U.S. harvest. The heavy fishing pressure took many fish before they had a chance to spawn, sending the population into a downward spiral from which it has yet to recover (Chesapeake Bay Journal, 2000). By the 1990s, the commercial catch was almost nonexistent. In 1996, only 1.4 million pounds were caught along the entire East Coast (Chesapeake Bay Journal, 2000). Much of the population collapse was blamed on foreign fishing fleets. During the 1960s and early 1970s — before the United States restricted fishing within 200 miles of its coast — the fleets were often seen harvesting fish within sight of the beach (Chesapeake Bay Journal, 2000).

Any comeback is hindered by plenty of other problems: the loss of essential spawning and nursery habitat because of water pollution and the construction of dams and other fish blockages. While little fishing effort is targeted at river herring today, concerns remain that large numbers may be taken as bycatch in other commercial fisheries (Chesapeake Bay Journal, 2000).

Blueback Herring

Population Abundance and Distribution: The blueback herring (*Alosa aestivalis*) is silvery in color, has a series of scutes (modified scales that are spiny and keeled) along their belly, and are characterized by deep bluish green backs. The most distinguishing characteristic of this species is the black to dusky in color of its peritoneum (the lining of the abdominal cavity). Blueback herring and alewives are difficult to distinguish from one another and are often regarded collectively as river herring. Alewives have larger eyes, greater body depth, and pearly to white peritoneal linings (Whitehead, 1985; Burkhead, 1994; Owens, 1998). The blueback is distributed along the Atlantic Coast from Cape Breton, Nova Scotia, to the St. Johns River, Florida. It ascends coastal rivers during spawning season.

Blueback herring spawn from Nova Scotia to northern Florida, but are most numerous in warmer waters from Chesapeake Bay south. In the mid-Atlantic region, both alewife and blueback herring are found in Chesapeake Bay and in virtually all its' tributaries (MDNR, 2007f).

Habitat Requirements: Bluebacks are anadromous; living in marine systems and spawning in deep, swift freshwater with a hard substrate. In the Chesapeake Bay, the blueback herring spawns in April and May in swift-flowing, deeper stretches of rivers and streams (Murdy, 1997). They migrate to spawning grounds in the spring. In Connecticut, blueback herring spawn in 7-14°C temperatures. Juveniles spend 3-7 months in freshwater then migrate to the ocean (Yako, 2002). Blueback herring are a planktivorous forage species (Winkelman, 2002).

Life History: Alewife spawn earlier (February through April) than blueback (late March through mid-May, with both migrating upstream in the spring like shad. Females from both species usually reach 100% maturity by age 5 and produce from 60,000 - 103,000 eggs (MDNR, 2007f). Males of both species generally mature at an earlier age (ages 3-4) and smaller size than females (MDNR, 2007f). Herring spawn in quieter, upper portions on streams and creeks, randomly releasing sticky eggs that sink and adhere to the bottom. The tiny eggs hatch in 2 to 3 days; young head for salt water when they are several months old. Immediately after spawning, adults migrate rapidly downstream. Juveniles will remain in freshwater nursery areas in spring and summer, feeding mainly on zooplankton. As water temperatures decline in the fall, most juveniles move downstream to more saline waters, eventually to the sea; however, some will remain in deeper waters of the Bay and its tributaries for their first winter.

Herring are pelagic, schooling and feeding in midwinter or at the surface, preying on zooplankton, as well as shrimp, other small crustaceans, small fish, and fish eggs. Little information is available on the life history of subadult and adult river herring after they immigrate to the sea as juveniles, and before they mature and return to freshwater to spawn.

Population Dynamics: The North American Fisheries Organization statistical bulletin includes blueback herring and alewives in the "other fish" category so no catch data are available (Scott, 1988). The generic term of "river herring" includes both species; which are very similar in size, conformation and anadromous spawning runs. Information about population dynamics based on historic harvest patterns applies generically to either species.

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Any comeback is hindered by plenty of other problems: the loss of essential spawning and nursery habitat because of water pollution and the construction of dams and other fish blockages. While little fishing effort is targeted at river herring today, concerns remain that large numbers may be taken as bycatch in other commercial fisheries (Chesapeake Bay Journal, 2000).

Green Sea Turtle

Population Abundance and Distribution: Green sea turtles (*Chelonia mydas*) are the largest of all the hard-shelled sea turtles, but have a comparatively small head. Adult green turtles are unique among sea turtles in that they are herbivorous, feeding primarily on sea grasses and algae. This diet is thought to give them greenish colored fat, from which they take their name. A green turtle's carapace (top shell) is smooth and can be shades of black, gray, green, brown, and yellow. Their plastron (bottom shell) is yellowish white. Scientists estimate green turtles reach sexual maturity between 20 and 50 years, at which time females begin returning to their natal beaches (i.e., the same beaches where they were born) every 2-4 years to lay eggs (NMFS, 2008d).

Habitat Requirements: Green sea turtles live in warm tropical waters from New England to South Africa and in the Pacific from Western Africa to the Americas (ADW, 2008b). In Atlantic and Gulf of Mexico waters, green turtles are found in inshore and nearshore waters from Texas to Massachusetts, the U.S. Virgin Islands, and Puerto Rico. The species primarily use three types of habitat: oceanic beaches (for nesting); convergence zones in the open ocean; and benthic feeding grounds in coastal areas. Adult females migrate from foraging areas to mainland or island nesting beaches and may travel hundreds or thousands of miles each way. After emerging from the nest, hatchlings swim to offshore areas, where they are believed to live for several years, feeding close to the surface on a variety of pelagic plants and animals. Once the juveniles reach a certain age/size range, they leave the pelagic habitat and travel to nearshore foraging grounds. Once they move to these nearshore benthic habitats, adult green turtles are almost exclusively herbivores, feeding on sea grasses and algae. The nesting season varies depending on location. In the southeastern United States, females generally nest between June and September, while peak nesting occurs in June and July. During the nesting season, females nest at approximately two week intervals, laying an average of five clutches (NMFS, 2008d).

Population Dynamics: The principal cause of the historical, worldwide decline of the green turtle is long-term harvest of eggs and adults on nesting beaches and juveniles and adults on feeding grounds. These harvests continue in some areas of the world and compromise efforts to recover this species. Incidental capture in fishing gear, primarily in gillnets, but also in trawls, traps and pots, longlines, and dredges is a serious ongoing source of mortality that also adversely affects the species' recovery. Green turtles are also threatened, in some areas of the world, by a disease known as fibropapillomatosis. The green sea turtle was listed under the ESA on July 28, 1978. The breeding populations in Florida and the Pacific coast of Mexico are listed as endangered, while elsewhere the species is listed as threatened (NMFS, 2008d).

Only two live individuals have been caught in Virginia waters since 1979, one from the York River and one from the Potomac River. Six dead specimens have been found from the lower Chesapeake Bay, the Eastern Shore, and Virginia Beach (VDGIF, 2008b). In the Chesapeake Bay, improved water quality and the resurgence of seagrass beds may have contributed to the recent increase in green turtle sightings (Mitchell, 1991 as cited in (HBMP, 2008a). When not migrating, green turtles prefer sea grass flats which occur in shallow areas of the Chesapeake Bay (VDGIF, 2008b). The green sea turtle was not observed in the Chesapeake Bay waters adjacent to CCNPP during numerous field studies conducted in 2006, 2007, and 2008 in support of the environmental permitting requirements for this project. In addition, no anecdotal reports of observations of the species by CCNPP site personnel have been made to date.

Leatherback Sea Turtle

Population Abundance and Distribution: The leatherback sea turtle (*Dermochelys coriacea*) is the largest turtle and the largest living reptile in the world. The leatherback is the only sea turtle that lacks a hard, bony shell. A leatherback's carapace consists of leathery, oil saturated connective tissue overlaying loosely interlocking dermal bones. Adult leatherbacks are primarily black with a pinkish white mottled ventral surface and pale white and pink spotting on the top of the head. The ridged carapace and large flippers are characteristics that make the leatherback uniquely equipped for long distance foraging migrations (NMFS, 2008e).

Female leatherbacks lay clutches of approximately 100 eggs on sandy, tropical beaches. Females nest several times during a nesting season, typically at 8-12 day intervals. After 60-65 days, leatherback hatchlings emerge from the nest (NMFS, 2008e).

Leatherbacks lack the crushing chewing plates characteristic of sea turtles that feed on hard-bodied prey. Instead, they have pointed tooth-like cusps and sharp edged jaws that are perfectly adapted for a diet of soft-bodied pelagic (open ocean) prey, such as jellyfish and salps (NMFS, 2008e).

Habitat Requirements: Leatherbacks are commonly known as pelagic animals but also forage in coastal waters. The species is the most migratory and wide ranging of the sea turtle species. Leatherbacks mate in the waters adjacent to nesting beaches and along migratory corridors. After nesting, female leatherbacks migrate from tropical waters to more temperate latitudes, which support high densities of jellyfish prey in the summer. Leatherback turtle nesting grounds are located around the world, with the largest remaining nesting assemblages found on the coasts of northern South America and west Africa. The Caribbean (primarily Puerto Rico and the Virgin Islands) and southeast Florida support minor nesting colonies but represent the most significant nesting activity within the United States. Adult leatherbacks are capable of tolerating a wide range of water temperatures and have been sighted along the entire continental coast of the United States as far north as the Gulf of Maine and south to Puerto Rico, the Virgin Islands, and into the Gulf of Mexico (NMFS, 2008e).

Population Dynamics: Leatherback turtles face threats on both nesting beaches and in the marine environment. The greatest causes of decline and the continuing primary threats to leatherbacks worldwide are long-term harvest and incidental capture in fishing gear. Harvest of eggs and adults occurs on nesting beaches while juveniles and adults are harvested on feeding grounds. Incidental capture primarily occurs in gillnets, but also in trawls, traps and pots, longlines, and dredges. Together these threats are serious ongoing sources of mortality that adversely affect the species' recovery. The leatherback sea turtle was listed under the ESA as endangered in 1970 (NMFS, 2008e).

Leatherbacks are frequently sited during aerial surveys of the Chesapeake Bay, especially at the mouth (and during the summer months) where they appear to be foraging (Keinath and Musick, in press as cited in NMFS and USFWS, 1992). They occur in the Chesapeake Bay and adjacent Atlantic Ocean primarily from May to September (Mitchell, 1991 as cited in HBMP, 2008b). An estimated 100-900 occur in summer in waters off of the northeastern U. S. (Shoop and Kenny, 1992 as cited in HBMP, 2008b). The leatherback sea turtle was not observed in the Chesapeake Bay waters adjacent to CCNPP during numerous field studies conducted in 2006, 2007, and 2008 in support of the environmental permitting requirements for this project. In addition, no anecdotal reports of observations of the species by CCNPP site personnel have been made to date.

Soft-shelled Clam

The soft-shell clam (*Mya arenaria*) is a bivalve mollusk with a thin, oval, elongated shell. The shell is chalky white with a thin, parchment-like covering that varies in color from brownish to yellowish to gray (Chesapeake Bay Program, 2008h).

Population Abundance and Distribution: Soft-shell clams are found off the Atlantic coast from Canada to the southern states. They generally range from Eastern Bay to Pocomoke Sound on the Eastern Shore of Chesapeake Bay and from Maryland 's Severn River to Virginia's Rappahannock River on the western shore (Chesapeake Bay Program, 2008h).

Habitat Requirements: Soft-shells can be found buried in soft sediments from the intertidal zone to depths of about 30 feet in the Bay and some tributaries (Chesapeake Bay Program, 2008h). The soft-shell clam can be found in shallow, sandy, parts of mesohaline portions of the Bay (Funderburke, 1991). Found in areas of low salinity and an influx of fresh water, buried 20 cm or so in mixtures of mud with sand or gravel (Telnack, 2008).

The soft-shelled clam has a relatively thin shell when compared to other clams. For this reason, it also has a very long siphon that stretches far to allow the clam to hide deep in the mud.

However, unlike most clams, the soft-shelled clam cannot retract its siphon completely inside its shell (Funderburke, 1991).

The soft-shelled clam requires a minimum dissolved oxygen level of 1 ppm and a minimum salinity level of 8 ppt. The optimum temperature range for soft-shell clam is 10°C - 20°C for eggs and 2°C - 34°C for adults (Funderburke, 1991).

Life History: Soft-shell clams usually spawn twice per year: once in late spring and once in mid- to late autumn. Both eggs and sperm are released into the water column. The number of eggs a female releases depends on the clam's size. Eggs develop into larvae within one day of being fertilized. Larvae swim freely for about one to three weeks, during which they develop their foot and shells (Chesapeake Bay Program, 2008h).

When the larvae are ready to metamorphose into juveniles they swim near and crawl on the bottom for several hours before settling. Newly settled clams, called spat, usually attach themselves to any available surface with thin threads secreted from a gland on the foot. Small juvenile soft-shell clams can be very active, crawling about with their foot. Eventually the clam burrows permanently, and, unless disturbed, spends the rest of its life in one place (Chesapeake Bay Program, 2008h).

Soft-shell clams are filter feeders. They draw water in through their incurrent siphon and filter out microscopic algae. Unused particles are ejected through the exhalent siphon (Chesapeake Bay Program, 2008h). They are a crucial part in Bay life by filtering microscopic algae out of the water and are a major food source to many animals. Such animals that prey off them include blue crabs, eels, cownose rays, mud crabs, flatworms, mummichogs, spot, ducks, geese, swans, muskrats, and raccoons (Funderburke, 1991).

Population Dynamics: Since the first year of major harvesting and exploitation of Maryland soft-shell clam stocks, in 1953, population levels of harvestable soft-shell clams have declined. From 1964 to 1971, harvests remained steady at 3,700,000 kg. Due to tropical storm Agnes, poor harvests were reported in Maryland during the early 1970's. In 1988, harvests in Maryland rebounded to 1,400,000 kg in 1988 from 300,000 kg in 1973 (Funderburke, 1991).

The Calvert Cliffs region is not a major spawning area for soft-shell clams (Richkus et al, 1980). Commercially harvestable densities of soft-shell clams have not historically and do not now occur in the Calvert Cliffs region (Richkus et al, 1980). Plant operations have increased the abundance, growth, and recruitment of soft-shell clams in the vicinity of the plant; however clam densities remain below harvestable levels (Richkus et al, 1980).

Abundances of soft-shell clam were only occasionally higher at the plant site than at reference areas during the preoperational period (Holland et al, 1979). Growth and recruitment of soft-shell clams was not higher at the plant site before operations began (Holland et al, 1979). During the preoperational period, average densities of market-size soft-shell clams near Calvert Cliffs ranged from 98 to 172 liters per hectare (ANSP, 1972d, 1973a; Abbe, 1974a, 1975a as cited in Holland et al, 1979). After plant operations began, the abundance of soft-shell clams immediately following recruitment was frequently larger near the plant site than it was at reference areas (Holland et al, 1979). Plant operations resulted in increased growth and recruitment of soft-shell clams in the discharge region (Holland et al, 1979).

Slender Sea Purslane

Slender sea purslane (*Sesuvium maritimum*) is an annual herb that flowers from summer to fall.

Population Abundance and Distribution: Slender sea purslane is known to occur along the Atlantic coast from Long Island south to Florida, Bahamas, and Cuba. This species is also known from Kansas, Oklahoma, and Texas (Nearctica, 2008).

Habitat Requirements: The Rare Plant Survey describes typical habitat (Fernald, 1970) as damp coastal sand. Preferred habitats for the slender sea purslane are sandy shores, beaches, dune swales, brackish marshes, banks along or near coasts, waste grounds, and ballast; from 0-100 m (eFloras, 2008).

Population Dynamics: *Sesuvium maritimum* is often overlooked in coastal environments, perhaps due to the small size of some individuals, particularly in the northern portions of its distribution. Nonetheless, this species appears to be infrequent (and possibly in decline) in coastal environments of northern states (e.g., Delaware, Maryland, New Jersey, and New York), where development of the coast has impacted sensitive environments. This species is also present in Kansas and Oklahoma but its distribution in those states is currently not well known (eFloras, 2008).

The Rare Plant Survey does not mention sandy beach habitat as a study area. It does report that slender sea purslane (*Sesuvium maritimum*) is included on the "List of Rare, Threatened, or Endangered Plant Species for Calvert County, Maryland – Maryland Natural Heritage Program, May 2004". The Rare Plant Survey describes "Typical Habitat (Fernald, 1970)" as "damp coastal sand" and describes areas of most probable occurrence on the project area as "none". The report includes a map depicting the approximate locations: of search areas walked to inspect for rare plants which clearly indicates that the beach area was not included in the search effort.

The Submerged Aquatic Vegetation (SAV) study looked for vegetation up to the shoreline, but does not clearly demonstrate that purslane would have been found if present in its on-beach habitat. The report states that "no SAV was observed at any of the stations during these surveys. In addition, no signs of SAV were observed along the shoreline or floating throughout the study area."

Since none of the studies specifically searched the beach area for sea purslane, one cannot conclude that the plant is not found on site.

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ER Impact:

No changes to the ER are required.

ITEM NUMBER 5 SUPPLEMENTAL REQUEST REGARDING RAI #16

NRC Request:

- Several species accounts have been incompletely put together.

  The Atlantic loggerhead turtle is said to nest on sandy beaches.

  Where are these nesting beaches located? Are any located in Chesapeake Bay?

- The population dynamics section for Kemp's Ridley Turtle only discusses threats and does not provide any information about population trends or status for the species.

  Provide information on population trends or status for the species as it relates to the Chesapeake Bay area.

- Weakfish: no information specific to Chesapeake Bay populations was provided.

  Provide information on weakfish populations and distribution that is specific to Chesapeake Bay

- Alewife are said to spawn in spring, perhaps as late as May (Life History section), but also to spawn in spring and summer (Reproduction Comments).

  When do alewife spawn in Chesapeake Bay?

- Blueback Herring are said to spawn in "deep, swift freshwater" (Habitat Requirements) or in "quieter, upper portions of streams and creeks" (Life History section).

  What is the preferred spawning habitat for blueback herring as it relates to Chesapeake Bay?

- A quote about blueback herring and alewife population changes was attributed to Greg Garman.

  Provide documentation for the quote.

- The response mentions that green and leatherback turtles were not observed near the plant in 2006-2008, but does not provide any information about their general occurrence in Chesapeake Bay.

  Please provide information about the general occurrence of green and leatherback turtles in Chesapeake Bay.

- The section on soft-shelled clam doesn't provide information about the occurrence of the species near the plant although the response to RAI #97 states that the species has been a focus of a special study at Calvert Cliffs.

  Provide information about the occurrence of soft-shelled clams at the CCNPP site.

UniStar Response:

The supplemental request for additional information is provided as follows:

Atlantic Loggerhead Turtle

Loggerheads (*Caretta caretta*) are large reddish-brown sea turtles that have disproportionately large heads (MDNR, 2006).

Population Abundance and Distribution: Loggerheads occur throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans. The loggerhead is the most abundant species of sea turtle found in U.S. coastal waters, including the Chesapeake Bay. Approximately 2,000 to 10,000 young loggerheads forage in the bay each summer for horseshoe crabs, jellyfish, and mollusks (Kimmel, Driscoll, and Brush, 2006 as cited in USEPA, 2007). In addition to the well-known juveniles, it has been reported that up to 5% of the loggerheads in Chesapeake Bay are adult females who are taking time off between nesting efforts.

Habitat Requirements: Loggerheads are most often seen near the mouths of rivers, in water greater than 13 ft (4 m) deep and are known to occur in open sea, mostly over the continental shelf, and in bays, estuaries, lagoons, and creeks in mainly warm temperate and subtropical regions not far from shorelines. Adults occupy various habitats, from turbid bays to clear waters of reefs. Subadults occur mainly in nearshore and estuarine waters. Hatchlings move directly to sea after hatching, and often float in masses of sea plants (*Sargassum*). These hatchlings may remain associated with the sargassum rafts for 3 to 5 years. In the Chesapeake Bay, loggerheads occur mainly in deeper channels, usually at river mouths or in the open bay (NatureServe, 2008d). Most sightings are in the Virginia portion of the bay, where salinity is higher.

Nesting occurs usually on open sandy beaches above the high-tide mark and seaward of well-developed dunes. Loggerheads nest primarily on high-energy beaches on barrier strands adjacent to continental land masses (NatureServe, 2008d). They prefer steeply sloped beaches with gradually sloped offshore approaches for nesting sites (CSTC, 1990 as cited in NatureServe, 2008d) and will generally return to the same area in subsequent years if the habitat remains suitable (NatureServe, 2008d). The loggerhead's nesting range in the U.S. is mainly the Atlantic coast from North Carolina to southern Florida (Shoop 1985, Dodd 1988 as cited in NatureServe, 2008d), Nesting also regularly in small numbers in Virginia and sometimes north to New Jersey. The Chesapeake Bay is an important habitat for subadults in summer (NatureServe 2008d). Juvenile loggerheads are not rare in the Chesapeake Bay, but it is unusual to find a nesting female loggerhead north of Cape Hatteras, North Carolina. Loggerheads use the bay as feeding habitat between nesting events, but nesting activities take place elsewhere along the Atlantic coast (VIMS, 2008a). There are no known nesting beaches for loggerheads in the Chesapeake Bay area (USEPA, 2007).

Life History: Loggerheads mate every 2 to 3 years from late March through early June. Nesting occurs mainly at night in late April through early September, and often at high tide. Eggs hatch in about 7 to 11 weeks. The sex of hatchlings is affected by incubation temperature, with warmer temperatures resulting in a preponderance of females and cooler temperatures producing mainly or only males. Hatchlings emerge from the nest a few days after hatching, typically during darkness. Females are sexually mature at an average age of about 15 to 30 years (NatureServe, 2008d) and are reproductively active over a period of about 30 years (CSTC, 1990 as cited in NatureServe, 2008d).

Population Dynamics: The stock structure of the U.S. population of loggerheads is poorly understood. Some evidence suggests that individuals nesting in Georgia represent a population distinct from the Florida nesters. If so, the northern population may be more severely threatened. NOAA Fisheries suggests that it may become necessary to consider listing them as endangered. Adult loggerheads are known to make extensive migrations between foraging areas and nesting beaches. The Virginia Institute of Marine Science Sea Turtle Program actively tracks individuals that nest on Virginia beaches in an effort to determine the migration routes of these turtles. At present, the place of origin of an individual turtle cannot be determined. Turtles feeding in the Chesapeake Bay may represent a number of nesting populations worldwide. At the global level, the primary threat to loggerhead turtle populations is incidental capture in fishing gear, especially in longlines and gillnets, but also in trawls, traps and pots, and dredges. NOAA Fisheries is currently implementing a program to evaluate the incidence of bycatch of sea turtles in various types of gear, including pound nets in the Chesapeake Bay. Egg mortality may result from predation, beach erosion, invasion of clutches by plant roots, crushing by off-road vehicles, or flooding by sea water overwash or excessive rainfall (NatureServe, 2008d).

Kemp's Ridley Turtle

The Kemp's ridley turtle (*Lepidochelys kempii*) is one of the smallest of the sea turtles, with adults reaching about 2 ft (0.6 m) in length and weighing up to 100 lbs (NMFS, 2008b). The Kemp's ridley turtle has been on the endangered species list since 1970.

Population Abundance and Distribution: Adult Kemp's ridley turtles are restricted to the Gulf of Mexico. Juvenile Kemp's ridley turtles inhabit the Gulf of Mexico and the U.S. Atlantic coast north to Nova Scotia (NatureServe, 2008e). A sizeable group of the Kemp's ridley turtle spends summers in the Chesapeake Bay, although most remain in the higher salinity waters of the Virginia portion of the bay.

Habitat Requirements: This turtle is a shallow water benthic feeder with a diet consisting primarily of crabs. Its preferred habitat is shallow, coastal, and estuarine waters, usually over sand or mud bottoms, where crabs are numerous. Nesting occurs on well-defined, elevated dune areas, especially on beaches backed up by large swamps or bodies of open water having seasonal, narrow, ocean connections (NatureServe, 2008e).

Life History: Females begin nesting at the age of 8 to 13 years (Schmid and Witzell, 1997 as cited in NatureServe, 2008e). Nesting occurs on Mexican beaches from April to July. Females lay one to four clutches of about 100 eggs at intervals of 10 to 28 days (NatureServe, 2008e). The eggs hatch in 50 to 55 days (CSTC, 1990 as cited in NatureServe, 2008e). After leaving the nesting beach, hatchlings are believed to become entrained in eddies within the Gulf of Mexico, where they are dispersed within the Gulf and Atlantic by oceanic surface currents. At two years of age, they enter coastal shallow water habitats. Individuals often nest in successive years. Large numbers of females may nest simultaneously on one beach. (NatureServe, 2008e).

Individual adult females lay 1-4 clutches averaging about 100 eggs at intervals of 10-28 days, during daylight from April to July. Individuals often nest in successive years. Large numbers of females may nest simultaneously on one beach. Eggs hatch in average of 50-55 days (CSTC 1990). Females begin nesting at an estimated age of 8-13 years (Schmid and Witzell 1997).Individual adult females lay 1-4 clutches averaging about 100 eggs at intervals of 10-28 days, during daylight from April to July. Individuals often nest in successive years. Large numbers of females may nest simultaneously on one beach. Eggs hatch in average of 50-55 days (CSTC 1990). Females begin nesting at an estimated age of 8-13 years (Schmid and Witzell 1997).Individual adult females lay 1-4 clutches averaging about 100 eggs at intervals of 10-28 days, during daylight from April to July. Individuals often nest in successive years. Large numbers of females may nest simultaneously on one beach. Eggs hatch in average of 50-55 days (CSTC 1990). Females begin nesting at an estimated age of 8-13 years (Schmid and Witzell 1997).

Population Dynamics: Kemp's ridley, has received protection in Mexico since the 1960's and was listed as endangered throughout its range December 2, 1970 under United States law. Less than fifty years ago, Kemp's ridley was a very abundant sea turtle in the Gulf of Mexico. The population was able to generate a synchronized reproductive effort of an estimated 40,000 females in one day on the single known nesting beach on the northeastern coast of Mexico (Carr 1963, Hildebrand 1963 as cited in USFWS and NMFS, 1992), and a much larger adult population may have existed. The population crash that occurred between 1947 and the early 1970's may have been the result of both intensive annual harvest of the eggs and mortality of juveniles and adults in trawl fisheries (Magnuson ei A. 1990 as cited in USFWS and NMFS, 1992). The recovery of the species has been forestalled primarily by incidental mortality in commercial shrimping, preventing adequate recruitment into the breeding population (USFWS and NMFS, 1992)

The Kemp's ridley is found throughout the Chesapeake Bay from the Potomac River south (VDGIF, 2008a). The Chesapeake Bay is a major summer foraging ground for Kemp's ridley sea turtles (VIMS, 2008). Developmental habitat for juveniles has been identified in the Chesapeake Bay (USFWS and NMFS, 1992).

The principal threats to this species occur on the nesting beaches, where both deliberate and accidental disturbances interfere with nesting success and in accidental take by fisheries vessels. Kemp's ridley turtles have incurred high mortality due to predation on eggs (especially by coyote), hatchlings, and nesting adults. Restoration of the species requires protecting sub-adult and adult animals by the use of turtle excluder devices on shrimp trawls wherever turtles occur.

Weakfish

Population Abundance and Distribution: Weakfish *(Cynoscion regalis)* are a migratory species occurring along the Atlantic coast of North America from Nova Scotia to southeastern Florida, although they are more common between New York and North Carolina. Important wintering grounds for the stock are located in offshore waters from Chesapeake Bay to Cape Lookout (ASMFC, 2007).

Habitat Requirements: Feeding on microscopic animals, larval weakfish journey from inshore spawning areas to coastal nursery areas, located in deeper portions of coastal rivers, bays, sounds, and estuaries. Growing into juveniles, they stay in the nursery areas until October to December of their first year, after which they migrate to the coast. As adults, inshore weakfish are often found near the periphery of eelgrass beds, perhaps because weakfish feed primarily on shrimp, other crustaceans, and small fish that are found near these grass beds (ASMFC, 2007).

Life History: When water temperatures rise in the spring, the mature fish migrate north and inshore to the spawning grounds. In these nearshore and estuarine areas between March and September, mature females produce large quantities of eggs that are fertilized by mature males as they are released into the water. Females continuously produce eggs during the spawning season and release them over a period of time rather than once. In the fall, an offshore and southerly migration of adults, coinciding with declining water temperatures, brings the mature weakfish back to the wintering grounds (ASMFC, 2007).

Growth in weakfish is especially rapid in the first year and they mature at a young age. 90 percent are mature at age one, 100 per cent by age two. Size at age one is variable but most fish are ten to eleven inches long (ASMFC, 2007).

Population Dynamics: In 2006, total weakfish harvest reached an all time low of less than 2 million pounds. For comparison, total weakfish harvest was greater than 31 million pounds in 1986. The apparent decline in abundance was supported by the results of the 2006 weakfish stock assessment. However, the assessment found that, concurrent with the decline in abundance, fishing mortality had not increased. Instead, total mortality—fishing mortality plus natural mortality—had increased. The leading theory suggests that increased predation on weakfish and reduced forage fish for weakfish have caused natural mortality to increase, although other hypotheses may not have been fully examined (ASMFC, 2008b).

Weakfish are currently managed under Amendment 4, and its addenda, to the Interstate Fishery Management Plan. States in the management unit have implemented regulations to achieve the biological reference points established in Amendment 4. State commercial regulations include a minimum size limit, corresponding mesh size limits, seasonal closures, bycatch reduction devices, and a bycatch limit. Recreational regulations include creel and size limits. Responding to the recent decline in abundance, the Commission also approved an addendum in 2007 to implement more conservative recreational creel limits, a reduced bycatch allowance, and two management triggers to initiate management action when the stock begins to recover (ASMFC, 2008b).

Weakfish are found throughout the Bay during spring and summer, when the coastal weakfish population migrates northward. In autumn they leave the Bay for their southward migration (Chesapeake Bay Program, 2008g). Larger fish (year 2 and older) appear in the lower Chesapeake Bay in April – May, with age-1 fish becoming abundant in summer (Murdy, 1997).

Weakfish landings by pound nets, gill nets, and haul seines constitute an important fishery in the lower Chesapeake Bay, but the fishery has been in decline since the 1940s. Maryland reported bayside landings of 700,000 pounds in 1948, but the catch has averaged less than 200,000 pounds in the 1980s and 1990s. In Virginia, the bay catch peaked at 16 million pounds in 1946 but has not exceeded 6 million pounds since 1948. Recent Virginia landings have rarely exceeded 2.5 million pounds. Weakfish are a major recreational species in the bay, with the 1985 estimated catch exceeding 1 million pounds (Murdy, 1997).

Alewife

Population Abundance and Distribution: The alewife, *Alosa pseudoharengus*, is an anadromous species, native to the Atlantic Ocean and the lakes and streams that drain to it from Newfoundland to North Carolina (Scott, 1998). This includes the Gulf of St. Lawrence, the outer coast of Nova Scotia, the Bay of Fundy, and the Gulf of Maine (Scott, 1988). It is also present, although non-native, in all of the Great Lakes (USA), and many lakes in northern New York.

Habitat Requirements: Much is known about the alewife's freshwater spawning habits, but little is known about its movements within the ocean. Alewives spend most of their time in coastal waters and most are caught in water 56-100 m deep at about 4°C. Light sensitive, they tend to be in deeper waters during daylight hours. They also follow diel movements of zooplankton in the water column. Adults can withstand temperatures up to 25°C and young of the year can live in waters up to 30°C (Scott, 1988).

Life History: Alewives spawn in the spring. In the Chesapeake Bay, alewife spawning peaks in late March and April (Murdy, 1997). The young swim to sea in anadromous populations or to deeper water in lake populations in the fall (Grosvenor, 1965). For anadromous populations, the temperature of the river water determines the timing of spawning migrations upstream, so spawning happens first in lower latitudes. Spawning generally starts in April in the south and lasts until the end of May in upper latitudes (Scott, 1998).

In all populations, females reach the spawning grounds first and older fish are the first to spawn. The oldest fish recorded at spawning sites were 9-10 years old. Spawning occurs in groups of 3 or in pairs (Grosvenor, 1965; Scott, 1998).

Females broadcast their eggs simultaneously with males broadcasting sperm (USDA, 2004). Although the eggs are adhesive at first and may stick to plants or rocks, they loose their adhesive qualities after a few hours and settle to the substrate. Alewives deposit their eggs over any type of substrate (USDA, 2004). The number of eggs per female may be 10,000 to 12,000 (Scott, 1998) or 48,000-360,000 (Scott, 1988).

In anadromous populations, adult alewives spend most of their lives at sea but spawn in streams above the influence of the tide. Although they cannot jump obstacles such as dams, they surmount rapids and fish runs, migrating farther upstream than the closely related American shad (Scott, 1998). Anadromous fish reach maturity at 3 years for males and 4 years for females (Scott, 1998).

Population Dynamics: Young alewives have a very high mortality rate. Less than 1% survive to migrate into the sea (USDA, 2004). Annual mortality for adult alewives is on the order of 70% per year. Most die during or shortly after the spawning season (USDA, 2004). Few land-locked alewives live longer than 5 years (Smith, 1970). Alewives are an important link in estuarine and marine food webs, between zooplankton and top piscivores. They may be highly utilized by gulls and terns (Fay, 1983). Lake populations often experience massive summer die-offs.

Alewives represent an important commercial fishery in the Atlantic Ocean. They are packaged fresh, smoked, salted, or pickled for human consumption and are often sold as "river herring."

Alewives have other uses, including pet food, lobster and snow crab bait, and processing into fishmeal and fish oil (Scott, 1988).

In last two decades the alewife has gained in recognition and interest as source of fish meal, fish oil, and fish protein, especially for the animal food industries (Fay, 1983). However, the species has declined in commercial importance in South Atlantic region in recent decades (NatureServe, 2008n).

Alewife are found in the Chesapeake Bay and in virtually all its' tributaries (MDNR, 2007f). The anadromous alewife enters the Chesapeake Bay in the spring to spawn. Young alewives remain in fresh or brackish waters through the summer before migrating to the sea in early fall, although some individuals apparently overwinter in the bay. More typically, both adults and juveniles overwinter in deeper water offshore (Murdy, 1997).

The North American Fisheries Organization statistical bulletin includes blueback herring and alewives in the "other fish" category so no catch data are available (Scott, 1988). The generic term of "river herring" includes both species; which are very similar. Information about population dynamics based on historic harvest patterns applies generically to either species. In sheer numbers, river herring greatly outnumbered shad. In the 1830s, as many as 750 million herring were taken during an eight-week spawning season on the Potomac River, compared with 22.5 million for shad. While shad are rebounding — helped in large part by major hatchery-based stocking efforts in all of the Bay states — river herring abundances remain low. "As much as we've been encouraged by statistically significant increased abundances for American shad and hickory shad in the James, the bottom has just dropped out for the blueback herring and the alewife," said Greg Garman, head of Virginia Commonwealth University's Center for Environmental Studies (Chesapeake Bay Journal, 2000). In fact, a 1991 Bay Program report stated, "Of all the anadromous fish species harvested in the Chesapeake Bay, the river herrings experienced the most drastic decline in commercial landings" (Chesapeake Bay Journal, 2000).

More than 25 million pounds of river herring were harvested in the Bay in 1931, making them second in quantity and fifth in value of all Chesapeake finfish (Chesapeake Bay Journal, 2000). In 1969 alone, the foreign fishery is estimated to have taken 74 million pounds of river herring — on top of the U.S. harvest. The heavy fishing pressure took many fish before they had a chance to spawn, sending the population into a downward spiral from which it has yet to recover (Chesapeake Bay Journal, 2000). By the 1990s, the commercial catch was almost nonexistent. In 1996, only 1.4 million pounds were caught along the entire East Coast (Chesapeake Bay Journal, 2000). Much of the population collapse was blamed on foreign fishing fleets. During the 1960s and early 1970s — before the United States restricted fishing within 200 miles of its coast — the fleets were often seen harvesting fish within sight of the beach (Chesapeake Bay Journal, 2000).

Any comeback is hindered by plenty of other problems: the loss of essential spawning and nursery habitat because of water pollution and the construction of dams and other fish blockages. While little fishing effort is targeted at river herring today, concerns remain that large numbers may be taken as bycatch in other commercial fisheries (Chesapeake Bay Journal, 2000).

Blueback Herring

Population Abundance and Distribution: The blueback herring (*Alosa aestivalis*) is silvery in color, has a series of scutes (modified scales that are spiny and keeled) along their belly, and are characterized by deep bluish green backs. The most distinguishing characteristic of this species is the black to dusky in color of its peritoneum (the lining of the abdominal cavity). Blueback herring and alewives are difficult to distinguish from one another and are often regarded collectively as river herring. Alewives have larger eyes, greater body depth, and pearly to white peritoneal linings (Whitehead, 1985; Burkhead, 1994; Owens, 1998). The blueback is distributed along the Atlantic Coast from Cape Breton, Nova Scotia, to the St. Johns River, Florida. It ascends coastal rivers during spawning season.

Blueback herring spawn from Nova Scotia to northern Florida, but are most numerous in warmer waters from Chesapeake Bay south. In the mid-Atlantic region, both alewife and blueback herring are found in Chesapeake Bay and in virtually all its' tributaries (MDNR, 2007f).

Habitat Requirements: Bluebacks are anadromous; living in marine systems and spawning in deep, swift freshwater with a hard substrate. In the Chesapeake Bay, the blueback herring spawns in April and May in swift-flowing, deeper stretches of rivers and streams (Murdy, 1997). They migrate to spawning grounds in the spring. In Connecticut, blueback herring spawn in 7-14°C temperatures. Juveniles spend 3-7 months in freshwater then migrate to the ocean (Yako, 2002). Blueback herring are a planktivorous forage species (Winkelman, 2002).

Life History: Alewife spawn earlier (February through April) than blueback (late March through mid-May, with both migrating upstream in the spring like shad. Females from both species usually reach 100% maturity by age 5 and produce from 60,000 - 103,000 eggs (MDNR, 2007f). Males of both species generally mature at an earlier age (ages 3-4) and smaller size than females (MDNR, 2007f). Herring spawn in quieter, upper portions on streams and creeks, randomly releasing sticky eggs that sink and adhere to the bottom. The tiny eggs hatch in 2 to 3 days; young head for salt water when they are several months old. Immediately after spawning, adults migrate rapidly downstream. Juveniles will remain in freshwater nursery areas in spring and summer, feeding mainly on zooplankton. As water temperatures decline in the fall, most juveniles move downstream to more saline waters, eventually to the sea; however, some will remain in deeper waters of the Bay and its tributaries for their first winter.

Herring are pelagic, schooling and feeding in midwinter or at the surface, preying on zooplankton, as well as shrimp, other small crustaceans, small fish, and fish eggs. Little information is available on the life history of subadult and adult river herring after they immigrate to the sea as juveniles, and before they mature and return to freshwater to spawn.

Population Dynamics: The North American Fisheries Organization statistical bulletin includes blueback herring and alewives in the "other fish" category so no catch data are available (Scott, 1988). The generic term of "river herring" includes both species; which are very similar in size, conformation and anadromous spawning runs. Information about population dynamics based on historic harvest patterns applies generically to either species.

In sheer numbers, river herring greatly outnumbered shad. In the 1830s, as many as 750 million herring were taken during an eight-week spawning season on the Potomac River, compared with 22.5 million for shad. While shad are rebounding — helped in large part by major hatchery-based stocking efforts in all of the Bay states — river herring abundances remain low. "As much as we've been encouraged by statistically significant increased abundances for American shad and hickory shad in the James, the bottom has just dropped out for the blueback herring and the alewife," said Greg Garman, head of Virginia Commonwealth University's Center for Environmental Studies (Chesapeake Bay Journal, 2000). In fact, a 1991 Bay Program report stated, "Of all the anadromous fish species harvested in the Chesapeake Bay, the river herrings experienced the most drastic decline in commercial landings" (Chesapeake Bay Journal, 2000).

More than 25 million pounds of river herring were harvested in the Bay in 1931, making them second in quantity and fifth in value of all Chesapeake finfish. In 1969 alone, the foreign fishery is estimated to have taken 74 million pounds of river herring — on top of the U.S. harvest. The heavy fishing pressure took many fish before they had a chance to spawn, sending the population into a downward spiral from which it has yet to recover (Chesapeake Bay Journal, 2000). By the 1990s, the commercial catch was almost nonexistent. In 1996, only 1.4 million pounds were caught along the entire East Coast (Chesapeake Bay Journal, 2000). Much of the population collapse was blamed on foreign fishing fleets. During the 1960s and early 1970s — before the United States restricted fishing within 200 miles of its coast — the fleets were often seen harvesting fish within sight of the beach.

Any comeback is hindered by plenty of other problems: the loss of essential spawning and nursery habitat because of water pollution and the construction of dams and other fish blockages. While little fishing effort is targeted at river herring today, concerns remain that large numbers may be taken as bycatch in other commercial fisheries (Chesapeake Bay Journal, 2000).

Green Sea Turtle

Population Abundance and Distribution: Green sea turtles (*Chelonia mydas*) are the largest of all the hard-shelled sea turtles, but have a comparatively small head. Adult green turtles are unique among sea turtles in that they are herbivorous, feeding primarily on sea grasses and algae. This diet is thought to give them greenish colored fat, from which they take their name. A green turtle's carapace (top shell) is smooth and can be shades of black, gray, green, brown, and yellow. Their plastron (bottom shell) is yellowish white. Scientists estimate green turtles reach sexual maturity between 20 and 50 years, at which time females begin returning to their natal beaches (i.e., the same beaches where they were born) every 2-4 years to lay eggs (NMFS, 2008d).

Habitat Requirements: Green sea turtles live in warm tropical waters from New England to South Africa and in the Pacific from Western Africa to the Americas (ADW, 2008b). In Atlantic and Gulf of Mexico waters, green turtles are found in inshore and nearshore waters from Texas to Massachusetts, the U.S. Virgin Islands, and Puerto Rico. The species primarily use three types of habitat: oceanic beaches (for nesting); convergence zones in the open ocean; and benthic feeding grounds in coastal areas. Adult females migrate from foraging areas to mainland or island nesting beaches and may travel hundreds or thousands of miles each way. After emerging from the nest, hatchlings swim to offshore areas, where they are believed to live for several years, feeding close to the surface on a variety of pelagic plants and animals. Once the juveniles reach a certain age/size range, they leave the pelagic habitat and travel to nearshore foraging grounds. Once they move to these nearshore benthic habitats, adult green turtles are almost exclusively herbivores, feeding on sea grasses and algae. The nesting season varies depending on location. In the southeastern United States, females generally nest between June and September, while peak nesting occurs in June and July. During the nesting season, females nest at approximately two week intervals, laying an average of five clutches (NMFS, 2008d).

Population Dynamics: The principal cause of the historical, worldwide decline of the green turtle is long-term harvest of eggs and adults on nesting beaches and juveniles and adults on feeding grounds. These harvests continue in some areas of the world and compromise efforts to recover this species. Incidental capture in fishing gear, primarily in gillnets, but also in trawls, traps and pots, longlines, and dredges is a serious ongoing source of mortality that also adversely affects the species' recovery. Green turtles are also threatened, in some areas of the world, by a disease known as fibropapillomatosis. The green sea turtle was listed under the ESA on July 28, 1978. The breeding populations in Florida and the Pacific coast of Mexico are listed as endangered, while elsewhere the species is listed as threatened (NMFS, 2008d).

Only two live individuals have been caught in Virginia waters since 1979, one from the York River and one from the Potomac River. Six dead specimens have been found from the lower Chesapeake Bay, the Eastern Shore, and Virginia Beach (VDGIF, 2008b). In the Chesapeake Bay, improved water quality and the resurgence of seagrass beds may have contributed to the recent increase in green turtle sightings (Mitchell, 1991 as cited in (HBMP, 2008a). When not migrating, green turtles prefer sea grass flats which occur in shallow areas of the Chesapeake Bay (VDGIF, 2008b). The green sea turtle was not observed in the Chesapeake Bay waters adjacent to CCNPP during numerous field studies conducted in 2006, 2007, and 2008 in support of the environmental permitting requirements for this project. In addition, no anecdotal reports of observations of the species by CCNPP site personnel have been made to date.

Leatherback Sea Turtle

Population Abundance and Distribution: The leatherback sea turtle (*Dermochelys coriacea*) is the largest turtle and the largest living reptile in the world. The leatherback is the only sea turtle that lacks a hard, bony shell. A leatherback's carapace consists of leathery, oil saturated connective tissue overlaying loosely interlocking dermal bones. Adult leatherbacks are primarily black with a pinkish white mottled ventral surface and pale white and pink spotting on the top of the head. The ridged carapace and large flippers are characteristics that make the leatherback uniquely equipped for long distance foraging migrations (NMFS, 2008e).

Female leatherbacks lay clutches of approximately 100 eggs on sandy, tropical beaches. Females nest several times during a nesting season, typically at 8-12 day intervals. After 60-65 days, leatherback hatchlings emerge from the nest (NMFS, 2008e).

Leatherbacks lack the crushing chewing plates characteristic of sea turtles that feed on hard-bodied prey. Instead, they have pointed tooth-like cusps and sharp edged jaws that are perfectly adapted for a diet of soft-bodied pelagic (open ocean) prey, such as jellyfish and salps (NMFS, 2008e).

Habitat Requirements: Leatherbacks are commonly known as pelagic animals but also forage in coastal waters. The species is the most migratory and wide ranging of the sea turtle species. Leatherbacks mate in the waters adjacent to nesting beaches and along migratory corridors.

After nesting, female leatherbacks migrate from tropical waters to more temperate latitudes, which support high densities of jellyfish prey in the summer. Leatherback turtle nesting grounds are located around the world, with the largest remaining nesting assemblages found on the coasts of northern South America and west Africa. The Caribbean (primarily Puerto Rico and the Virgin Islands) and southeast Florida support minor nesting colonies but represent the most significant nesting activity within the United States. Adult leatherbacks are capable of tolerating a wide range of water temperatures and have been sighted along the entire continental coast of the United States as far north as the Gulf of Maine and south to Puerto Rico, the Virgin Islands, and into the Gulf of Mexico (NMFS, 2008e).

Population Dynamics: Leatherback turtles face threats on both nesting beaches and in the marine environment. The greatest causes of decline and the continuing primary threats to leatherbacks worldwide are long-term harvest and incidental capture in fishing gear. Harvest of eggs and adults occurs on nesting beaches while juveniles and adults are harvested on feeding grounds. Incidental capture primarily occurs in gillnets, but also in trawls, traps and pots, longlines, and dredges. Together these threats are serious ongoing sources of mortality that adversely affect the species' recovery. The leatherback sea turtle was listed under the ESA as endangered in 1970 (NMFS, 2008e).

Leatherbacks are frequently sited during aerial surveys of the Chesapeake Bay, especially at the mouth (and during the summer months) where they appear to be foraging (Keinath and Musick, in press as cited in NMFS and USFWS, 1992). They occur in the Chesapeake Bay and adjacent Atlantic Ocean primarily from May to September (Mitchell, 1991 as cited in HBMP, 2008b). An estimated 100-900 occur in summer in waters off of the northeastern U. S. (Shoop and Kenny, 1992 as cited in HBMP, 2008b). The leatherback sea turtle was not observed in the Chesapeake Bay waters adjacent to CCNPP during numerous field studies conducted in 2006, 2007, and 2008 in support of the environmental permitting requirements for this project. In addition, no anecdotal reports of observations of the species by CCNPP site personnel have been made to date.

Soft-shelled Clam

The soft-shell clam (*Mya arenaria*) is a bivalve mollusk with a thin, oval, elongated shell. The shell is chalky white with a thin, parchment-like covering that varies in color from brownish to yellowish to gray (Chesapeake Bay Program, 2008h).

Population Abundance and Distribution: Soft-shell clams are found off the Atlantic coast from Canada to the southern states. They generally range from Eastern Bay to Pocomoke Sound on the Eastern Shore of Chesapeake Bay and from Maryland 's Severn River to Virginia's Rappahannock River on the western shore (Chesapeake Bay Program, 2008h).

Habitat Requirements: Soft-shells can be found buried in soft sediments from the intertidal zone to depths of about 30 feet in the Bay and some tributaries (Chesapeake Bay Program, 2008h). The soft-shell clam can be found in shallow, sandy, parts of mesohaline portions of the Bay (Funderburke, 1991). Found in areas of low salinity and an influx of fresh water, buried 20 cm or so in mixtures of mud with sand or gravel (Telnack, 2008).

The soft-shelled clam has a relatively thin shell when compared to other clams. For this reason, it also has a very long siphon that stretches far to allow the clam to hide deep in the mud. However, unlike most clams, the soft-shelled clam cannot retract its siphon completely inside its shell (Funderburke, 1991).

The soft-shelled clam requires a minimum dissolved oxygen level of 1 ppm and a minimum salinity level of 8 ppt. The optimum temperature range for soft-shell clam is 10°C - 20°C for eggs and 2°C - 34°C for adults (Funderburke, 1991).

Life History: Soft-shell clams usually spawn twice per year: once in late spring and once in mid- to late autumn. Both eggs and sperm are released into the water column. The number of eggs a female releases depends on the clam's size. Eggs develop into larvae within one day of being fertilized. Larvae swim freely for about one to three weeks, during which they develop their foot and shells (Chesapeake Bay Program, 2008h).

When the larvae are ready to metamorphose into juveniles they swim near and crawl on the bottom for several hours before settling. Newly settled clams, called spat, usually attach themselves to any available surface with thin threads secreted from a gland on the foot. Small juvenile soft-shell clams can be very active, crawling about with their foot. Eventually the clam burrows permanently, and, unless disturbed, spends the rest of its life in one place (Chesapeake Bay Program, 2008h).

Soft-shell clams are filter feeders. They draw water in through their incurrent siphon and filter out microscopic algae. Unused particles are ejected through the exhalent siphon (Chesapeake Bay Program, 2008h). They are a crucial part in Bay life by filtering microscopic algae out of the water and are a major food source to many animals. Such animals that prey off them include blue crabs, eels, cownose rays, mud crabs, flatworms, mummichogs, spot, ducks, geese, swans, muskrats, and raccoons (Funderburke, 1991).

Population Dynamics: Since the first year of major harvesting and exploitation of Maryland soft-shell clam stocks, in 1953, population levels of harvestable soft-shell clams have declined. From 1964 to 1971, harvests remained steady at 3,700,000 kg. Due to tropical storm Agnes, poor harvests were reported in Maryland during the early 1970's. In 1988, harvests in Maryland rebounded to 1,400,000 kg in 1988 from 300,000 kg in 1973 (Funderburke, 1991).

The Calvert Cliffs region is not a major spawning area for soft-shell clams (Richkus et al, 1980). Commercially harvestable densities of soft-shell clams have not historically and do not now occur in the Calvert Cliffs region (Richkus et al, 1980). Plant operations have increased the abundance, growth, and recruitment of soft-shell clams in the vicinity of the plant; however clam densities remain below harvestable levels (Richkus et al, 1980).

Abundances of soft-shell clam were only occasionally higher at the plant site than at reference areas during the preoperational period (Holland et al, 1979). Growth and recruitment of soft-shell clams was not higher at the plant site before operations began (Holland et al, 1979). During the preoperational period, average densities of market-size soft-shell clams near Calvert Cliffs ranged from 98 to 172 liters per hectare (ANSP, 1972d, 1973a; Abbe, 1974a, 1975a as cited in Holland et al, 1979). After plant operations began, the abundance of soft-shell clams immediately following recruitment was frequently larger near the plant site than it was at reference areas (Holland et al, 1979). Plant operations resulted in increased growth and recruitment of soft-shell clams in the discharge region (Holland et al, 1979).

ER Impact:

No changes to the ER are required.

ITEM NUMBER 6 SUPPLEMENTAL REQUEST REGARDING RAI #58 / #63

NRC Request:

These two RAIs requested more detailed information about the proposed dredging, including the method and the specific location of dredging for the intake system. The responses to RAIs #58 and #63 were compared with information provided to other agencies (e.g., Section 3 of the Supp. Env. Resource Report (SERR) issued in May 2008 in support of the 404 application). Please provide up-to-date information about the construction of the intake system and the dredging that will occur in the Bay.

- RAI #58 states (and RAI #63 repeats) that dredging will occur "within the existing CWIS embayment behind the baffle wall..." However, SERR Sections 3.4 and 3.7 state that an expansion of the existing CWIS will be dredged. Please provide the specific locations where dredging will occur. Also, provide information about dredging that will occur during construction of the intake system: the area (size and location) to be dredged? the current water depth in the area to be dredged? To what depth will it be dredged? How much material will be removed? Where will it be disposed? Will there be any armoring at the new intake structure? If so, what is the extent (i.e., length and basal width) of the armored section to be added?

- RAI #58 states (and RAI #63 repeats) that about 15,000 cubic yards of material will be removed to enlarge the barge slip. However, SERR section 3.9.2 states that 60,000 cubic yards will be removed. What is the correct amount of material anticipated to be dredged?

- RAI #58 states (but RAI #63 does not state) that pilings may be driven to support the pipeline installation. Will pilings be driven in Chesapeake Bay to support the pipeline installation? If so, what type of pilings will be used and how will they be installed? If wood pilings are used, will they be treated (what type)? If barges will be used for pile driving, how will they be positioned (e.g., anchors, jack-up supports)? If pile driving will occur, the response to RAI #62 needs to be revisited.

- RAI #58 states (and RAI #63 repeats) that the potential for anchor scarring of the benthos is small. What is the basis for this conclusion? If anchors are used, the potential impacts can extend well beyond the dredging area. This may not be a factor for the barge area because dredging will be from shore, but could be an issue for the pipeline trenching. Explain whether this is an issue for the barge area because dredging will be from shore and whether this is an issue for the pipeline trenching.

- Will the intake system include a fish return system? If so, please provide information about this system including the location, length, and position of the return pipe (i.e., what part of the water column). If a pipe will extend into the Bay, will installation of any part of the pipe or outfall require trenching in the bay? Will it lay on the bay bottom? How long is the outfall pipe? What is its diameter? Will it be protected with riprap or stone? If so, how much, what type, etc.? Will flow within the pipe be enough to keep it from getting filled with sediment (e.g., during storms)?

- Describe any other construction activities at the intake area, discharge area, or barge facility that could affect aquatic resources in the Bay. For example, will new crane foundations be placed at the barge facility? If so, describe the foundations, their locations, and how they will be placed so that potential impacts to aquatic resources can be evaluated.

UniStar Response:

To construct the new Unit 3 intake, will require installing a sheet pile wall extending approximately 180 linear feet from the existing shoreline to existing baffle wall and extending approximately 90 feet channelward of the approximate mean high water shoreline creating an approximately 9,000 square foot wedged shaped pool. To install the new sheet pile wall, approximately 50 feet of existing shoreline armor protection will be removed. Once the new sheet pile wall is in place, approximately 60-feet of armor within the wedged shape pool will be removed and temporary upland sheet piling will be installed along the make up water pipe routing. This upland sheet piling will extend out into the wedge shaped pool approximately 30 feet to facilitate dewatering, installation of the pipe and the associated trash rack. The area within the wedged shaped pool surrounded by the sheet piling will be dewatered and dredged by mechanical method to create an approximately 30-feet wide by 30-feet long by 25-feet deep area, resulting in approximately 900 cubic yards of sand and gravel, which will be deposited at an existing upland (non-wetland), environmentally controlled area at the Lake Davies laydown area onsite. Existing water depths range from approximately -18 to -24 feet. After dredging, two 60-inch intake pipes with trash racks at the pipe openings, extending approximately 20 feet channelward to a bottom elevation of -25 feet mean low water, will be installed. After installation of the pipes and associated trash racks, shoreline armor protection along the shore approximately 80 linear feet and extending 10 feet channelward will be restored within the wedged shaped area. In addition, armor protection will extend out beyond the new sheet pile wall approximately 75 linear feet and extend approximately 205 feet channelward. As a final step, the temporary sheet pile wall, around the 60-inch intake pipes will be removed allowing the area to flood and submerge the pipes (attached Figure 3A).

The existing barge slip will be restored and extended to re-establish use of an approximately 1,500-foot by 130-foot (average width), 195,000 square foot area to a bottom elevation of -16 feet mean low water, requiring approximately 50,000 cubic yards of mechanical dredging. Approximately 1,065-feet of the dredging is considered maintenance, and the remaining 435-feet is an extension beyond the original dredging limits and is required to reach the bottom elevation of -16 feet mean low water. Of the approximately 50,000 cubic yards of dredging required, 45,000 cubic yards are considered maintenance dredging, and 5,000 cubic yards are considered new dredging.

Pilings will not be utilized during the discharge pipeline installation.

Impacts to benthos as a result of anchor scarring will be temporary. Once dredging activities are completed, anchoring of vessels and therefore anchor scarring will cease. It is expected that the benthic community will be fully restored as the organisms repopulate areas affected by anchor scarring once the activities are completed. It is also probable the some mobile organisms, such as blue crabs, will escape the area once the dredging activity begins and return shortly after dredging is completed. Organisms would be expected to return to the new bottom and any scarred areas within 1-2 years after dredging.

A fish return system will be provided as a part of the intake design. This design will be similar to the existing Unit1/Unit 2 fish return and will be finalized as a part of the detailed design effort and in conjunction with the purchase of intake pumps and screens.

To construct the proposed fish return outfall, an 18-inch diameter HDPE pipe will be installed in a mechanically excavated trench. At the shoreline, the pipe will be installed 4 feet below grade and will extend 40 feet channelward where it will emerge from the bay bottom (see attached Figure 4A). The outfall location will be protected with a 10-foot by 10-foot riprap apron extending approximately 48 feet channelward. To install the pipe, approximately 40 linear feet of the existing shoreline revetment will be removed, and approximately 500 cubic yards of material will be dredged within the work area. Sufficient dredge material will be returned to the trench after the pipe is placed in order to match adjacent bottom topography. The existing shoreline revetment will be restored to its original design after pipe installation. Turbidity curtains are anticipated during the work to contain suspended sediments.

No new cranes or associated crane foundations will be constructed as part of this project.

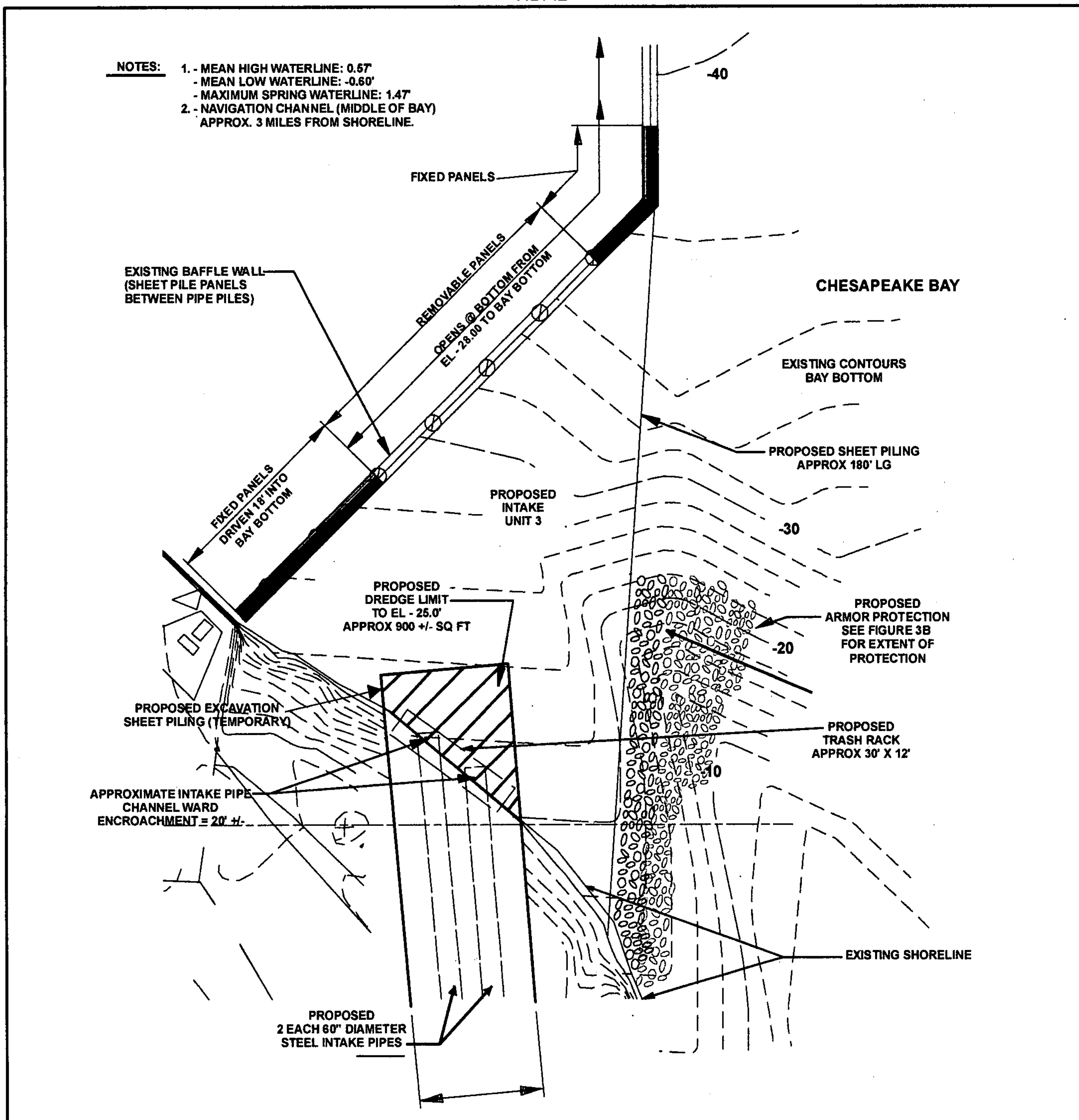
Near shore maintenance dredging will require removal of sediment which has mounded up over the past 30 years and will include restoration of an existing culvert outfall. Due to silt build up over the years, the discharge from this outfall meanders in a north-south direction prior to discharging into the barge slip area. The restoration activities in this area will include the installation of a 40-foot x 40-foot x 2-foot deep riprap apron extending approximately 40 feet channelward will be placed directly in front the existing outfall allowing the discharge to flow directly in the bay as originally designed. The existing waterway depths range from approximately 0 feet to -16 feet elevation within the work area.

ER Impact:

No changes to the ER are required.

Figures Supporting this RAI response are as follows:

TIDAL



PURPOSE: PLANT EXPANSION
DATA SOURCE:
BECHTEL CORPORATION
DATUM: (NGVD 29)
PROJECT LATITUDE/LONGITUDE:
38.424133
-76.441598

FIGURE 3A
SITE PLAN @ UNIT 3 INTAKE STRUCTURE - SHT 2

SCALE IN FEET
0 25 50
Feet

CALVERT CLIFFS NUCLEAR POWER PLANT

IN:
PATUXENT / WEST CHESAPEAKE BAY
COUNTY OF: CALVERT STATE: MD

APPLICATION BY:
CALVERT CLIFFS 3 NUCLEAR PROJECT, LLC
AND UNISTAR NUCLEAR OPERATING SERVICES,LLC

DATE: 5/09/08 REV1 7/14/08

Map Document: (G:\Calvert Cliffs\frozen_5_1_08\404\Final Figures\figure4__key.mxd)
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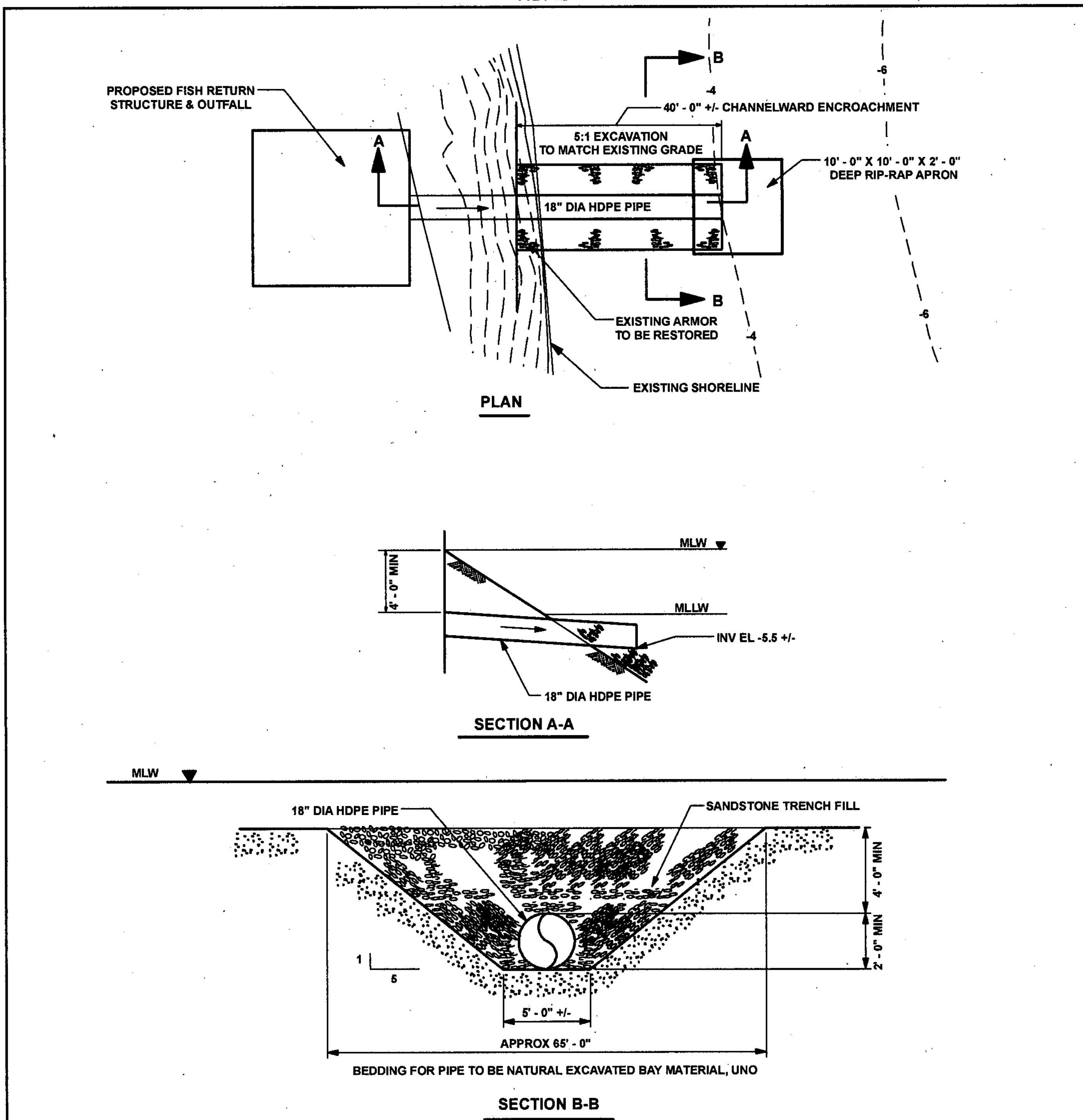

PURPOSE: PLANT EXPANSION DATA SOURCE: BECHTEL CORPORATION DATUM: (NGVD 29) PROJECT LATITUDE/LONGITUDE: 38.424133 -76.441598	**FIGURE 4A FISH RETURN** SCALE IN FEET **NOT TO SCALE**	**CALVERT CLIFFS NUCLEAR POWER PLANT** IN: PATUXENT / WEST CHESAPEAKE BAY COUNTY OF: CALVERT STATE: MD APPLICATION BY: CALVERT CLIFFS 3 NUCLEAR PROJECT, LLC AND UNISTAR NUCLEAR OPERATING SERVICES,LLC DATE: 5/09/08 REV1 7/14/08

Map Document: (G:\Calvert Cliffs\frozen_5_1_08\404\Final Figures\figure4__key.mxd)
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ITEM NUMBER 7 SUPPLEMENTAL REQUEST REGARDING RAI #59

NRC Request:

What is the basis for the conclusion that prop wash impacts to the benthos will be small? What size vessels will use the barge dock? What is the time period during which the barge dock will be used?

UniStar Response:

Barges arriving at the CCNPP Unit 3 dock will normally be connected to the tug tow at its bow, with the props pointed out towards the center of the bay. The docking procedure is to bring the barge to a full stop, with minimal contact force. The tow will typically accomplish this by cutting the engines and coasting towards the dock, with the engines in low speed reverse as necessary to fine tune the final approach. Once the barges are docked, the barges will not be maneuvered within the barge facility until they are removed. Therefore, impacts associated with prop wash due to maneuvering vessels at the barge facility should not be factor (Ebbesmeyer et al., 1995). The removal of unloaded barges should require minimal engine force. Tows will again be typically connected to the barge at the bow, with props pointed out towards the center of the bay. Props will be engaged in low reverse during the initial movement away from the dock, with gradual acceleration as the barge and tow move over deeper water. Impacts from prop wash should only occur during arrival and departure. The lack of strong tidal currents and the lack of large waves should result in the rapid settling of sediment in 2 hours or less (Thouverez, 2000).

Typical barges to use the dock are 35 feet wide but can range up to 50 feet wide with heights ranging from 3 to 13 feet. Drafts can vary depending on the tonnage between 2 feet to 11 feet. Based on preliminary construction schedule estimates, the barge dock may be in use for approximately 5 years.

References:

Ebbesmeyer, C.C., M.D. Francisco, C.D. Boatman., D. Norton, and T. Michelsen. 1995. "Currents generated by vessel traffic along Seattle's waterfront." In: *Oceans '95 MTS/IEEE Conference* Proceedings, Vol 1: 26-41.
Thouverez, H. 2000. Cargo Port Impacts: Environmental Impacts of Ports on Florida East Coast Indian River Lagoon, Florida; An Executive Summary. Saint Lucie Water Front Council and Marine Resources Council of East Florida. 15pp

ER Impact:

No changes to the ER are required.

Item Number 8 Supplemental Request Regarding RAI #61

NRC Request:

RAI #61 requested information about the discharge pipeline installation. The response provides some of the physical dimensions of the pipe and diffuser system. Please provide specific information about the pipeline installation.

- The response states that the trench will limited to that needed to install the pipe, but doesn't give any details. How wide will the trench be dredged? How much material will be removed? Where will it be disposed?

- The response states that riprap or stone will be used to cover the pipe. What size and type of rock (riprap) will be used to cover the outfall pipe and to protect the diffuser? To what width around the pipe and diffuser will the rock be placed? How far above sediment grade will the riprap extend? Figure 3.8-3 of the Supp. ER appears to show that the top of the pipe will be about 4 ft beneath the bay bottom, but shows that the pipe will be covered with riprap and filter. What is "filter"? [typo for filler?] The figure also suggests that part of the trench may be filled with material other than riprap. If so, what is that material and what is its source?

UniStar Response:

The trench to be dredged for the discharge pipe installation will be 550 feet in length. The trench will be dredged in a trapezoidal form at a 5:1 side slope to prevent sloughing of the trench sides. The actual trench bottom width will range from 3 to 6 feet wide. Maximum width of the trench top will be approximately 70 feet wide (attached Figures 5B, 5C, and 5D). Approximately 7,000 cubic yards of material will be dredged for the pipe installation. Of the 7,000 cubic yards, approximately 5,800 cubic yards will be used to backfill the trench with the remaining approximately 1,200 cubic yards will be deposited at an existing upland (non-wetland), environmentally controlled area at the Lake Davies laydown area onsite.

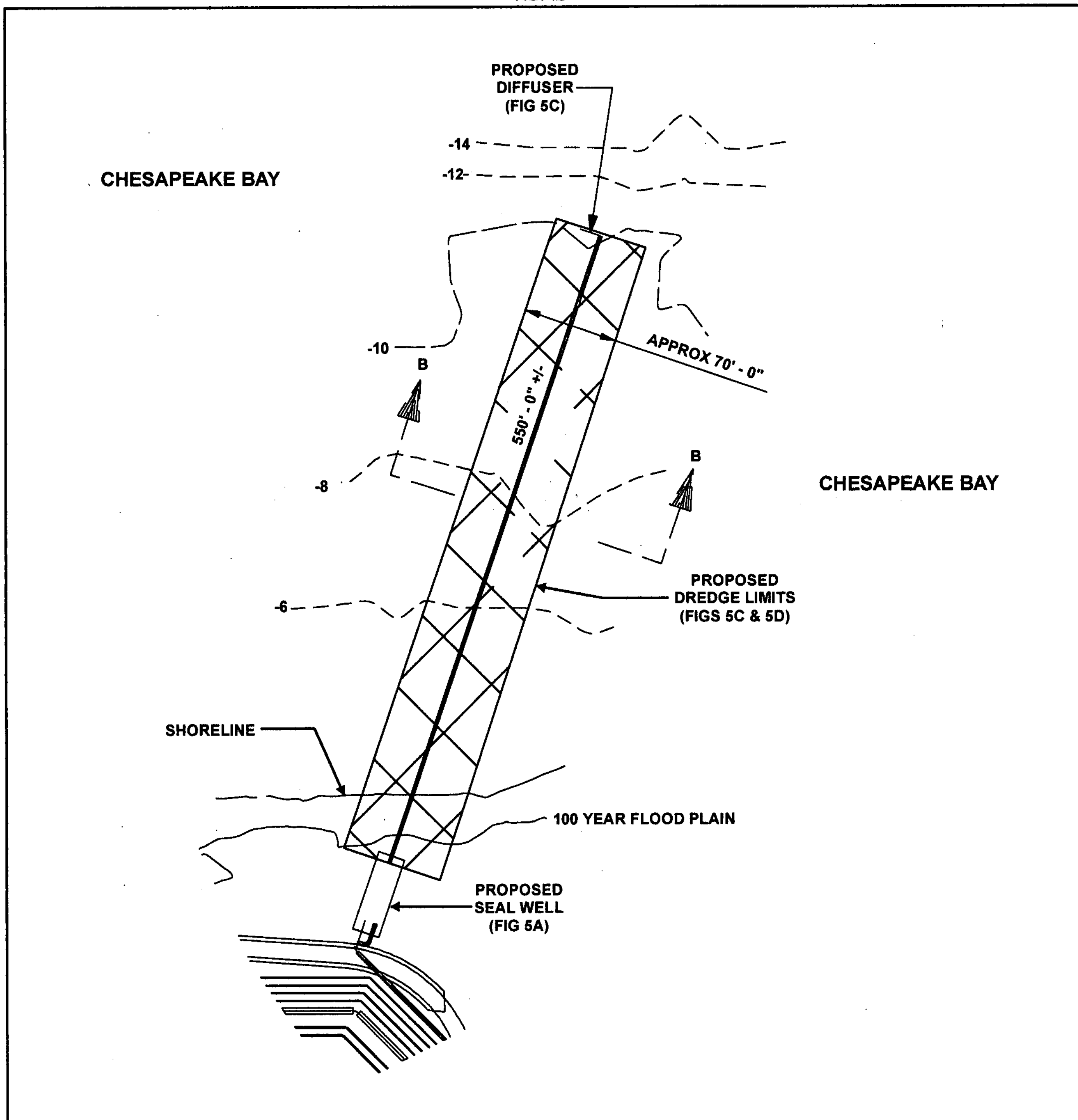
The trench will be back filled with the material dredge from the bay bottom for the discharge pipe trench. D_{50}=12 riprap and filter fabric will be placed on top of the back filled material for a minimum of 4 feet of cover over the discharge pipe (attached Figure 5D). The riprap will be placed within discharge pipe trench to the top of the trench at the original grade of the bay bottom. This riprap will not extend above the existing bay bottom topography. The riprap will extend approximately 10 feet on each side of the diffuser.

ER Impact:

No changes to the ER are required.

Figures Supporting this RAI response are as follows:

TIDAL



PURPOSE: PLANT EXPANSION
DATA SOURCE:
BECHTEL CORPORATION
DATUM: (NGVD 29)
PROJECT LATITUDE/LONGITUDE:
38.424133
-76.441598

FIGURE 5B
SEAL WELL &
DISCHARGE PIPING

SCALE IN FEET

0 100 200 Feet

CALVERT CLIFFS NUCLEAR POWER PLANT

IN:
PATUXENT / WEST CHESAPEAKE BAY
COUNTY OF: CALVERT STATE: MD

APPLICATION BY:
CALVERT CLIFFS 3 NUCLEAR PROJECT, LLC
AND UNISTAR NUCLEAR OPERATING SERVICES,LLC

DATE: 5/09/08 REV1 7/14/08

Map Document: (G:\Calvert Cliffs\frozen_5_1_081404\Final Figures\figure4__key.mxd)
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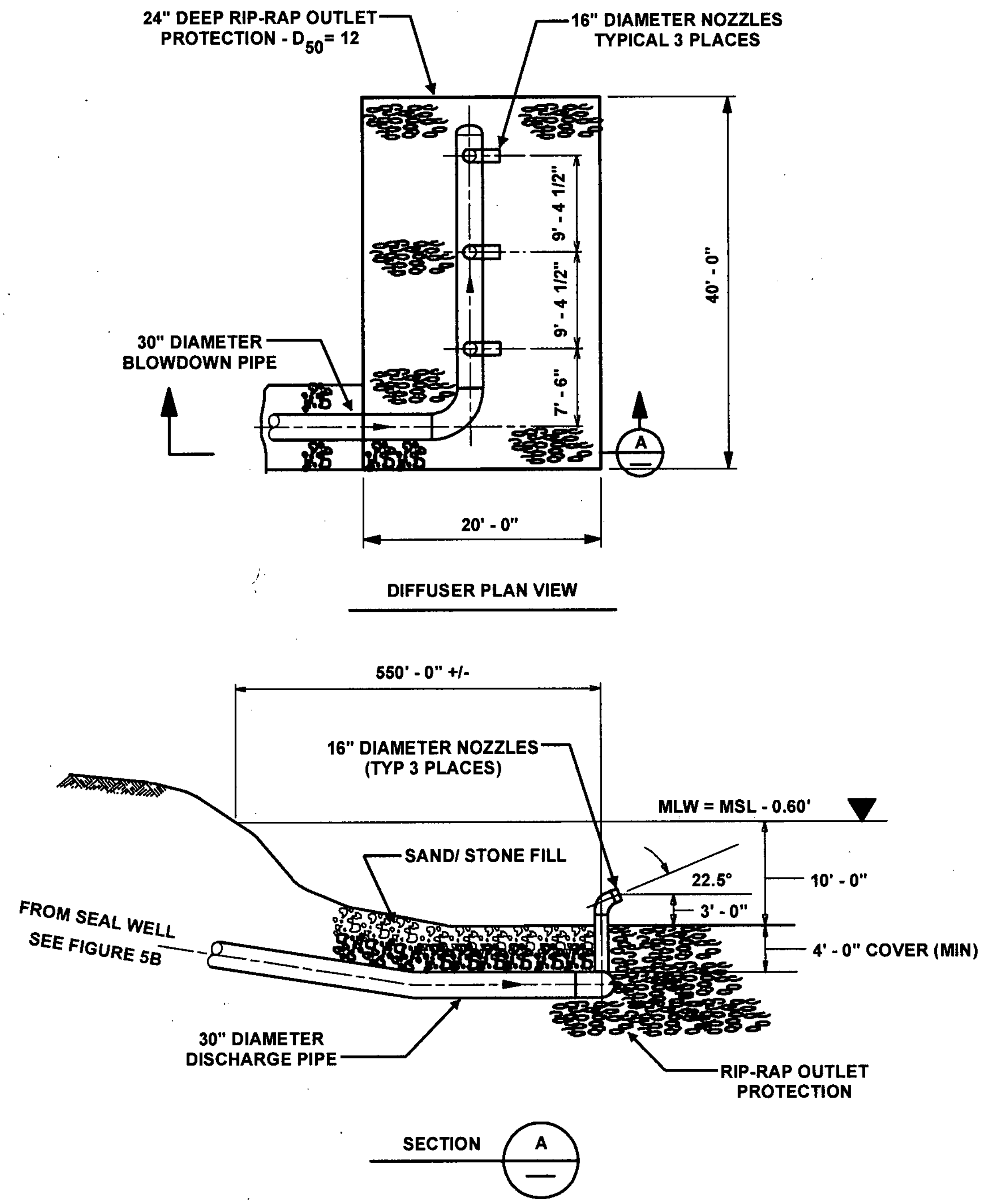

PURPOSE: PLANT EXPANSION
DATA SOURCE:
BECHTEL CORPORATION
DATUM: (NGVD 29)
PROJECT LATITUDE/LONGITUDE:
38.424133
-76.441598

FIGURE 5C
DISCHARGE OUTFALL DETAILS

SCALE IN FEET

NOT TO SCALE

CALVERT CLIFFS NUCLEAR POWER PLANT

IN:
PATUXENT / WEST CHESAPEAKE BAY
COUNTY OF: CALVERT STATE: MD

APPLICATION BY:
CALVERT CLIFFS 3 NUCLEAR PROJECT, LLC
AND UNISTAR NUCLEAR OPERATING SERVICES,LLC

DATE: 5/09/08 REV1 7/14/08

Map Document: (G:\Calvert Cliffs\frozen_5_1_08\404\Final Figures\figure4__key.mxd)
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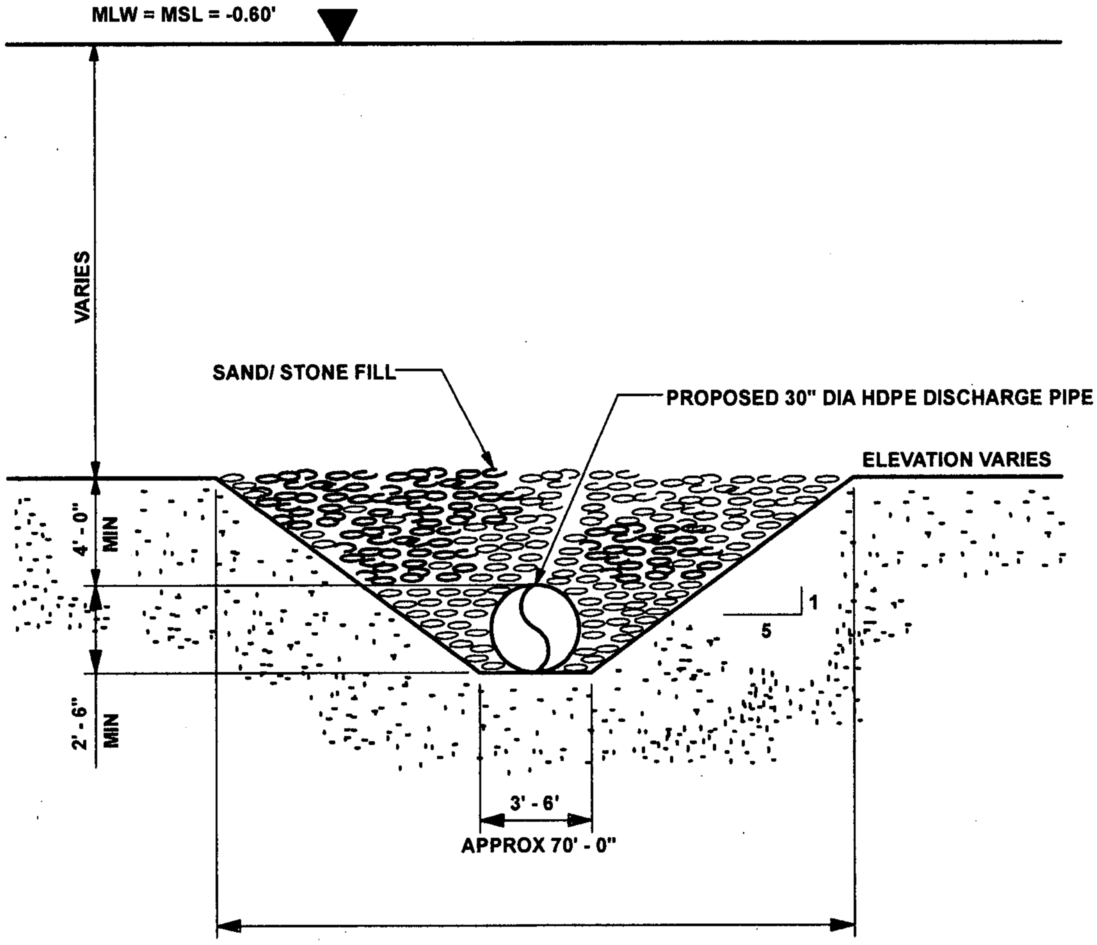

BEDDING FOR PIPE TO BE NATURAL EXCAVATED BAY MATERIAL, UNO
SEE FIG 5C FOR RIP-RAP PROTECTION @ DIFFUSER END

SECTION B

PURPOSE: PLANT EXPANSION DATA SOURCE: BECHTEL CORPORATION DATUM: (NGVD 29) PROJECT LATITUDE/LONGITUDE: 38.424133 -76.441598	**FIGURE 5D DISCHARGE OUTFALL DETAILS** SCALE IN FEET **NOT TO SCALE**	**CALVERT CLIFFS NUCLEAR POWER PLANT** IN: PATUXENT / WEST CHESAPEAKE BAY COUNTY OF: CALVERT STATE: MD APPLICATION BY: CALVERT CLIFFS 3 NUCLEAR PROJECT, LLC AND UNISTAR NUCLEAR OPERATING SERVICES,LLC DATE: 5/09/08 REV1 7/14/08

Map Document: (G:\Calvert Cliffs\frozen_5_1_08\404\Final Figures\figure4__key.mxd)
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ITEM NUMBER 9 SUPPLEMENTAL REQUEST REGARDING RAI #62

NRC Request:

This RAI requested a description of the possible impacts associated with pile driving. Only a list of three possible impacts was provided.

If pile driving will be used during the project, describe the potential impacts from sediment deposition (how much, to what extent?), noise (what levels and duration, any impacts to fish, birds, turtles?), and intense vibrations (how intense and for what duration, taxa most likely affected?). Also, if treated-wood pilings will be used, describe the potential impacts associated with that usage.

UniStar Response:

Section 4.3.2.2.4 notes impacts on aquatic life within the project area. The bay anchovy and Atlantic menhaden are the most common mid-water fish species in the immediate area of the project, based on monitoring of the baffle wall and intake screens for CCNPP Units 1 and 2. It was also noted that neither the shortnose sturgeon nor the loggerhead turtle has been found impinged on the CCNPP Unit 1 and 2 intake screens during the 21 years of monitoring data. Additionally, the National Marine Fisheries Service concluded that CCNPP license renewal would not adversely affect either the shortnose sturgeon or the loggerhead turtle because the CCNPP Units 1 and 2 discharge/intake do not lie within the areas normally used by either species.

This discussion expands upon the original submittal to address in greater detail the noise, vibration and sediment impacts associated with pile driving. The discussion relies heavily on research and interim guidance developed by the Fisheries Hydroacoustic Working Group (FHWG), which appears to constitute the most comprehensive and up to date efforts to avoid, minimize or mitigate the impacts of pile driving hydroacoustics. While the FHWG studies focus only on fish, the intent is to establish guidelines that are protective of marine mammals, sea turtles, diving birds and other aquatic organisms by addressing the most sensitive representative (fish) for all of these fauna.

Research and Guidelines

Until recently, very little data or guidance has been available that specifically addressed the noise impacts of pile driving. This deficiency was recognized when design of earthquake resistant structures such as replacement of the San Francisco Oakland Bay Bridge required the use of large diameter cast in steel shell (CISS) piles driven with impact hydraulic hammers. In response, the California Department of Transportation (Caltrans) in coordination with the Federal Highways Administration (FHWA) and the departments of transportation in Oregon and Washington established a Fisheries Hydroacoustic Working Group (FHWG) in order to improve and coordinate information on fishery impacts due to underwater sound pressure caused by in-water pile driving. In addition to the above transportation agencies, the FHWG is composed of representatives from NOAA Fisheries (Southwest), NOAA Fisheries (Northwest), U.S. Fish and Wildlife Service, California Department of Fish and Game, and the U.S. Army Corps of Engineers. The FHWG is supported by a panel of hydroacoustic and fisheries experts who have been recommended by the FHWG members. A Steering Committee oversees the FHWG and is composed of managers with decision-making authority from each of the members' organizations (Caltrans, 2008).

The goal of the Working Group is to reach agreement on: 1) The nature and extent of knowledge about the current scientific basis for underwater noise effects on fish, 2) Interim guidelines for project assessment, mitigation, and monitoring for effects of pile-driving noise on fish species, and; 3) Future scientific research needed to satisfactorily resolve uncertainties regarding hydroacoustic impacts on fish species.

Metrics: From numerous options, the FHWG utilizes two standards for measurement of underwater pile driving sound and vibration impacts. The peak sound-pressure level (Peak Pressure or peak) is measured in decibels relative to a reference level of one micro Pascal (dB re 1 *u*Pa). The cumulative sound exposure level (SEL) is: dB re 1 uPa^2-s and is defined as the constant sound level of 1s duration that would contain the same acoustic energy as the original sound. Both measures are standardized at a distance of 10 m from the pile (Hawkins, A. 2006).

Background Studies-Pile Driving Sound: Support for development of the FHWG Interim Criteria included studies collecting and evaluating currently available information. This included compilation of available measurements of noise and vibration impacts associated with various forms of pile driving. Typical ranges of Peak Pressure and Cumulative SEL are illustrated in Table 1 (Hastings, M. 2005).

Pile Type	Distance from Pile (m)	Peak Pressure (dB re 1 μPa)	RMS(impulse) Pressure (dB re 1 μPa)	SEL (dB re 1 μPa2-s)
--Various Projects				
Timber (12-in) Drop	10	177	165	157
CISS (12-in) Drop	10	177	165	152
Concrete (24-in) Impact (diesel)	10	188	176	166
Steel H-Type Impact (diesel)	10	190	175	--
CISS (12-in) Impact (diesel)	10	190	180	165
CISS (24-in) Impact (diesel)	10	203	190	178
CISS (30-in) Impact (diesel)	10	208	192	180
--Richmond-San Rafael Bridge				
CISS (66-in) Impact (diesel)	4	219	202	--
CISS (66-in) Impact (diesel)	10	210	195	--
CISS (66-in) Impact (diesel)	20	204	189	--
--Benicia-Martinez Bridge				
CISS (96-in) Impact (Hydraulic)	5	227	215	201
CISS (96-in) Impact (Hydraulic)	10	220	205	194
CISS (96-in) Impact	20	214	203	190

(Hydraulic)				
--SFOBB East Span				
CISS (96-in) Impact (Hydraulic)	25	212	198	188
CISS (96-in) Impact (Hydraulic)	50	212	197	188
CISS (96-in) Impact (Hydraulic)	100	204	192	180

Table 1. Summary of Measured Underwater Sound Levels Near Marine Pile Driving

In addition to pile type and size, numerous other factors contribute to the noise impacts of pile driving. Tables 2 & 3 (Caltrans, 2007) illustrate differences between using an impact hammer vs. a vibratory driver; Table 2 also illustrates differences associated with relative water depth.

Pile Type and Approximate Size	Relative Water Depth	Average Sound Pressure Measured in dB		
		Peak	**RMS**	**SEL**
0.30 meter (12-inch) Steel H-type-Thin	<5 meters	190	175	160
0.30 meter (12-inch) Steel H-type-Thick	~5 meters	195	183	170
0.6 meter (24-inch) AZ Steel Sheet	~15 meters	205	190	180
0.61 meter (24-inch) Concrete Pile	~5 meters	185	170	160
0.61 meter (24-inch) Concrete Pile	~15 meters	188	176	166
0.30 meter (12-inch) Steel Pipe Pile	<15 meters	192	177	—
0.36 meter (14-inch) Steel Pipe Pile	~15 meters	200	184	174
0.61 meter (24-inch) Steel Pipe Pile	~15 meters	207	194	178
0.61 meter (24-inch) Steel Pipe Pile	~5 meters	203	190	177
1 meter (36-inch) Steel Pipe Pile	<5 meters	208	190	180
1 meter (36-inch) Steel Pipe Pile	~10 meters	210	193	183
1.5 meter (60-inch) Steel CISS	<5 meters	210	195	185
2.4 meter (96-inch) Steel CISS	~10 meters	220	205	195

Table 2. Summary of Near-Source (10-Meter) Unattenuated Sound Pressures for In-Water Pile Driving using an Impact Hammer

Pile Type and Approximate Size	Relative Water Depth	Average Sound Pressure Measured in dB		
		Peak	RMS	SEL
0.30 meter (12-inch) Steel H-type	<5 meters	165	150	150
0.30 meter (12-inch) Steel Pipe Pile	<5 meters	171	155	155
1meter (36-inch) Steel Pipe Pile-Typical	~5 meters	180	170	170
0.6 meter (24-inch) AZ Steel Sheet-Typical	~15 meters	175	160	160
0.6 meter (24-inch) AZ Steel Sheet-Loudest	~15 meters	182	165	165
1 meter (36-inch) Steel pipe Pile-Loudest	~5 meters	185	175	175
1.8 meter (72-inch) Steel Pipe Pile-Typical	~5 meters	183	170	170
1.8 meter (72-inch) Steel Pipe Pile-Loudest	~5 meters	195	180	180

Table 3. Summary of Near-Source (10-Meter) Unattenuated Sound Pressures for In-Water Pile Installation using a Vibratory Driver/Extractor

Background Studies-Impacts of Sound on Fish: The FHWG analyzed all available studies to address known impacts of sound on fish and to establish noise standards that would be protective of fishery resources. The objectives of this analysis are summarized as follows (Theiss, S. 2007):

"Ideally we want to define interim sound exposure criteria as representing the received signal level that defines the *onset* of effects, rather than using data representing effects at some point past their onset; however, data for the onset of effects in fishes are not available in the literature. Moreover, instead of proposing one set of criteria, peak sound pressure level (SPL) and cumulative sound exposure level (SEL), we propose criteria for each of *three different effects on fish*:

1) Hearing loss due to temporary threshold shift (TTS);
2) Damage to auditory tissues (generally sensory hair cells of the ear); and
3) Damage to non-auditory tissues.

At the same time, we also recognize that the biology of individual fish species as well as the physiological state of individual fish may alter the nature and sequence of effects. Based on the available scientific literature, vulnerability to non-auditory tissue damage increases as the mass of the fish decreases. Therefore, non-auditory tissue damage criteria are different depending on the mass of the fish. "

Interim Criteria: The FHWG met in June 2008 and agreed to new interim, dual criteria for injury to fish from pile driving noise. These new criteria are to be used as of August 2008 until further notice. This criteria (See Table 4) includes a peak level of 206 dB AND a cumulative SEL level of 187 dB for fish 2 grams and heavier OR a cumulative SEL of 183 dB for fish smaller than 2 grams.

Interim Criteria for Injury	**Agreement in Principle**
Peak	206 dB (for all size of fish)
Cumulative SEL	187 dB – for fish size of two grams or greater. 183 dB – for fish size of less than two grams.*

Table 4. FHWG Agreement in Principle Technical/Policy Meeting Vancouver, WA *June, 11 2008*

Signatories to the FHWG Interim Criteria include California Department of Transportation, Oregon Department of Transportation, Washington State Department of Transportation, California Department of Fish and Game, Federal Highways Administration (FHWA), NOAA Fisheries (Southwest), NOAA Fisheries (Northwest), U.S. Fish and Wildlife Service, and the U.S. Army Corps of Engineers.
While the Interim Criteria are currently applicable to the three west coast states, ongoing research may contribute to expansion of these (or succeeding) criteria to other coastal jurisdictions. Towards this end, Caltrans is participating in the National Cooperative Highway Research Program (NCHRP) study #25-28 "Predicting and Mitigation Hydroacoustic Impacts on Fish from Pile Installation" and the Transportation Pooled Fund Program Study "Structural Acoustic Analysis of Piles."

Pile Driving proposed for CCNPP Unit 3

Project Overview: This information is preliminary and sizing of the sheet piles is based on the existing design.

Three pile driving tasks are proposed for construction. Of these, the project adjacent to the Intake Area would produce the most significant hydroacoustic impacts. The proposed sheet piling would be 180' W x 60' L, with an embedded length of approximately 15'. Soldier piles (30" dia. steel piles), would be installed on approximately 10' centers. These piles will be driven with conventional pile hammers.

PZ 27/22 or equivalent steel sheet piling is anticipated for construction of the CCNPP Unit 2 intake structure and barge unloading area. Sheet piling is anticipated to be driven with vibratory hammers. Construction duration for this project is estimated as two (2) months (see Figure Key and Figure 3).

The second project, to be constructed in the Barge Unloading Area, is a smaller project that will entail shallower depths. Any impacts from this activity would be reduced in comparison to impacts of sheet piling installation in the intake area. The project would be 90' W x 20'L, with

PZ 27/22 sheet piling and 30" soldier piles supporting the sheet piling. Construction duration for this project is estimated as two (2) weeks (see Figure Key, Figure 6 and 6A).

The third project, to be constructed in the Intake Cofferdam Area, will occur on uplands and is not expected to have any impact on aquatic resources. The project will be 1600' W x 60' L, PZ 27/22 sheet piling with an embedded length of approximately 45'. Construction duration is estimated as four (4) months (see Figure Key and Figure 4).

Project Sites: The intake area consists of several hundred feet of sheet pile that protect the sea-water intakes for CCNPP units 1 and 2. Shoreline adjacent to the existing sheet pile has been armored with riprap to protect against shore erosion. The sheet pile enclosure blocks the passage of most fish that might get close to the intake structures; a return system discharges any impinged fish back to the ocean. The proposed new sheet pile for unit 3 will entail only a minor modification to the existing sheet pile in this area.

The barge unloading area receives barges up to 200' long with a maximum load depth of 11'. The typical barge is 35' wide, but barges up to 50' wide can be accommodated. The proposed new unit 3 at CCNPP will necessitate expansion of docking capacities at the barge unloading area. However, the proposed sheet pile at this location will constitute only a minor portion of the unloading area expansion.

Pile Construction Noise and Vibration Impacts: The proposed project will employ 30" steel piles and conventional pile hammers to drive them. Vibratory hammers will be employed to drive the sheet piles. The shallow depth of the installation is associated with noise and vibration impacts that are less than pile driving activities in deeper water.

Among the Pile Driving examples illustrated in Tables 1 - 3, the entry in Row 7 of Table 1 represents the only entry for 30" steel pipe, with a peak sound impact of 208 db and a cumulative SEL of 180 dB. No water depth is indicated for this entry. Table 2, Row 9 lists an entry for 24" steel pipe in approximately 5 meters water depth. This impact is 203 db peak and 177 db SEL. Table 2, Row 10 lists 208 dB peak and 180 dB SEL for 36" steel pipe in less than 5 meters water depth.
These entries suggest that driving 30" steel pipe piles with conventional hammers at the project sites could produce sound impacts that approach or exceed the interim guidance criteria of 206 dB Peak. The project does not appear likely to exceed the minimum SEL criteria of 183 dB for fish size less than 2 grams. Driving the sheet piling does not appear to approach any of the interim criteria thresholds.
If warranted, additional measures for minimizing noise and vibration impacts are available for heavy duty pile driving, large projects or highly sensitive project environments. These include bubble curtains around large piles to muffle sound and vibration, alternative hammers/drivers that generate less sound, and timing to avoid sensitive periods (diurnal and/or seasonal). In some cases it may be possible to employ pre-drilled excavation and back-filling (auger cast pile) in lieu of driving piles or to construct cofferdams that isolate the pile driving from the water.
Appendix A provides a list of estuarine species in the Chesapeake Bay that could be exposed to noise and vibration impacts of the proposed project. The list indicates the relative sensitivity of each species and their probable response to noise and vibration impacts.

Sediment Impacts of Pile Driving: Minimal sediment disturbance will occur in conjunction with the pile driving operation. Pile driving compresses the surrounding soils, resulting in a stabilizing effect on the soils. Installation of rock armor along the toe of the sheet piling will protect against any transport of sediment away from this area that might result from wind, tides or currents.

Proposed sheet piling construction in the intake wedge area will result in minimal changes to the existing shoreline configuration and sediment transport/deposition patterns. The proposed construction will affect 180 feet of existing sheet piling and armored shoreline in an area where prior construction has occurred.

References

Caltrans, 2008. Fisheries – Bioacoustics, California Department of Transportation, Biological Resources Issues Links http://www.dot.ca.gov/hq/env/bio/fisheries_bioacoustics.htm accessed September 9, 2008

Caltrans, 2007. Caltrans unpublished "Guidance Manual of the Effects of Pile Driving Sound on Fish," Appendix-Compendium of Pile Driving sound Data [September 27, 2007].

Carlson, Thomas, Mardi Hastings, and Arthur N. Popper. Update on Recommendations for Revised Interim Sound Exposure Criteria for Fish during Pile Driving Activities. CALTRANS-Arlington Memo Update 12-21-07

Hastings, Mardi C. Ph.D. and Arthur N. popper, Ph.D. Effects of Sound on Fish. California Department of Transportation Contract No. 43A0139, Task Order 1. January 28, 2005 (Revised Appendix B – August 23, 2005).
Hawkins A. 2006. Assessing the impact of pile driving upon fish. IN: Proceedings of the 2005 International Conference on Ecology and Transportation, Eds. Irwin CL, Garrett P, McDermott KP. Center for Transportation and the Environment, North Carolina State University, Raleigh, NC: p. 22.

Appendix A – Pile Driving Impacts to Estuarine Species in Chesapeake Bay near the CCNPP Site

Figures Illustrating Project Site and Proposed Sheet Pile Construction

Figure Key – Figure Key plan, Calvert Cliffs Nuclear Power Plant

Figure 3 – Site Plan @ Unit 3 Intake Structure, Sheet 1

Figure 4 - Site Plan @ Unit 3 Intake Structure, Sheet 1

Figure 6 - Proposed Restoration of Barge Slip (With Existing Contours)

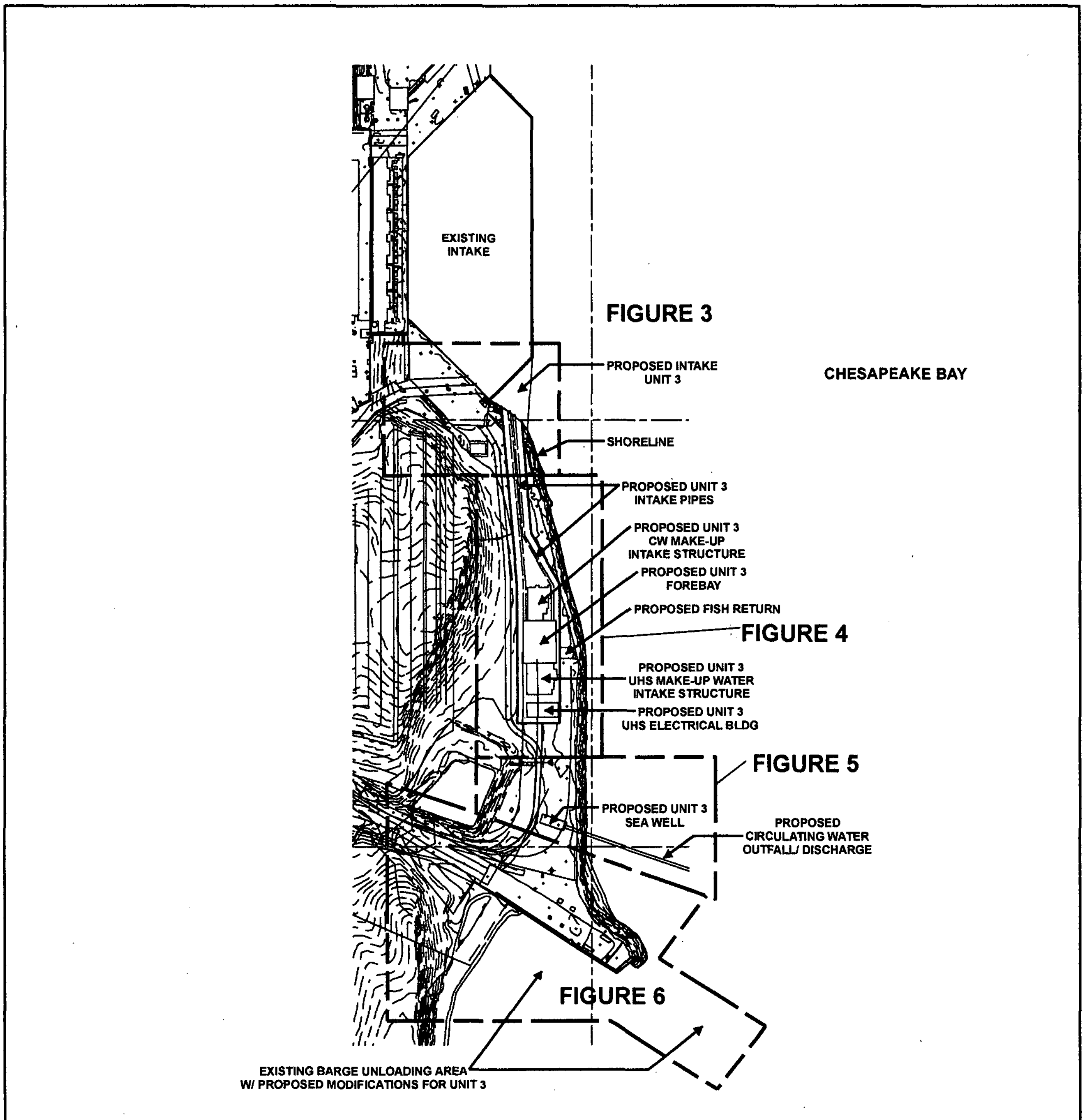
Figure 6A – Modifications @ Existing Barge Unloading Facility

ER Impact:

No changes to the ER are required.

Figures Supporting this RAI response are as follows:

TIDAL



PURPOSE: PLANT EXPANSION DATA SOURCE: BECHTEL CORPORATION DATUM: (NGVD 29) PROJECT LATITUDE/LONGITUDE: 38.424133 -76.441598 N	KEY PLAN SCALE IN FEET 0 300 600 Feet	CALVERT CLIFFS NUCLEAR POWER PLANT IN: PATUXENT / WEST CHESAPEAKE BAY COUNTY OF: CALVERT STATE: MD APPLICATION BY: CALVERT CLIFFS 3 NUCLEAR PROJECT, LLC AND UNISTAR NUCLEAR OPERATING SERVICES,LLC DATE: 5/09/08 REV1 7/14/08

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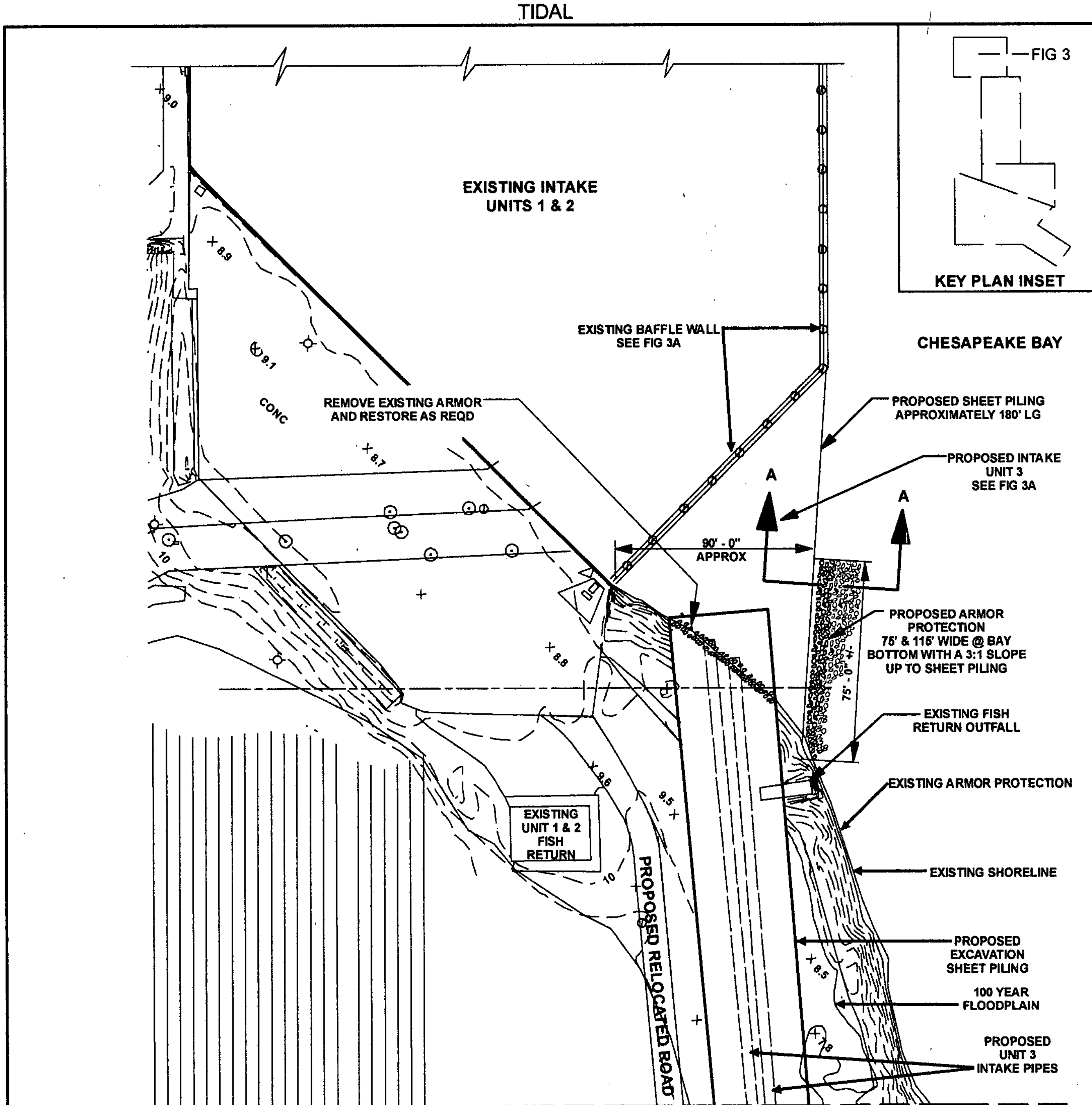

MATCH LINE (SEE FIGURE 4)

PURPOSE: PLANT EXPANSION
DATA SOURCE:
BECHTEL CORPORATION
DATUM: (NGVD 29)
PROJECT LATITUDE/LONGITUDE:
38.424133
-76.441598

N

FIGURE 3
SITE PLAN @ UNIT 3 INTAKE STRUCTURE - SHT 1

SCALE IN FEET

0 50 100 Feet

CALVERT CLIFFS NUCLEAR POWER PLANT

IN:
PATUXENT / WEST CHESAPEAKE BAY
COUNTY OF: CALVERT STATE: MD

APPLICATION BY:
CALVERT CLIFFS 3 NUCLEAR PROJECT, LLC
AND UNISTAR NUCLEAR OPERATING SERVICES,LLC

DATE: 5/09/08 REV1 7/14/08

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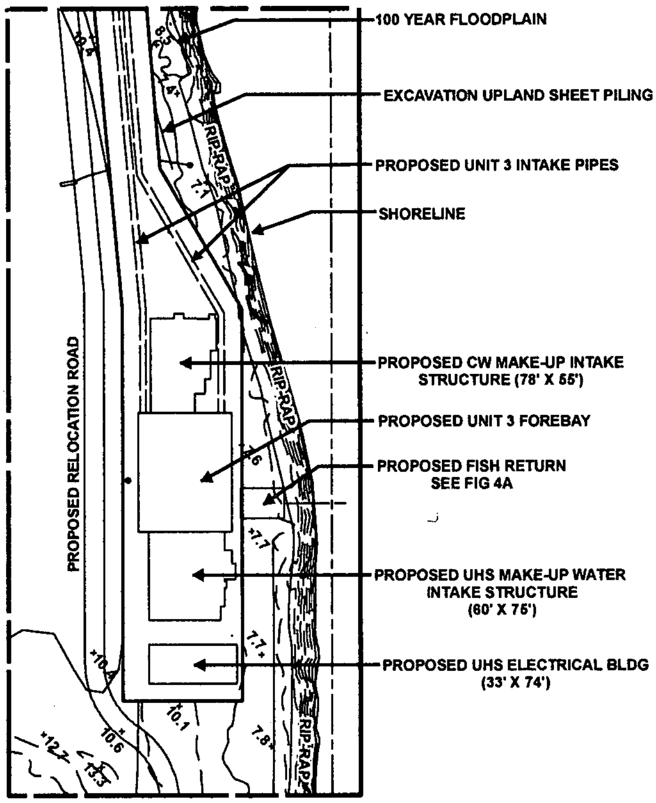
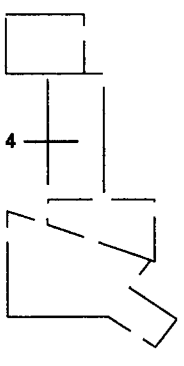


CHESAPEAKE BAY



KEY PLAN INSET

NOTES:
1. - MEAN HIGH WATERLINE: 0.57'
- MEAN LOW WATERLINE: -0.60'
- MAXIMUM SPRING WATERLINE: 1.47'
2. - NAVIGATION CHANNEL (MIDDLE OF BAY) APPROX. 3 MILES FROM SHORELINE.

PURPOSE: PLANT EXPANSION
DATA SOURCE:
BECHTEL CORPORATION
DATUM: (NGVD 29)
PROJECT LATITUDE/LONGITUDE:
38.424133
-76.441598

N

FIGURE 4
SITE PLAN @ UNIT 3 INTAKE STRUCTURE - SHT 1

SCALE IN FEET

0 150 300 Feet

CALVERT CLIFFS NUCLEAR POWER PLANT

IN:
PATUXENT / WEST CHESAPEAKE BAY
COUNTY OF: CALVERT STATE: MD

APPLICATION BY:
CALVERT CLIFFS 3 NUCLEAR PROJECT, LLC
AND UNISTAR NUCLEAR OPERATING SERVICES,LLC

DATE: 5/09/08 REV1 7/14/08

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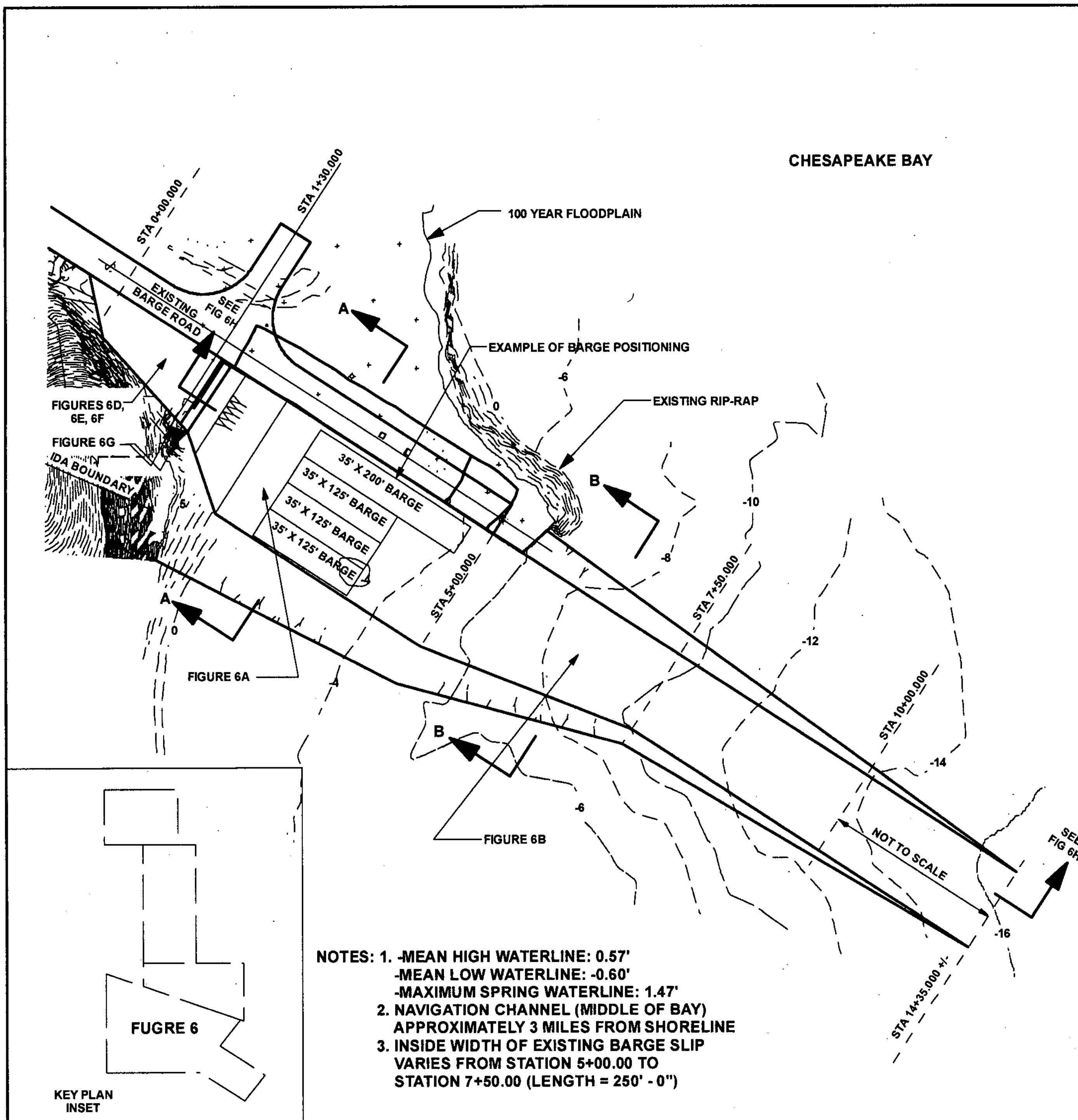

PURPOSE: PLANT EXPANSION DATA SOURCE: BECHTEL CORPORATION DATUM: (NGVD 29) PROJECT LATITUDE/LONGITUDE: 38.424133 -76.441598 N	**FIGURE 6 PROPOSED RESTORATION OF BARGE SLIP (WITH EXISTING CONTOURS)** SCALE IN FEET 0 100 200 300 Feet	**CALVERT CLIFFS NUCLEAR POWER PLANT** IN: PATUXENT / WEST CHESAPEAKE BAY COUNTY OF: CALVERT STATE: MD APPLICATION BY: CALVERT CLIFFS 3 NUCLEAR PROJECT, LLC AND UNISTAR NUCLEAR OPERATING SERVICES,LLC DATE: 5/09/08 REV1 7/14/08

Map Document: (G:\Calvert Cliffs\frozen_5_1_08\404\Final Figures\figure4__key.mxd)
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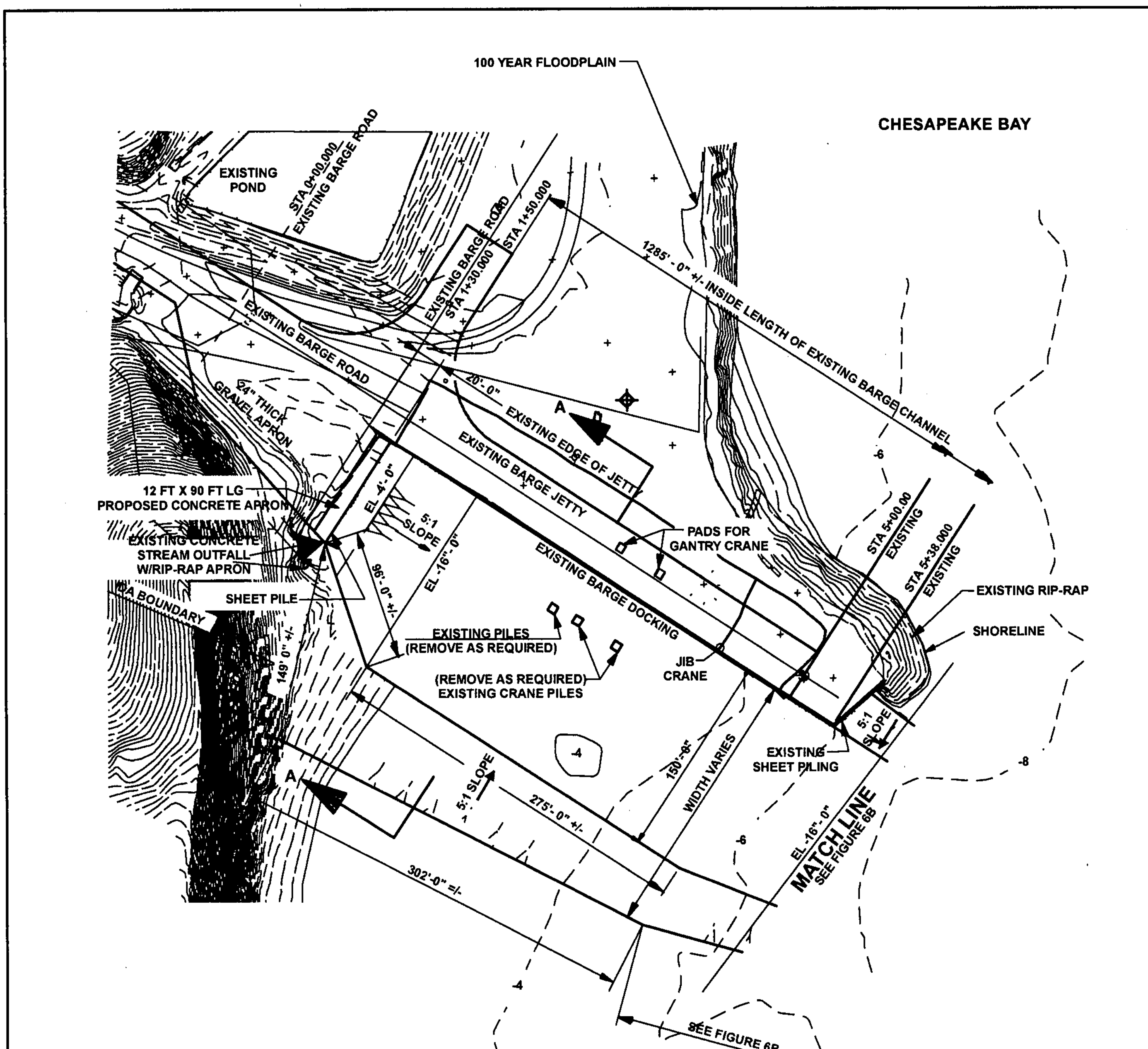

NOTES:
1. - MEAN HIGH WATERLINE: 0.57'
- MEAN LOW WATERLINE: -0.60'
- MAXIMUM SPRING WATERLINE: 1.47'
2. - NAVIGATION CHANNEL (MIDDLE OF BAY) APPROX. 3 MILES FROM SHORELINE.
3. - INSIDE WIDTH OF EXISTING BARGE SLIP VARIES FROM STATION 5+00.00 TO STATION 7+50.00 (LENGTH = 250' - 0")

PURPOSE: PLANT EXPANSION
DATA SOURCE:
BECHTEL CORPORATION
DATUM: (NGVD 29)
PROJECT LATITUDE/LONGITUDE:
38.424133
-76.441598

N

FIGURE 6 A
MODIFICATIONS @ EXISTING BARGE UNLOADING FACILITY

SCALE IN FEET
0 50 100 150 Feet

CALVERT CLIFFS NUCLEAR POWER PLANT

IN:
PATUXENT / WEST CHESAPEAKE BAY
COUNTY OF: CALVERT STATE: MD

APPLICATION BY:
CALVERT CLIFFS 3 NUCLEAR PROJECT, LLC
AND UNISTAR NUCLEAR OPERATING SERVICES,LLC

DATE: 5/09/08 REV1 7/14/08

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ITEM NUMBER 10 SUPPLEMENTAL REQUEST REGARDING RAI #92 / #93

NRC Request:

More recent entrainment data are available (see note for Item 1, RAI #12 above).

Why weren't these recent data used? Would the calculated losses from entrainment differ had the recent data been used? Do the recent data suggest differences from the historical data in the taxa or relative abundance of taxa impacted?

The response states that NOAA (2008) data (which are actually for 2006-7) demonstrate that historical data are valid to use in the assessment of entrainment impacts.

Provide the NOAA and historical data, or representative examples that support the conclusion.

UniStar Response:

More recent entrainment characterization data for Calvert Cliffs Units 1 and 2 are now available. A summary is provided below:

Methods:

Entrainment sampling at the CCNPP Units 1 or 2 intakes and baffle wall was conducted from March 2006 through September 2007. Entrainment samples were collected at Unit 2 intake from April 2006 through December 2006 and at Unit 1 during January 2007 through September 2007. Samples were collected from the fore bay of Units 1 and 2, using a sampling frame that was positioned in the stop log slot, while samples at the baffle wall were collected by boat, approximately 100 ft from the wall. Samples were collected between dusk and dawn (approximately 1900-0700 hours) once per week from March through August 2006, twice per month from September 2006 through February 2007, and weekly from March through September 2007. To characterize the diurnal period during peak ichthyoplankton season, from March through August 2006, additional entrainment samples were collected during the daytime (0800-1800 hours). During March through September 2007, this daytime sampling was increased to twice per month.

Sampling was conducted with a pump and net/barrel collection system that was identical at both the intake and baffle wall sample sites. To direct water into the barrel/net device, a 4 in gas powered trash pump fitted with a 4 in discharge hose, which provided approximately 300 gpm (1.1 m^3/min), was used as well as an inline flow meter to measure sample volume. At both the intake and baffle wall, the inlet hose to the pump was positioned to sample at three depths: near surface, mid-depth and near-bottom. Sampling duration was identical at each site and lasted for 20 minutes at each of the 3 depths, resulting in a 1 hour composite sample during each event. Five independent sampling events occurred during each dusk to dawn or daytime sampling period. In this case, water was pumped into a plastic barrel containing a plankton net made of 500 micron mesh netting with an attached codend ring and collection jar. At the lab, the contents from each jar were placed in a 500 micron mesh sieve and rinsed with water to remove formalin. A Folsom Plankton Splitter was used for samples that contained a high abundance of organisms so that samples were split into equal aliquots for sorting as per procedures mentioned above. Key characteristics of the fish larvae and eggs were identified and compared to taxonomic keys and descriptions, identified to the lowest practicable taxonomic level, enumerated and assigned a life stage. 25 fish were measured to the nearest 0.1 mm using an ocular micrometer for each sample, if more the 25 fish larvae were present in one sample, 25 randomly selected specimens per life stage were measured. Fish eggs were measured occasionally to aid in the identification process.

To estimate the total entrainment catch under maximum cooling-water flow conditions, the number of entrained organisms collected from Unit 1 or Unit 2 was multiplied by the ratio of maximum possible Unit 1 or Unit 2 cooling-water flow to the actual flow on that day. The estimated entrainment total for the sampled day was assumed to be the total for other days that were not sampled within a given temporal stratum. Over the annual sampling period, strata were designated around each individual sampling day. A stratum was determined by counting the days from the sampling day halfway back to the previous sampling date and halfway forward to the subsequent sampling date. The total annual estimate for each taxon was calculated by summing the entrainment estimates for individual stratum. To compute confidence intervals for the annual estimate, the year was portioned into superstrata consisting of 3 to 4 temporally sequential strata as defined above.

Results

A total of 25 species/genera were collected during the 2006 and 2007 studies at CCNPP. Eighteen (18) species were collected in 2006 and 21 species in 2007 at the intake, while 15 species were collected at the baffle wall. Identical species were found at both sites with the exception of the halfbeak (*Hyporhamphus* sp.) and all life stages were found.

The dominant taxa found in 2006, were bay anchovy fertilized eggs, juveniles, and post-yolk larvae (64.2, 5.0 and 4.4% respectively). Other dominant taxa found in 2006 include Sciaenidae sp. fertilized eggs, Atlantic menhaden (*Brevoortia tyrannus*) fertilized eggs and naked goby post-yolk sac larvae (18.5, 2.9, and 0.5% respectively). The species composition for 2007 was similar except for the increased abundance of hogchoker. Dominant species found in 2007 included bay anchovy fertilized eggs, bay anchovy post-yolk sac larvae and hogchoker fertilized eggs (49.7, 15.7, and 14.1% respectively). Other dominant species found in 2007 included Sciaenidae sp. fertilized eggs, Atlantic menhaden fertilized eggs, bay anchovy juveniles, naked goby post-yolk sac larvae and skilletfish post-yolk sac larvae (6.0, 4.5, 3.1, 2.4, and 1.1% respectively). The dominant species listed above accounted for 97% of the total icthyoplankton collected at the intake (Table 1).

A total of 5 taxa accounted for 97% of the individuals collected at the baffle wall in 2006. Bay anchovy fertilized eggs comprised a larger percentage (78.1%) at the baffle wall than at the intake while Sciaenidae sp. fertilized eggs comprised a smaller percentage (11.9). The relative abundance of bay anchovy juveniles was much lower at the baffle wall (0.002%) compared to the intake (5.0%) (Table 2).

Temporally, for all months in 2006, the average density of ichthyoplankton was higher at night than day (405 and 324/100m^3 respectively). Similar trends were observed for in 2007, when sampling was carried out twice per month during the day. Occasionally, higher densities were observed during the day, which was attributed to the composition of taxa during a particular sampling event, since some taxa had a stronger nighttime trend than others.

When densities of organisms in in-plant entrainment samples versus samples taken outside the baffle wall were statistically evaluated, there was no clear discernable pattern. Of the 70 taxon/lifestage combinations tested, only 7 exhibited significant differences. At the baffle wall, bay anchovy yolk sac larvae, northern pipefish post-yolk sac larvae and rough silverside eggs had significantly higher densities, while bay anchovy juveniles, damaged eggs, naked goby post-yolk sac larvae and unidentified sciaenid eggs had significantly higher densities in entrainment samples. These results indicate that differences between the two sampling locations are likely due do random patchiness of ichthyoplankton populations and not due to the location itself.

Over the entire 2 year study, the lowest abundance period was from late September through early May, which is typical for this part of the bay. By mid-May during both years, densities increased and then peaked in late June due to an abundance of bay anchovy fertilized eggs and Atlantic menhaden fertilized eggs. Peak densities for abundant taxa for the years 2006 and 2007 are listed in Table 2. High entrainment rates for both years were primarily due to the high abundance of bay anchovy of all life stages. Over all, the average density was lower in 2007 than in 2006. Generally, taxa and trends were similar between 2006 and 2007, except for the low abundance of hogchoker in 2006.

A comparison of the species collected during the April 1978 to September 1980 studies to the studies performed during 2006 and 2007 suggests that in general the dominant ichthyoplankton species and life stages are similar. In the earlier study, hogchoker eggs were the dominant species-life stage, comprising over 70% of the total followed by bay anchovy eggs (23.0%) and post-yolk sac larvae and naked goby post-yolk sac larvae (See RAI 92 Rev 000). Other dominant species included blenny larvae, spot juveniles, bay anchovy juveniles, and Atlantic menhaden juveniles. In 2006, hogchoker eggs accounted for only 0.3% of the total entrained but 14.1% in 2007. Bay anchovy eggs ranked first in both years comprising 64.2% in 2006 and 49.7% in 2007. Other dominant species life stages included bay anchovy post-yolk sac larvae and naked goby post-yolk sac larvae.

CCNPP Unit 1 and 2 maximum design cooling water flows during the entrainment sampling period were 479,305.84 million gallons and 472,384.45 million gallons in 2006 and 2007 respectively. These maximum design flows assume full circulating water pumping capacity at each unit for 277 days (March-December) in 2006 and 273 days (March –September) in 2007 with no outages for any purpose.

The estimated total annual entrainment of fish eggs and larvae that would be entrained at Unit 3 based on the 1978-79 study was estimated to be approximately 17.6 million organisms. The annual estimate of fish egg and larval entrainment based on the 2006 and 2007 data was estimated to range between 132 and 83 million for the two years studied (Table 3). The difference can be accounted for by the large disparity between the density estimates of the two studies and the changes in species dominance of a few species. Density estimates were considerably higher during the 2006 and 2007 study particularly for bay anchovy eggs and larvae. The differences between the early studies and those conducted in 2006 and 2007 is indicative of the variability that occurs in ichthyoplankton species composition, dominance and density.

Regardless, the three dominant species, by virtue of their abundance in entrainment samples, bay anchovy, naked goby and spot, are all present in either egg, larval, or juvenile stages in the immediate vicinity of the plant in each of the studies. Although bay anchovy and hogchoker eggs and naked goby larvae are entrained in larger numbers, these species are ubiquitous throughout the western North Atlantic and Chesapeake Bay. For this reason, the small fraction entrained will not adversely affect population size, which has been demonstrated throughout the period of CCNPP operation. Even at the higher 2006 and 2007 entrainment estimates the overall number of equivalent adults would be low (Table 4).

Survival rates of organisms were difficult to quantify because survival rates of organisms collected at the cooling water intake were generally not significantly different than observed for those collected at the discharge following entrainment. The stress of collection and processing at the intake was equal to the stress of entrainment. The 2006-2007 Study determined that survival at the discharge provided the best estimate of entrainment survival, while these numbers are likely overestimates of mortality because of the added stress of handling and processing of the organisms. Survival rates for observed organisms are listed in Table 5. The taxa in this table accounted for approximately 71% of the estimated total number of organisms entrained during the 2006-2007 studies at CCNPP.

The removal of early life stages of the representative important species (RIS) could potentially alter energy flow and trophic dynamics and was examined at the CCNPP Units 1 and 2. McLean et al. (2002) estimated changes at the ecosystem level of Chesapeake Bay by determining the proportion of the system's net primary productivity (NPP) that would go underutilized if early life stages were eliminated via entrainment. Based upon this analysis, the overall ecological effect of the CCNPP Units 1 & 2 on primary productivity was estimated to result in the loss of 0.73% of net primary productivity (NPP) and 0.1% of total primary productivity (TPP) (McLean et al., 2002), which largely mirrors the effects of the entrainment of the forage fishes, e.g. bay anchovy, naked goby. Overall estimated ecological impacts associated with Unit 3 could potentially be as low as 0.01% of NPP and 0.001% TPP respectively, assuming that Unit 3 impacts are generally 1.8% of those associated with Units 1 and 2 and that this relationship is linear.

NOAA Data

In the original response to RAI 92, to address the concern about the validity of existing historical entrainment and related fisheries data, a literature and web based search of current fisheries data was undertaken. However, the only current relative abundance data located, other than the 2006 and 2007 entrainment data, was that listed by NOAA for commercial and recreational catches in Chesapeake Bay. The NOAA data reflect variations in effort over time but provide a qualitative comparison of relative abundance of species harvested such as winter flounder, menhaden and spot. The comparison demonstrates that the number of equivalent adults lost to entrainment is small compared to the number taken by the recreational and commercial fisheries. This assessment holds true when the number of equivalent adults lost to entrainment is combined with the number of juvenile and adults impacted by impingement.

As indicated previously, however, many of the dominant RIS entrained at CCNPP are not adequately represented in the commercial catches. In addition, the historical and more recent entrainment data suggest that abundance of fish eggs and larvae is highly variable and that entrainment estimates will also vary substantially over time. Yet given the low number of equivalent adults represented by the entrained RIS species, the relative impact of entrainment at Unit 3, along with Units 1 and 2, will be small. Examples of the NOAA commercial and recreational catch data are found in NOAA (2008a, 2008b). The commercial fisheries statistic web site allows one to search for annual commercial landings by species and location over a selected time frame. Similarly, the recreational survey queries allow one to search by species, time frame, regions, subregions and state.

Summary

Based on the 2006 and 2007 CCNPP Units 1 and 2 entrainment data, no changes with respect to the assessment of impact of CCNPP Unit 3 entrainment and impingement is warranted. The estimated total annual amount of fish eggs and larvae that would be entrained at Unit 3, based on the 1978-79 study, was estimated to be approximately 17.6 million organisms. The annual estimate of fish egg and larval entrainment at Unit 3 based on the 2006 and 2007 data was estimated to range between 132 million and 83 million for the two years studied. This difference can be explained by the large disparity between the density estimates of the two studies. Density estimates were considerably higher during the 2006 and 2007 study particularly for bay anchovy eggs and larvae. There were also some differences in species dominance and abundance between years in the more recent studies. This is to be expected given the highly variable reproductive success between years for any given estuarine fish species, especially bay anchovy. Even at the higher 2006 and 2007 entrainment estimates, the overall number of equivalent adults potentially lost to the operation of Unit 3 would be low.

Since more recent abundance data were not found other than the entrainment density estimates, NOAA commercial and recreational catch data were evaluated to determine qualitatively the relative abundance of those fish species represented in the catch statistics. Temporal variability in catches is evident for those species tracked by NOAA, but catches are sufficiently large to demonstrate that the number of equivalent adults potentially lost due to entrainment and to impingement at CCNPP Units 1, 2 and 3 is a small fraction of the populations present and that the addition of Unit 3 will not materially change previous conclusions made with respect to the impact of Units 1 and 2.

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ER Impact:

No changes to the ER are required.

Enclosure 1
UN#08-037

Supplemental Responses to Aquatic RAIs

Attachment 1

Entrainment Characterization Data Report for Calvert Cliffs Nuclear Power Plant

ENTRAINMENT CHARACTERIZATION DATA REPORT FOR CALVERT CLIFFS NUCLEAR POWER PLANT

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July 2007

TABLE OF CONTENTS

Page

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

1.1 BACKGROUND

Pursuant to U.S. EPA's Phase II Rule for implementation of Section 316(b) of the Clean Water Act, Constellation Generation Group (CGG) initiated activities in anticipation of demonstrating compliance with new performance standards for the reduction of impingement mortality and entrainment of aquatic organisms within the cooling-water intake system at the Calvert Cliffs Nuclear Power Plant (CCNPP). Impingement refers to the trapping of juvenile and adult fish and larger macroinvertebrates on the cooling-water intake traveling screens. Entrainment is the pumping of small aquatic organisms through the cooling water system. As a first step in the process, CGG prepared a Proposal for Information Collection (PIC) and submitted it to the Maryland Department of the Environment (MDE) on December 28, 2005. The PIC included a sampling plan for collection of entrainment samples. This sampling plan covered those activities necessary to collect the required entrainment data at Calvert Cliffs for development of a scientifically valid estimate of entrainment. It also included sampling in the Chesapeake Bay to ascertain populations in the waterbody potentially entrainable and to determine if the CCNPP intake might be subject to a Calculation Baseline credit as allowed under 40 CRF 125.93 and 125.94(b)(1). This report is an interim data report containing data collected to date, as described in Appendix B of the PIC. The sampling plan was modified in 2007 in response to comments received from MDE on May 2, 2007 to increase daytime sampling to provide a better statistical estimate of ichythyoplankton abundance.

On July 9, 2007, U.S. EPA formally suspended the Phase II Rule, except for 40 CFR 90(b) (72 Fed. Reg. 130:37107-37109) and directed states to continue to issue NPDES permits with Best Professional Judgment (BPJ) controls for fish protection at power plant intakes as outlined in a March 20, 2007 memo from Mr. Benjamin Grumbles, Assistant Administrator for Water. In anticipation or the Rule's suspension, CGG met with Maryland Department of Environment (MDE) representatives on May 03, 2007 to discuss the process for a BPJ determination. CGG and MDE concurred that the entrainment characterization study is an essential element for a BPJ determination. This report represents the second interim report submitted to MDE; the final report will be issued upon completion of the entrainment characterization study.

1.2 LOCATION AND FACILITY DESCRIPTION

CCNPP is located on the Chesapeake Bay north of the mouth of the Patuxent River in Lusby, Maryland (Figure 1). The facility has two nuclear generating units, both using once-through cooling water. Each once-through condenser cooling water system withdraws a maximum of 1,728 MGD from Chesapeake Bay through a shoreline cooling water intake structure (CWIS) located behind a baffle wall designed to direct water flow from the lower portion of the water column.

2.0 SCOPE OF STUDY

The objectives of this study are as follows:

- Provide data on the rates of entrainment currently occurring at the cooling water intake structure;
- Collect and identify early life stages of fish in the near shore vicinity of cooling water intake structure that could be susceptible to entrainment;
- Characterize, by species and life stage, the seasonal variation in entrainment of fish;
- Provide data for the determination of the entrainment calculation baseline based on the results of the Entrainment Characterization Studies; and
- Provide sound data necessary for choosing an appropriate compliance alternative, if required.

Samples of entrained ichthyoplankton were collected from the cooling water intake forebay utilizing a sampling intake apparatus incorporated in the stop log slot behind the trash racks. Near shore samples were collected from a boat anchored outboard of the CCNPP baffle wall. In accordance with the Sampling Plan, samples were collected once per week from April through August 2006, and twice per month from September 2006 through February 2007, and weekly in March 2007. There was no baffle-wall sampling conducted in February and March 2007. A 4-inch trash pump was used to collect water from an intake forebay at Unit 1 or Unit 2 of CCNPP. Water was then pumped into a conical 0.5 m plankton net made with 500-μm mesh suspended in a 200-gal 48-inch deep barrel. A digital flow meter was used to monitor sample volume. A similar pump-sampling apparatus was used to collect baffle wall samples.

Entrainment sampling was conducted generally over a 12-hr period (dusk to dawn, approximately 1900-0700 hours) during each sampling event. Five 1-hr samples were collected at approximately 1.75-hr intervals. Each 1-hr sample was a composite, composed of three 20-min segments, collected near-bottom, mid-depth, and near surface. On one scheduled sampling date each month, beginning April 24, 2006 daylight sampling was conducted; similar to the standard night sampling, each daylight event consisted of five 1-hr depth-composite samples. Daylight sampling was conducted through August 2006, and also in March 2007.

3.0 ENTRAINMENT SAMPLING METHODS

3.1 SAMPLING LOCATION AND GEAR DESCRIPTION

Samples of entrained ichthyoplankton were collected from the cooling water intake forebay utilizing a sampling intake apparatus incorporated in the stop log slot behind the trash racks. Entrainment abundance samples were collected using a pump and net/barrel collection system. A 4-in. gas-powered trash pump was used to direct water from the intake to the collection device. The pump was connected sequentially to each of three rigid pipes set with their intakes at depths to collect distinct samples at three sampling depths relative to mean low water (MLW): near bottom, mid-depth and near surface. The pipes were attached to a frame that could be raised and lowered in the stop log tracks at the intake. At the beginning of each sampling event, the near surface pipe was adjusted to 3-feet below surface, if necessary. An inline flowmeter (GF+Signet 8150) was used to measure sample volume on the discharge side of the pump. The pump was throttled to adjust flow (approximate flow of 1.1 m^3/min or 300 gal/min) into the net/barrel systems. Each sampling barrel contained a 0.5-m diameter conical plankton net (1:3 diameter to length ratio) made of 500-µm mesh nylon net. The net was fitted with a standard cod end collection jar. The net was suspended such that the mouth ring was approximately 6-inches above the top of the barrel.

3.2 SAMPLING PROCEDURE

3.2.1 Intake Sampling

The open end of the intake hose was attached via camlock to the surface-depth pipe. The line was flushed for 5 minutes before sampling. During this flush, flow adjustments were made and water was discharged directly into the sampling barrel, not through the plankton net. After flushing the sampling line, the start volume was recorded from the flowmeter and pumping was started through the plankton net suspended in the barrel. The intlet was positioned just beneath the surface of the water in the barrel to avoid damage to any organisms. Sampling continued for approximately 20 minutes at each of the three depths (surface, mid-depth, and bottom) resulting in a 1-hour composite sample during each event. Approximately five (5) independent sampling events were conducted during each dusk-to-dawn or daytime period. Pumping started from the surface-depth pipe and continued for 20 minutes. At the end of this time, the pump was stopped, and the intake line was switched to the mid-depth pipe. If necessary at this time, due to debris or ctenophores, a new net was switched in and the original net rinsed. After 20 minutes the procedure was repeated, and the intake line was connected to the bottom-depth pipe, and pumping was continued for 20 minutes. At the end of each 1-hour sample period, the end volume and total volume sampled was recorded from the flowmeter, and the pump was shut down. The standpipe in the barrel was pulled to drain the barrel, and the net was washed down from the outside to move all sample material into the codend receiver. The sample was concentrated to approximately 900 ml, and preserved with 10 percent buffered formalin containing Rose Bengal stain and stored in jars labeled inside and out. All collection information was recorded by field crews on standard Entrainment Sampling Data Sheets. All samples were checked for proper preservation before being packed onsite for return to the laboratory.

3.2.2 Baffle-Wall Sampling

The near shore ichthyoplankton community in the vicinity of the CCNPP cooling water intake was sampled on the outboard side of the intake baffle wall. Sampling gear, procedures, and frequency were the same as described in Section 3.2.1 for entrainment sampling in the CCNPP intake. Samples were collected concurrent with the intake entrainment samples; i.e., samples started and ended within a few minutes of one another.

EA subcontracted a 55-foot research vessel to provide a stable work platform for sampling at the intake baffle wall. The vessel was anchored outboard of the baffle wall during each sampling event. Entry and departure from the secured area in front of the intake was coordinated with CCNPP security for each sampling event. Communication and coordination between the crews sampling at the intake and the baffle wall was maintained by 2-way radio, cell phones, or both, contingent on CCNPP security clearance and procedures.

Sample handling and processing, and analytical procedures were as described above for the intake sampling.

3.3 WATER QUALITY MEASUREMENTS

Measurements of water temperature, dissolved oxygen (DO), pH, specific conductance, and salinity were taken at mid-depth in the intake forebay at the beginning and end of each sample period (dusk and dawn). At the baffle wall, the same parameters were measured at surface, mid-depth, and near bottom. The collected water quality data are presented in Appendix A.

3.4 PLANT FLOW DATA

Plant flow data, reported as million gallons per day, on each sampling date are in Appendix B. These data were provided by CCNPP personnel.

3.5 ICHTHYOPLANKTON LABORATORY PROCEDURES

3.5.1 Sample Sorting

Samples were preserved in 10 percent buffered formalin containing Rose Bengal dye. The contents in each sample jar were placed in a standard 500-µm mesh sieve to remove the formalin from the sample. Small portions of the sample were placed in a sorting dish with water (approximately 25 mL total volume), and viewed under dissecting scopes. Fish larvae and fish eggs were removed from each portion of the sample with forceps and placed into small vials containing five percent formalin. All sample information, including sample site, sample collection date and time, and the number of individuals for each phenotypic group were recorded on a general sorting sheet.

Those samples containing a high abundance of organisms were split with a Folsom Plankton Splitter to obtain manageable portions for sorting. The Folsom Plankton Splitter is used to proportion the sample into equal aliquots for sorting. These aliquots were then sorted using the procedures mentioned above.

3.5.2 Sample Identification

The fish eggs and larvae were identified with the aid of a stereomicroscope. Key characteristics were examined and compared to published taxonomic keys and descriptions. Organisms were identified to the lowest practicable taxonomic level, enumerated, and assigned a life stage (i.e. fertilized egg, yolk-sac larvae, post-yolk sac larvae, juvenile, or adult). Taxonomic resources included Fuiman et al (1983), USFWS (1978), and Wang and Kernehan (1979). For each sample, 25 fish larvae were measured to the nearest 0.1mm using an ocular micrometer. If more than 25 larvae of a given species were collected, 25 randomly selected specimens per life stage were measured. Occasional measurements of fish eggs were done to aid in the identification process.

3.6 DATA HANDLING AND ANALYSIS

3.6.1 Data Entry, Storage, and Retrieval

All data were entered into an SQL Server database using a Microsoft Access® based, "front-end" data-entry template. Reports were then printed out and proofed against the original data sheets and electronic corrections were made as necessary. All data manipulations, calculations, and summaries included in this report were performed within the database, or in Microsoft Excel® formats exported from the database.

An example of the entrainment calculation sequence is provided in Appendix C (Table C-1) using actual data from one of the sampling events at CCNPP. This procedure is consistent with historical entrainment studies at CCNP (EA 1981) and with general industry-wide procedures reviewed by EPRI (2005). To estimate the total daily number of each ichthyoplankton taxon entrained under maximum cooling-water flow conditions, the average daily density (number/100 m^3) of each taxon was first calculated for each sampling date. This average density was based on the average of either the five nighttime samples, or five nighttime and five daytime samples, depending on the sampling date in question. The absolute number of a taxon estimated to be entrained during the 24-hour sampling date was based on the average density of the taxon and maximum possible cooling-water flow in 24 hours. The estimated entrainment total for the sampled day was the total assumed for other days that were not sampled. Over the annual sampling period strata were designated with each individual sampling day. A stratum was determined by counting the days from the sampling day halfway back to the previous sampling date and halfway forward to the subsequent sampling date. The total annual estimate for each taxon was calculated by summing the individual stratum entrainment estimates.

3.6.2 Confidence Limit Calculation

In order to compute confidence intervals for the annual estimate, the year was partitioned into superstrata consisting of 3 to 4 temporally sequential strata as defined above. The estimate E_i and variance $Var(E_i)$ for the *i*th superstrata were then obtained for each taxon as follows:

$$E_i = V_i \times \bar{\rho}_i,$$

$$Var(E_i) = V_i^2 \times \left(1 - \frac{n_i}{N_i}\right) Var(\bar{\rho}_i) = V_i^2 \times \left(1 - \frac{n_i}{N_i}\right) \frac{Var(\boldsymbol{\rho}_i)}{n_i},$$

$$\bar{\rho}_i = \frac{1}{v_i} \sum_{j=1}^{n_i} v_{ij} \times \rho_{ij}$$

where

v_{ij} = sample volume for the j^{th} strata of the i^{th} superstrata,
v_i = total volume sampled for the i^{th} superstrata,
V_i = total intake volume for the i^{th} superstrata,
n_i = number of days sampled in the i^{th} superstrata,
N_i = total number of days in the i^{th} superstrata,
ρ_{ij} = estimate per unit volume for the j^{th} strata of i^{th} superstrata
$\boldsymbol{\rho}_i$ = vector of estimates per unit volume in the i^{th} superstrata
$\bar{\rho}_i$ = average estimate per unit volume for the i^{th} superstrata.

The annual estimate and variance was then obtained by summing across superstrata as follows:

$$E_T = \sum_{i=1}^{12} E_i$$

$$Var(E_T) = \sum_{i=1}^{12} Var(E_i)$$

The 80% confidence interval for E_T was then calculated by assuming a normal distribution as

$$E_T \pm 1.28 \times \sqrt{Var(E_T)}.$$

4.0 RESULTS

The following data summary includes information from the collection period 30 March 2006 through 27 March 2007 at the intake and 6 April though 23 January 2007 at the baffle wall. Samples were collected at an intake forebay from a fixed sampling apparatus incorporated in the stop log slot behind the trash racks. Samples were also taken simultaneously from a boat anchored just outside the baffle wall to compare ichthyoplankton abundance in the near field Bay before the water is withdrawn below the baffle wall. The baffle wall was not sampled in March 2006 and sampling was discontinued after the January sampling was completed when review of the preliminary data indicated little difference in abundance trends between the intake and the baffle wall sampling locations. MDE concurred in a letter from Mr. John McGillen to Mr. Joseph Pollock dated January 16, 2007. The ichthyoplankton abundance data are a combination of the number of eggs, fish larvae, and juveniles that were collected per survey. The data have been converted from actual numbers collected to a standard density expressed as number per meter cubed. In addition, the abundance data have been extrapolated using the CCNPP maximum design flow rate data to arrive at an estimate of the total monthly and annual entrainment abundance rate assuming 100% operation throughout the year. The water quality data are in Appendix A, the actual total plant flow during sampling is in Appendix B, and the abundance data are presented in Appendix D. Table 1 includes a phylogenetic list of all organisms collected during the survey period.

Deviations from scheduled sampling included: on 8 May, the first of the five samples was not collected at the intake due to equipment problems; 24-25 July (24-hr event), eight of the ten scheduled mid-water samples could not be collected at the intake due to fouling on the sampling pipe.

4.1 INTAKE ENTRAINMENT

4.1.1 Composition and Density

Average density collected at the intake during each sampling event is presented in Table D-1. On a per survey basis, the highest density was on 12-13 June when $2190/100m^3$ individuals were collected. The catch was dominated by bay anchovy eggs which comprised 95 percent of the abundance. The next highest density was on 23-24 May with $1196/100m^3$, also dominated by bay anchovy eggs (96 percent). The lowest daily catch was on 5-6 December when zero individuals were collected followed by 8-9 February when $0.59/100m^3$ were collected.

The highest monthly total ichthyoplankton abundance was recorded in June when the average density was $714/100m^3$ with bay anchovy eggs the dominant comprising 89 percent of the total (Table 2). The next highest abundance was in May when the density collected was $430/100m^3$ and also dominated by bay anchovy eggs which comprised 86 percent of the monthly total. The lowest abundance occurred in December and February when the density collected was $1.14/100m^3$ and $2.01/100m^3$, respectively. In general, the highest density months were during the period May through August (303-714/100m^3) and the lowest were during March and April 2006, September 2006 through March 2007 (1.14-28.20/100m^3).

There were a total of 18 taxa collected during March 2006 – March 2007 (Table 2). Taxa include species and genus level (e.g. *Fundulus*) but exclude damaged individuals, multiple life stages, or major groups that encompass unidentifiable specimens (e.g. Atherinopsidae). A major group level would be counted as a taxon if no genus or species individuals within that group were collected for a given time frame. The highest number of taxa per month was in May and June when 11 taxa were collected during both months. During the period May through September, the number of taxa was highest ranging from 7 to 11 taxa. During March, April, and October 2006 through March 2007, the number of taxa ranged from only 2 to 4 taxa per month.

The dominant taxon during the sampling period was bay anchovy eggs which comprised 63 percent of the total specimens collected (Table 3, Figure 2). The second most abundant was eggs in the family Sciaenidae, which comprised 21 percent of the total. Sciaenidae could include Atlantic croaker, northern kingfish, silver perch, spot, and weakfish, all of which were collected as larvae or juveniles during the study. Other life stages of the bay anchovy also ranked high, with juveniles ranking third, comprising 4 percent and post-yolk sac larvae ranking fourth comprising 3 percent of the ichthyoplankton collected. Including Atlantic menhaden eggs at 3 percent and naked goby post-yolk sac larvae at 2 percent, the top six comprised 96 percent of the total collected.

On a monthly basis, during the peak abundance period, bay anchovy eggs were the dominant taxon in May and June comprising 86 and 89 percent, respectively, of the monthly total and Sciaenidae eggs were the dominant in July and August comprising 57 and 46 percent of the total (Table D-2 through D-14). During the lower abundance months the dominants were Atlantic menhaden juveniles in March 2006 (93 percent) and April (55 percent); bay anchovy juveniles in September (75 percent); Atlantic croaker juveniles in October, November, December, January, and February (59, 66, 38, 53, and 29 percent); and spot juveniles in March 2007 (66 percent).

Sampling was conducted over a 24-hr period once a month during March through August to determine if there were day versus night differences in entrained ichthyoplankton abundance. During May, June, July 2006, and March 2007 abundance was higher during the day comprising 51, 61, 66, and 60 percent of the average density over the 24 hr sampling event (Table 4). In April and August, abundance was higher at night with 65 and 78 percent of the abundance. Focusing on the months of high abundance, May through August, bay anchovy was the dominant responsible for the higher daytime abundance during May (eggs), June (eggs), and July (juveniles). In August, when nighttime abundance was higher, bay anchovy larvae and Sciaenidae eggs were the dominants.

Length data for the fish larvae collected at the intake are presented in Table 5. Bay anchovy, the most abundant fish collected, ranged from 1.5 – 66 mm and averaged 14.5 mm. Juveniles were the most abundant life stage followed by larvae and a small number were adults. Naked goby was the second most abundant fish measured and it ranged from 2 – 18.2 mm and averaged 6.1 mm. Larvae was the most abundant life stage followed by juveniles.

4.1.2 Annual Entrainment Estimate with Confidence Limits

Entrainment density data were used in conjunction with station cooling-water flow data to estimate the total number of each fish taxon entrained, both on a monthly and annual basis, based on maximum cooling-water flow rates (Table 6). Approximately 7.8 billion organisms were estimated to be entrained in the 12 month entrainment sampling period. The most abundant entrained organisms on an annual basis were bay anchovy eggs, estimated at 4.9 billion (63 percent), and Sciaenidae eggs, estimated at 1.5 billion (20 percent).

4.1.3 Water Quality

Measurements of dissolved oxygen, pH, salinity, and water temperature were taken at mid-depth at the beginning and end of each sampling event (Table 7). Most water quality values were within normal and expected ranges for the Chesapeake Bay, with DO and temperature following an inverse relationship (Figure 3). During the months of June through August, five of the sampling events had average DO readings that were significantly below saturation for the temperature and salinity conditions. These levels ranged from 1.0 to 3.4 mg/L (Figure A-1). Typically pH readings were between 7.2 and 8.3 (Figure A-2). During the 25-26 September sampling event, mean pH values were as low as 6.6. Salinity values ranged from 8.5 to 18.5 ppt (Figure A-3). The lowest salinities were recorded in the month of July and the highest readings were recorded in September and October. Water temperature ranging from 1.6 to 28.2 °C showed seasonal variation, with the highest temperatures recorded during July and August and lowest temperatures recorded in February and March (Figure A-4).

4.2 BAFFLE WALL ENTRAINMENT

4.2.1 Composition and Density

Average density collected at the baffle wall during each sampling event is presented in Table D-15. On a per survey basis, the highest density was on 12-13 June when 3,632/100m^3 individuals were collected. The catch was dominated by bay anchovy eggs which comprised 94 percent of the abundance. The next highest density was on 23-24 May with 1,033/100m^3, also dominated by bay anchovy eggs (98 percent). The lowest daily catch was on 6-7, 13-14 and 18-19 April; 25-26 September; 26-27 October; 6-7, 27-28 November; 18-19 December; and 11-12 and 22-23 January when zero individuals were collected.

The highest monthly total ichthyoplankton abundance was recorded in June when the average density was 1,046/100 m^3 with bay anchovy eggs comprising 90 percent of the total (Table 8). The next highest abundance was in May when the density collected was 396/100 m^3 and also dominated by bay anchovy which comprised 91 percent of the monthly total. The lowest abundance occurred in November and January when zero individuals were collected. In general, the highest density months were during the period May through August (60-1046/100 m^3) and the lowest were during April and September through January (0-2.31/100 m^3).

There were a total of 15 taxa collected during April 2006 through January 2007 (Table 8). The highest number of taxa per month was in July when 12 taxa were collected. Diversity was also high in May and June when 9 and 10 taxa were collected, respectively. During April and September through January, the number of taxa only ranged from 0 to 3 taxa per month.

The dominant taxon during the sampling period was bay anchovy eggs which comprised 79 percent of the total specimens collected (Table 9, Figure 4). The second most abundant was Sciaenidae eggs, which comprised 11 percent of the total. Sciaenidae could include Atlantic croaker, northern kingfish, silver perch, spot, and weakfish, all of which were collected at either the intake or baffle wall. Post-yolk sac larvae of the bay anchovy also ranked high comprising 3 percent of the ichthyoplankton collected. Including naked goby post-yolk sac larvae at 2.4 percent and Atlantic menhaden eggs at 1.7 percent, the top five taxa comprised 97 percent of the total collected.

On a monthly basis, during the peak abundance period, bay anchovy eggs were the dominant in May and June comprising 91 and 90 percent, respectively, of the monthly total and Sciaenidae eggs were the dominant in July and August comprising 56 and 55 percent, respectively, of the total (Tables D-16 through D-23). During the lower abundance months, bay anchovy post-yolk sac larvae were dominant in September (75 percent), only northern pipefish were collected in December, an unidentified egg in April, unidentified larvae in October, and no fish were collected in November and January.

Sampling was conducted over a 24 hr period once a month during April through August to determine if there were day versus night differences in entrained ichthyoplankton abundance. During April, May, and July 2006 abundance was higher during the day comprising of 100, 57, and 82 percent (respectively) of the average density over the 24 hr sampling event (Table 10). In June and August 2006, abundance was higher during nighttime hours, with 79 percent and 85 percent (respectively) of the abundance. In May and July, the number of organisms collected during the day was a result of the high density of bay anchovy eggs obtained. In June and August the higher numbers collected during the nighttime hours was dominated by Sciaenidae sp. eggs, bay anchovy larvae, and bay anchovy eggs.

Length data for the fish larvae collected at the baffle wall are presented in Table 11. The most abundant fish collected was bay anchovy, ranging from 2 mm to 14.9 mm, averaging 4.8 mm. Post yolk-sac larvae bay anchovies were the most abundant. Naked goby was the second most abundant fish larvae collected, ranging from 2.1 mm to 17.8 mm, averaging 5.9 mm. The dominant life stage for this species was post yolk-sac larvae.

4.2.2 Water Quality

Water quality measurements, including DO, pH, salinity, and water temperature were taken at near-surface, mid-depth, and near bottom at the beginning and end of each sampling event (Table 12). Similar to the water quality results at the intake, the DO and temperature followed an inverse relationship, as temperature increased the DO decreased and as the temperature decreased the DO increased (Figure 5). There were three sampling events in June and July that had relatively low DO readings (Figure A-5). As expected the DO readings were lowest on the bottom, ranging from 0.2 to 2.6 mg/L. DO readings at mid-depth ranged from 1.0 to 4.7 mg/L and 2.1 to 10.1 mg/L on the surface. The pH readings reflected typical estuarine values on the alkaline side (Reid 1961). Mean pH values ranged from 7.0 to 8.7 (Figure A-6). Mean salinity values ranged from 6.9 to 17.9 ppt. The lowest salinity values were recorded during July (Figure A-7) due to significant rainfall prior to the 17-18 July and 24-25 July sampling events. Mean temperature values ranged from 6.6 to 29.5 °C (Figure A-8). Unlike the intake, there was no sampling at the baffle wall after January 2007.

4.3 COMPARISON OF INTAKE AND BAFFLE WALL SAMPLING

Little difference was observed between intake and baffle-wall entrainment. Summation of the average annual densities from the intake (Table 2) and baffle wall (Table 8) yields 226 eggs and larvae per 100 m^3 at the intake and 206 eggs and larvae per 100 m^3 at the baffle wall. Monthly densities of total ichthyoplankton and abundant taxa are compared between intake and baffle wall in Figures 6 through 12. Figure 6 includes all ichthyoplankton taxa and illustrates an approximately 50 percent greater density at the baffle wall in June, but similar or lower densities at the baffle wall in other months. This distribution is largely driven by densities of bay anchovy eggs (Figure 7), the most abundant taxon. Whereas bay anchovy post-yolk sac larval densities were quite similar between the intake and baffle wall (Figure 8), juvenile densities (Figure 9) were dramatically higher at the intake. The reason for this is not evident from the data, but it is consistent with the greater size of bay anchovy young from intake samples (Table 5) compared to baffle-wall samples (Table 11). Other common species varied as to their location of greatest densities. Atlantic menhaden (Figure 10) and Sciaenid eggs (Figure 11) were notably more abundant in intake samples whereas naked goby post-yolk sac larvae (Figure 12) were substantially more abundant at the baffle wall in June, but more abundant in the intake in May. Total ichthyoplankton densities were just 10 percent higher at the baffle wall due primarily to bay anchovy eggs and, to a lesser extent, Sciaenid eggs.

5.0 REFERENCES

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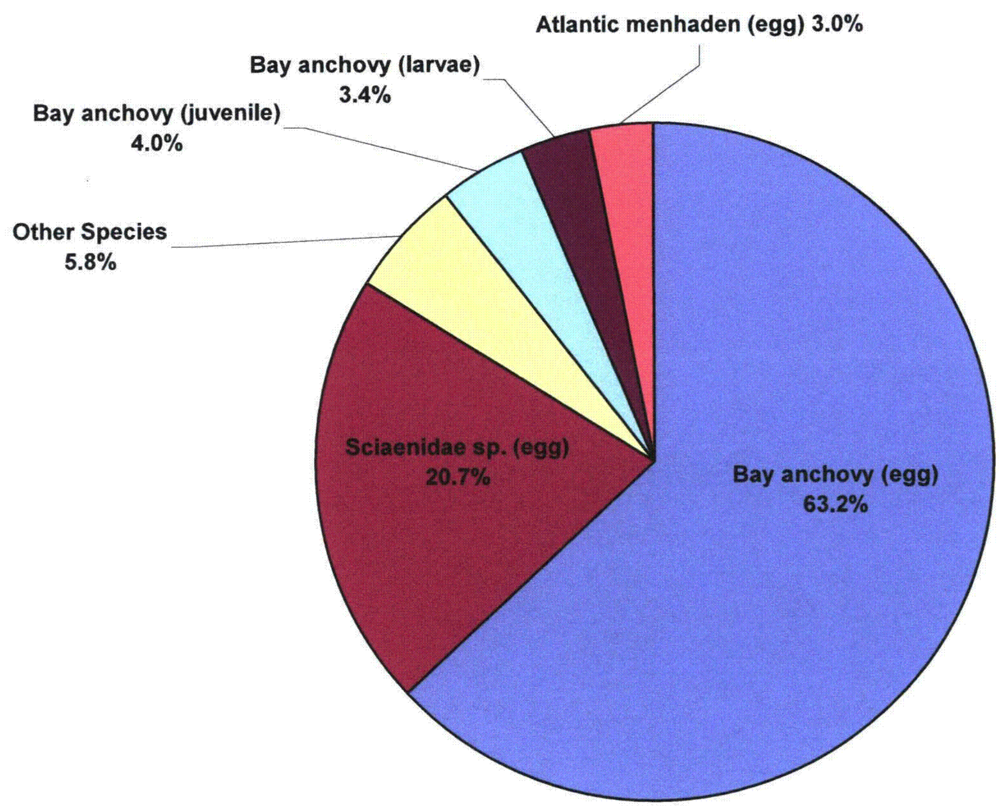
Figure 1. Site Location of Calvert Cliffs Nuclear Power Plant, Lusby, Maryland

Figure 2 Percent Composition of Fish Entrained at Calvert Cliffs Nuclear Power Plant Intake, March 2006 - March 2007



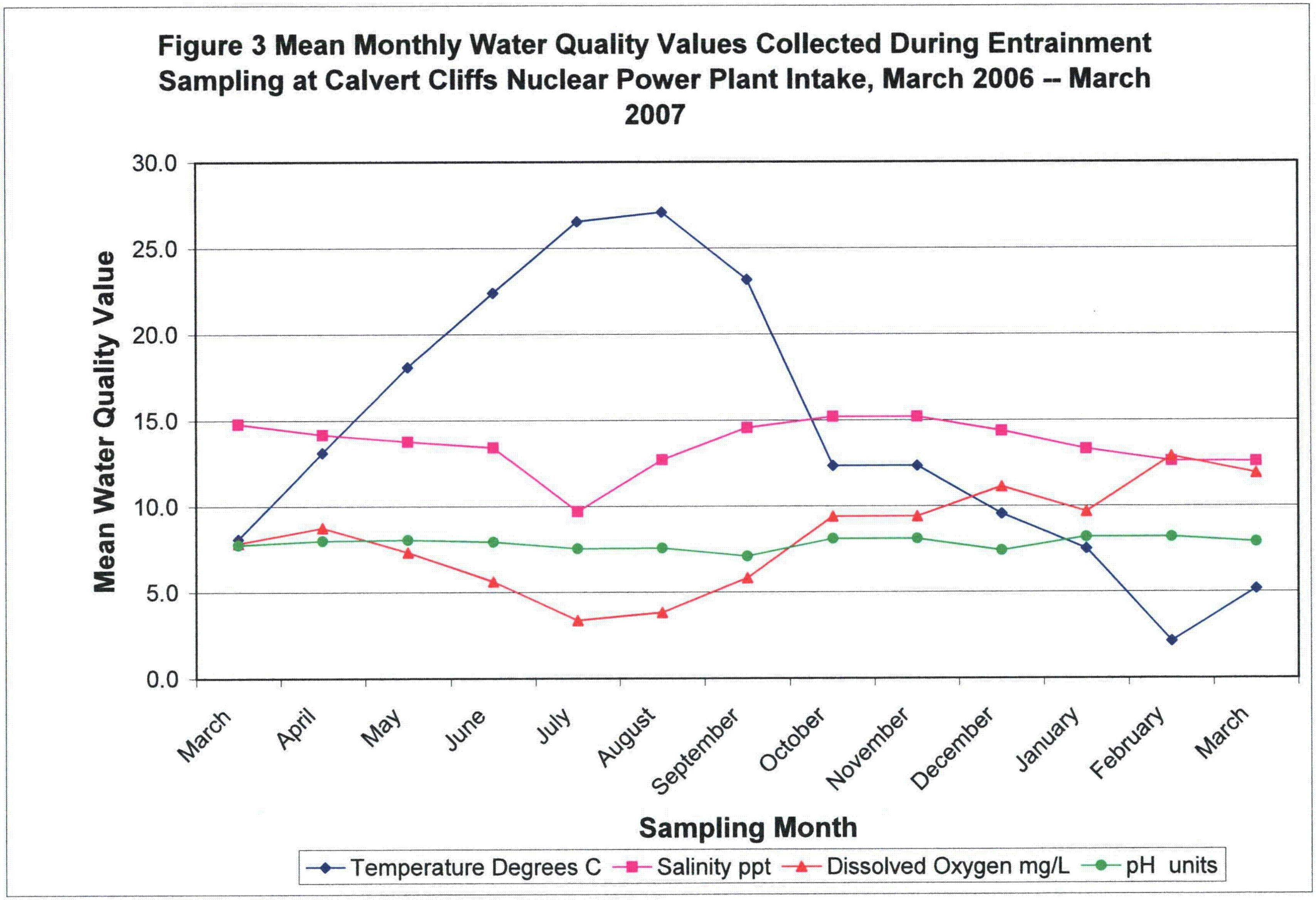
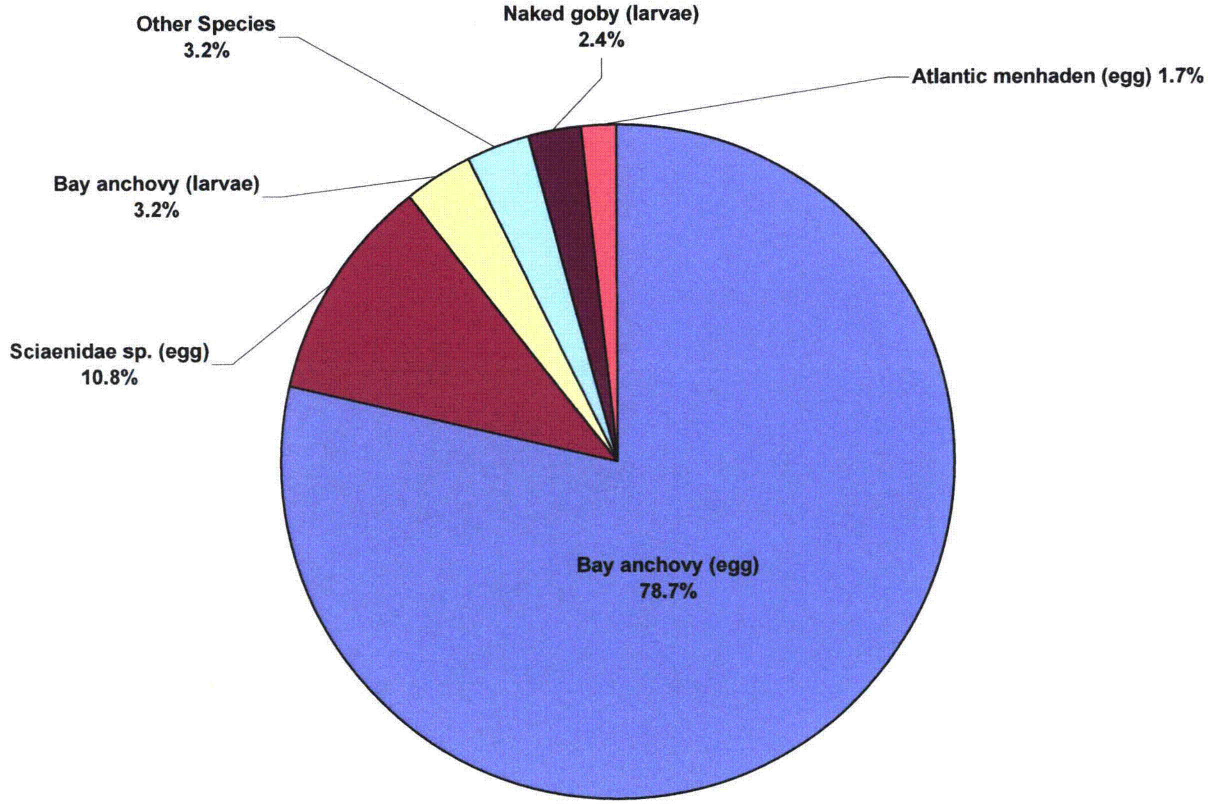


Figure 3 Mean Monthly Water Quality Values Collected During Entrainment Sampling at Calvert Cliffs Nuclear Power Plant Intake, March 2006 -- March 2007
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Mean Water Quality Value
March
April
May
June
July
August
September
October
November
December
January
February
March
Sampling Month
Temperature Degrees C
Salinity ppt
Dissolved Oxygen mg/L
pH units

Figure 4 Percent Composition of Fish Entrained at Calvert Cliffs Nuclear Power Plant Baffle Wall, April 2006 -- January 2007



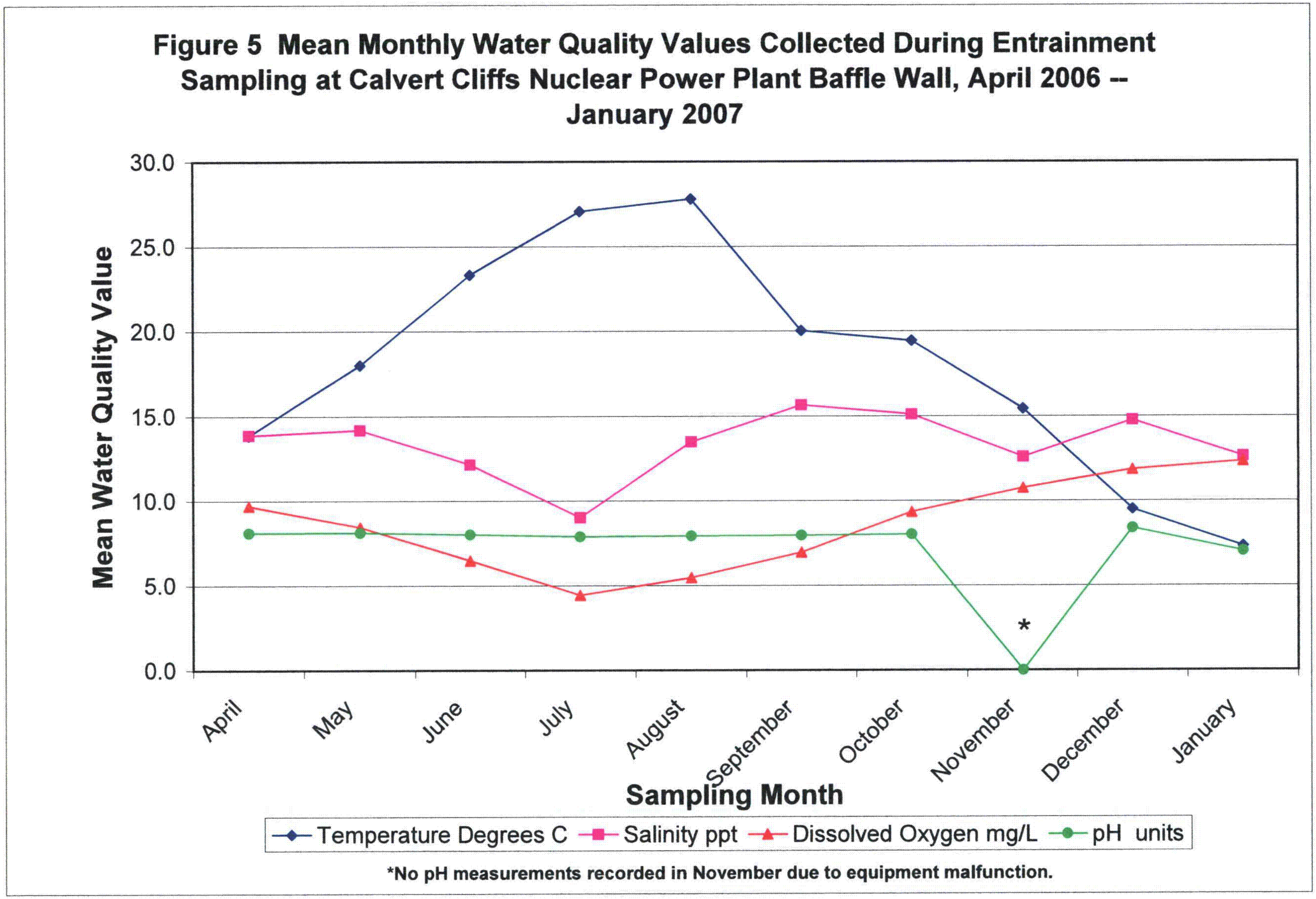


Figure 5 Mean Monthly Water Quality Values Collected During Entrainment Sampling at Calvert Cliffs Nuclear Power Plant Baffle Wall, April 2006 -- January 2007
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Mean Water Quality Value
*
April
May
June
July
August
September
October
November
December
January
Sampling Month
Temperature Degrees C
Salinity ppt
Dissolved Oxygen mg/L
pH units
*No pH measurements recorded in November due to equipment malfunction.

Figure 6 Density of Total Ichthyoplankton Taxa in Intake and Baffle Wall Samples

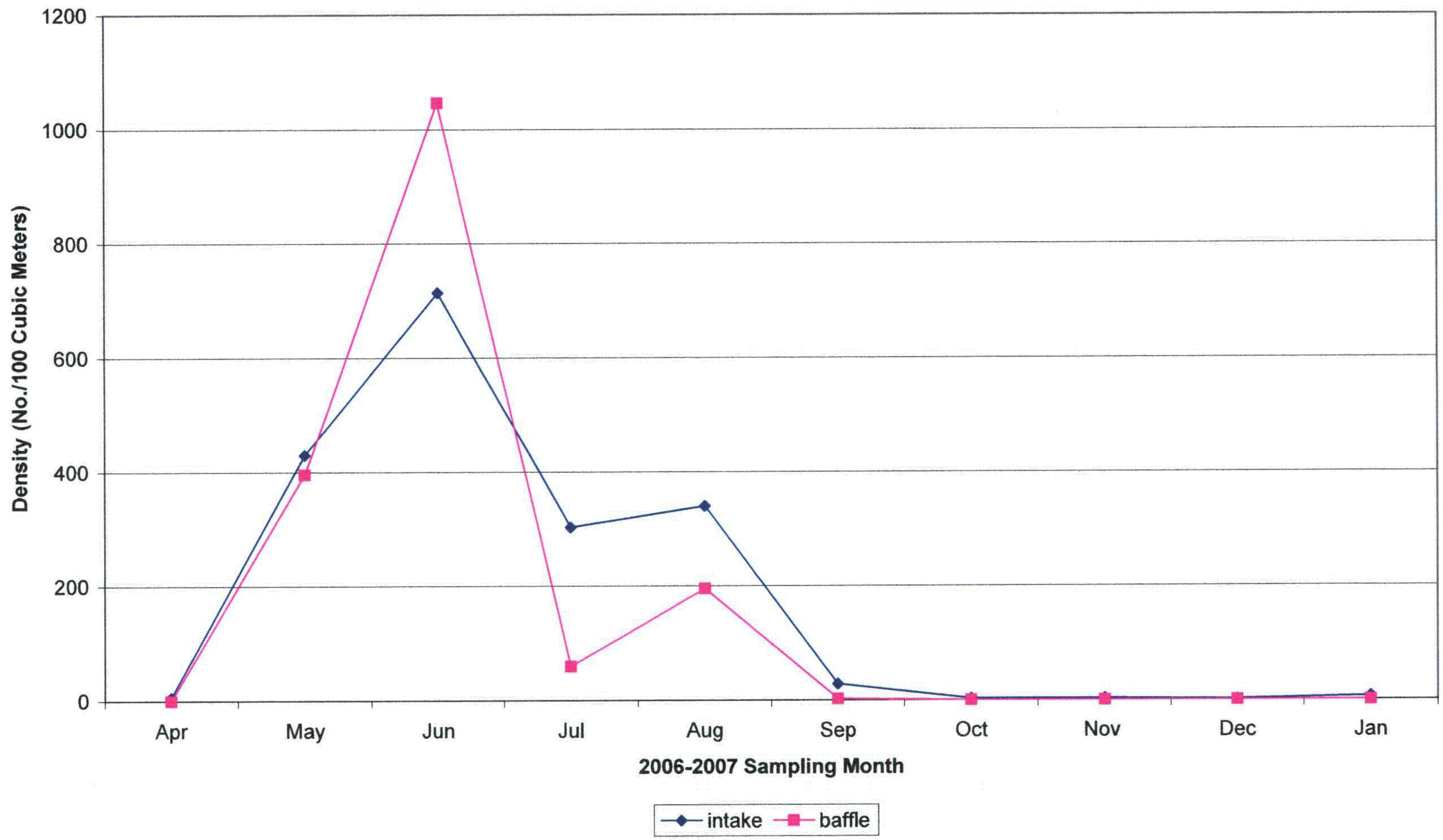


Figure 7 Density of Bay Anchovy Eggs in Intake and Baffle Wall Samples

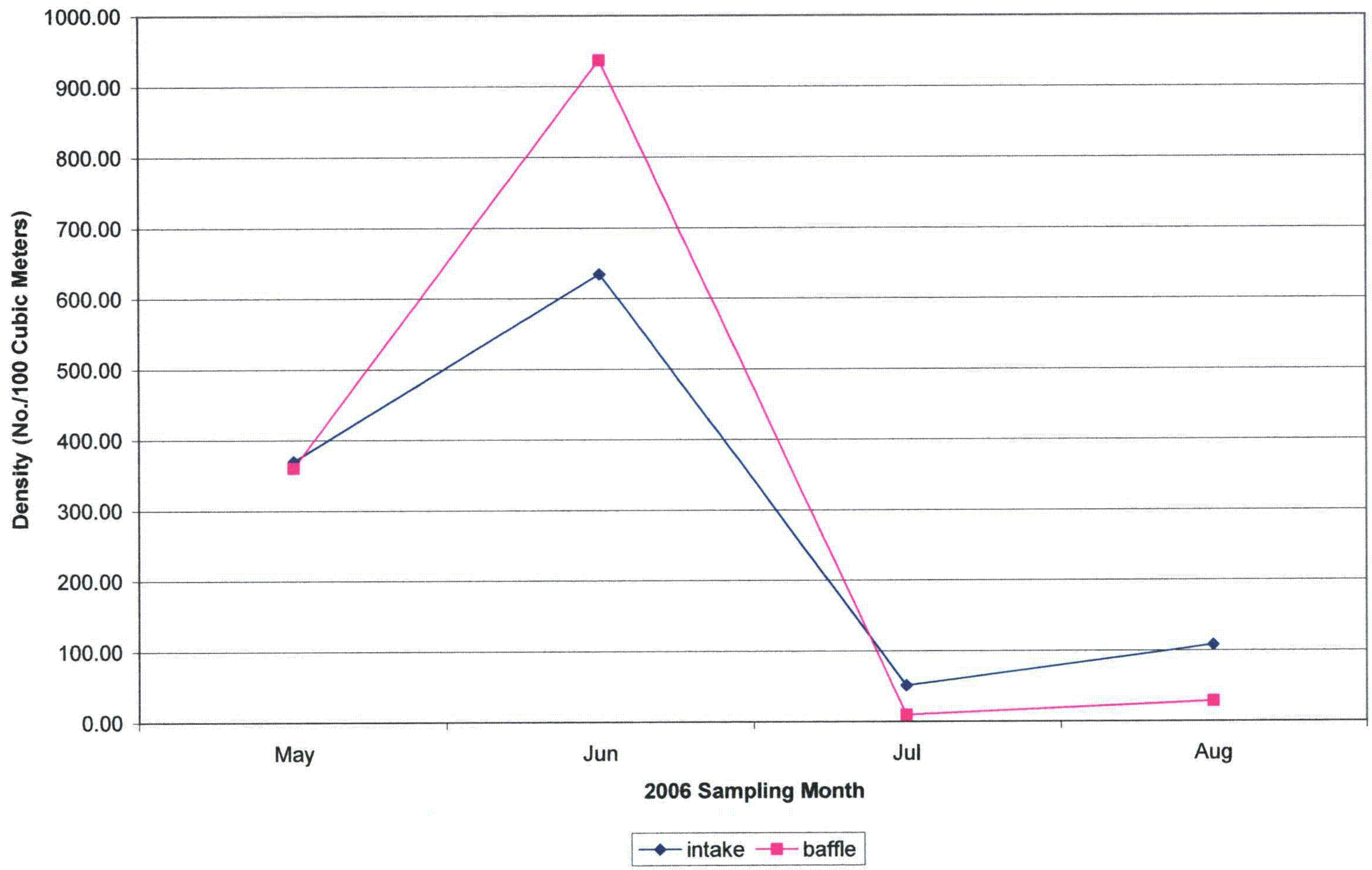


Figure 8 Density of Bay Anchovy Post-Yolk Sac Larvae in Intake and Baffle Wall Samples

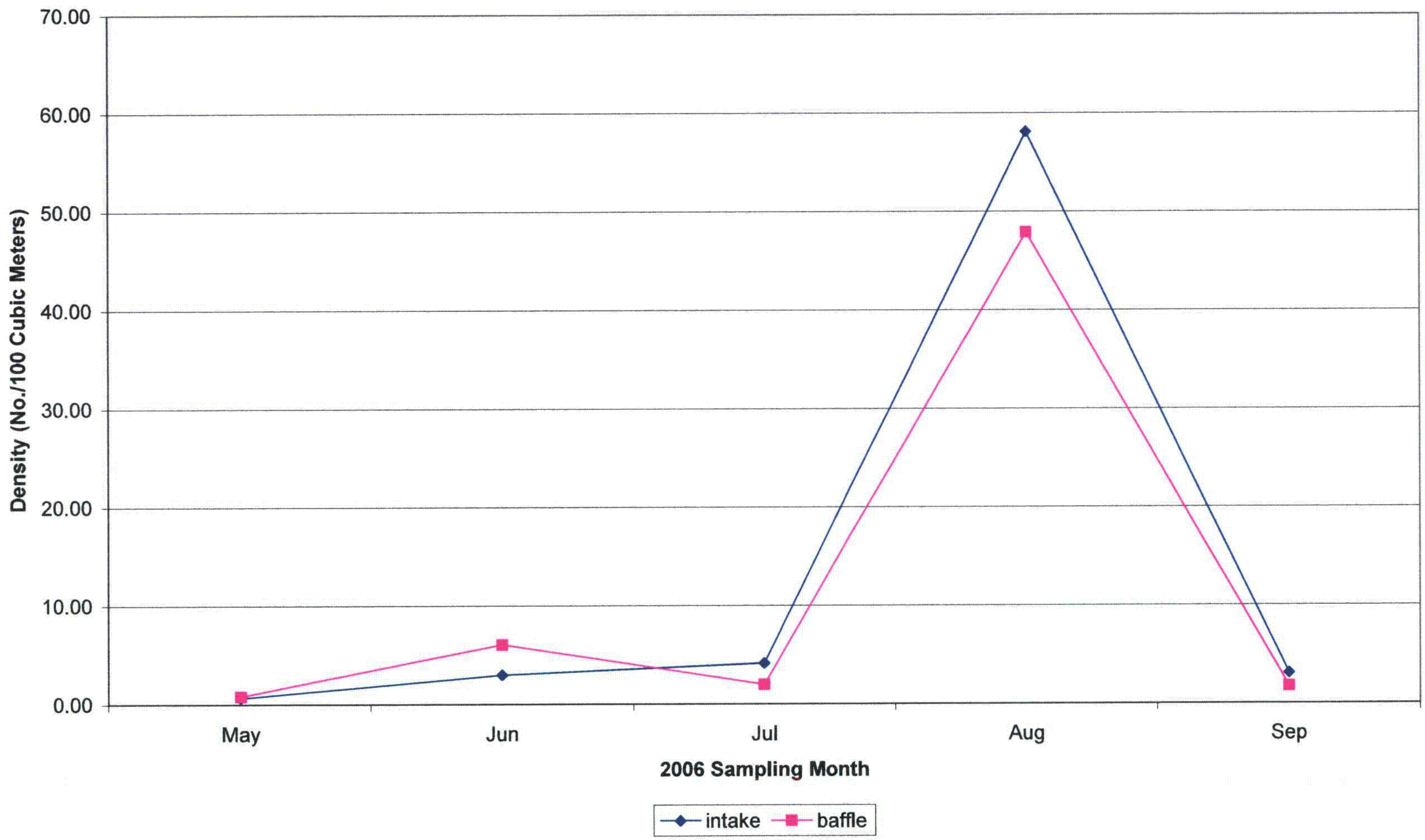


Figure 9 Density of Bay Anchovy Juveniles in Intake and Baffle Wall Samples

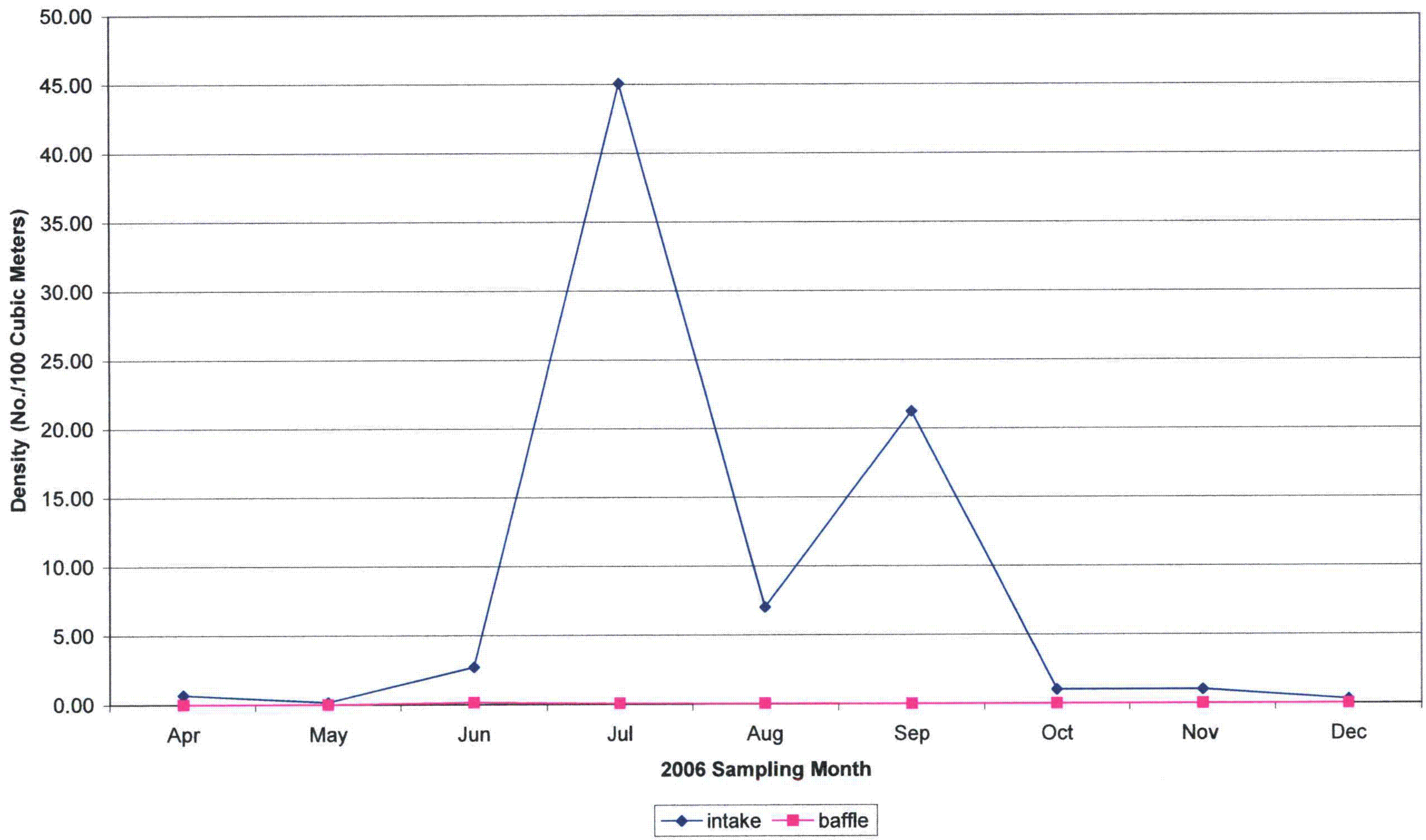


Figure 10 Density of Atlantic Menhaden Eggs in Intake and Baffle Wall Samples

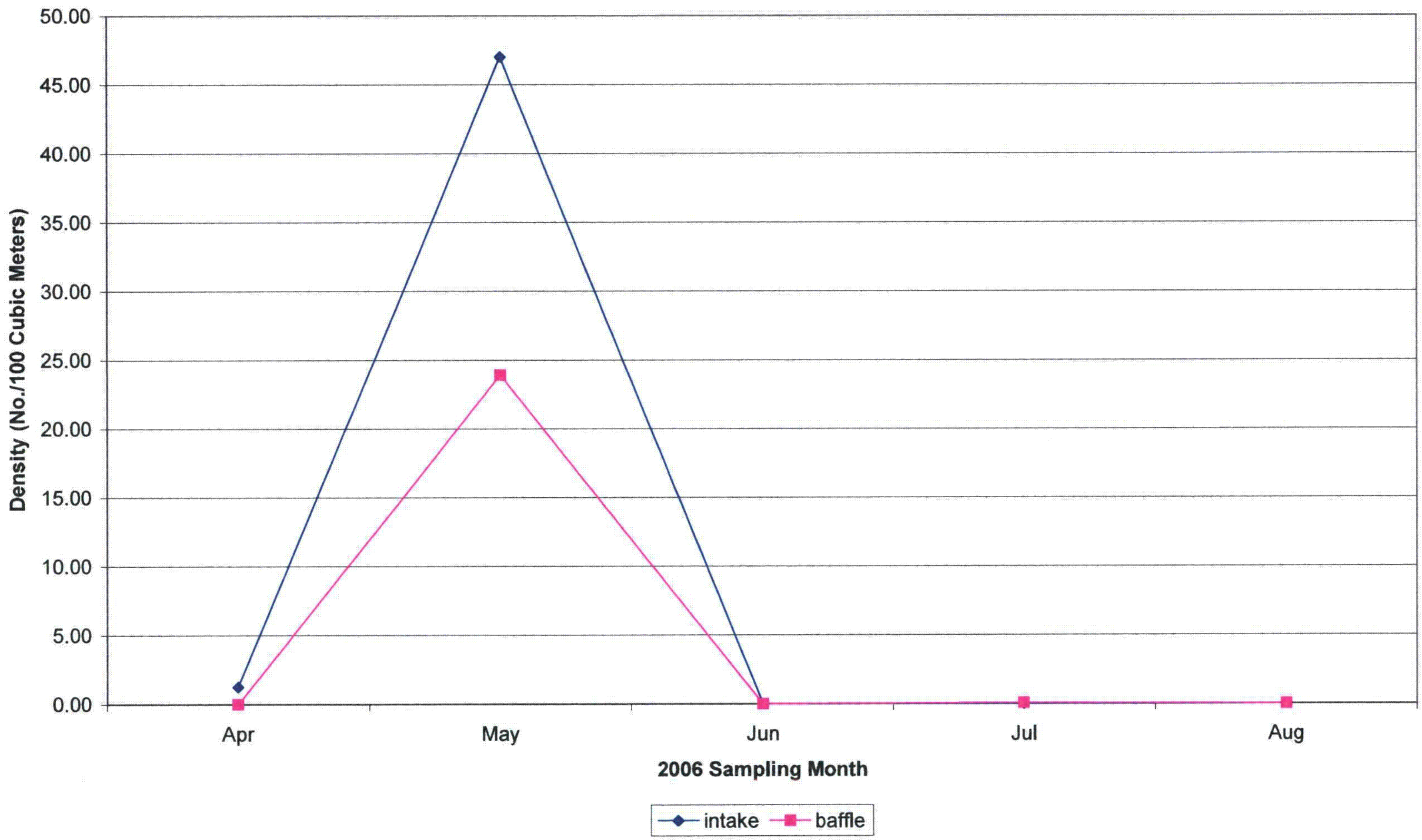


Figure 11 Density of Sciaenidae Eggs in Intake and Baffle Wall Samples

Figure 12 Density of Naked Goby Post-Yolk Sac Larvae in Intake and Baffle Wall Samples

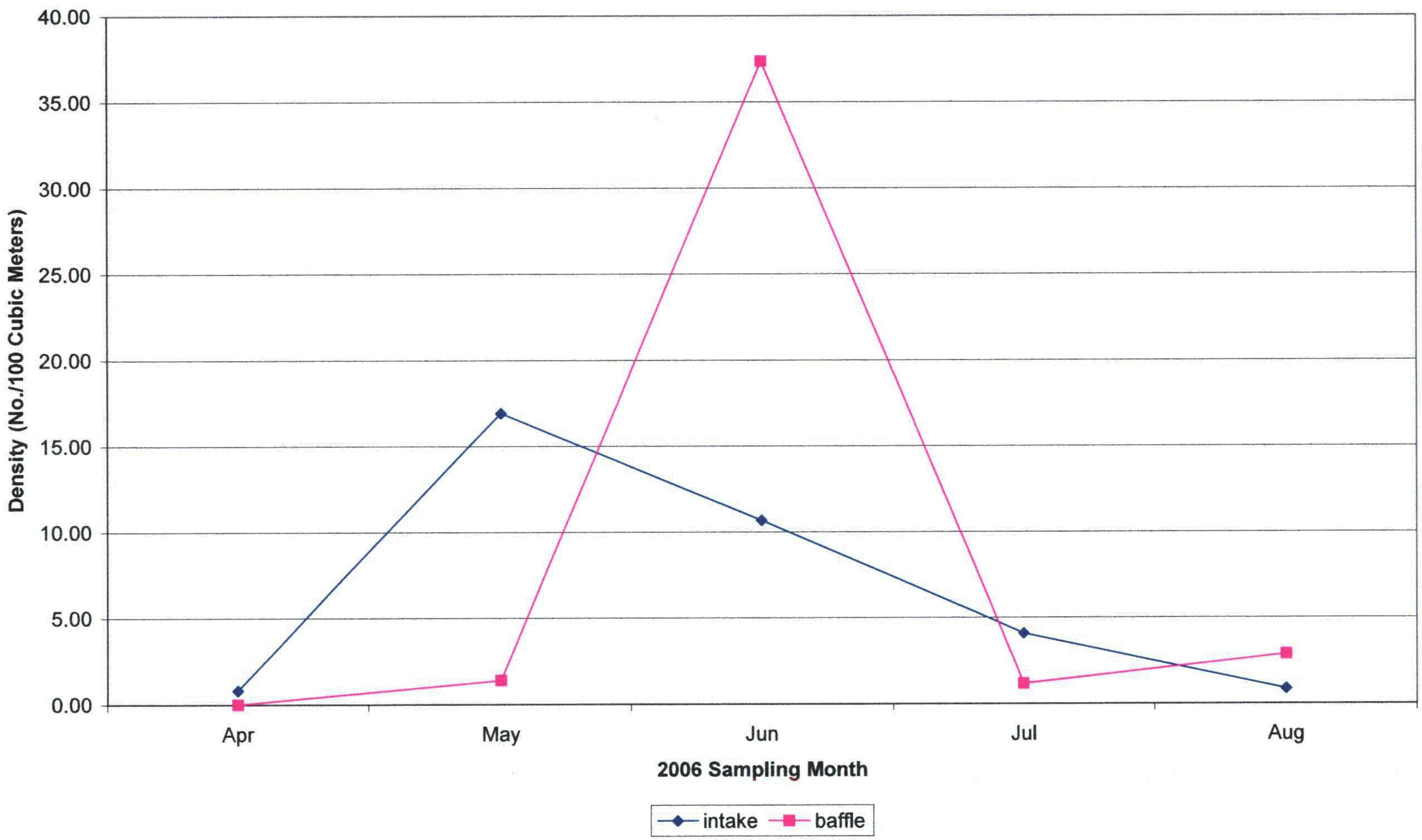


TABLE 1. NAMES OF FINFISH COLLECTED AT THE CALVERT CLIFFS NUCLEAR POWER PLANT

	FAMILY	COMMON NAME	SCIENTIFIC NAME
Anguillidae	Freshwater eels	American eel	*Anguilla rostrata*
Engrailidae	Anchovies	Bay anchovy	*Anchoa mitchilli*
Clupeidae	Herrings	Gizzard shad	*Dorosoma cepedianum*
		Atlantic menhaden	*Brevoortia tyrannus*
Gobiesicidae	Clingfishes	Skilletfish	*Gobiesox strumosus*
Hemiramphidae	Halfbeaks	---	*Hyporhamphus* sp.
Cyprinodontidae	Killifishes	---	*Fundulus* sp.
Atherinopsidae	New World Silversides	Atlantic silverside	*Menidia menidia*
		Inland silverside	*Menidia beryllina*
		Rough silverside	*Membras martinica*
Syngnathidae	Pipefishes and Seahorses	Northern pipefish	*Syngnathus fuscus*
Sciaenidae	Drums and croakers	Atlantic croaker	*Micropogonias undulatus*
		Northern kingfish	*Menticirrhus saxatilis*
		Weakfish	*Cynoscion regalis*
		Spot	*Leiostomus xanthurus*
		Silver perch	*Bairdiella chrysoura*
Gobiidae	Gobies	Naked goby	*Gobiosoma bosci*
		Green goby	*Microgobius thalassinus*
Blenniidae	Combtooth Blennies	Feather blenny	*Hypsoblennius hentz*
Achiridae	American soles	Hogchoker	*Trinectes maculatus*

*Finfish names from Nelson et al (2004)

TABLE 2 MONTHLY AVERAGE DENSITY (NO./100M3) OF ENTRAINED FISH AT CALVERT CLIFFS NUCLEAR POWER PLANT INTAKE, MARCH 2006 - MARCH 2007

Species/Taxon	Life Stage	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
American eel	juvenile	0.00	0.04	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29
Atherinopsidae sp.	fertilized egg	0.00	0.00	0.03	0.15	0.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atherinopsidae sp.	unstaged	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atherinopsidae sp.	post-yolk sac larvae	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atlantic croaker	juvenile	0.00	0.00	0.00	0.00	0.00	0.00	0.71	1.47	1.98	0.43	3.47	0.58	0.00
Atlantic croaker	post-yolk sac larvae	0.00	0.00	0.00	0.00	0.00	0.14	0.15	0.00	0.00	0.00	0.00	0.00	0.00
Atlantic menhaden	fertilized egg	0.00	1.25	47.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atlantic menhaden	juvenile	23.17	3.30	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atlantic menhaden	post-yolk sac larvae	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.00
Atlantic menhaden	yolk-sac larvae	0.00	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atlantic silverside	fertilized egg	0.00	0.00	0.07	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atlantic silverside	juvenile	0.00	0.00	0.00	0.51	0.00	0.00	0.00	0.00	0.00	0.43	0.00	0.00	0.00
Atlantic silverside	post-yolk sac larvae	0.00	0.00	2.36	1.66	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atlantic silverside	unfertilized egg	0.00	0.00	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atlantic silverside	yolk-sac larvae	0.00	0.00	0.49	0.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bay anchovy	adult	0.00	0.07	0.06	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.57	0.57	0.61
Bay anchovy	fertilized egg	0.00	0.00	369.78	634.50	50.91	108.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bay anchovy	juvenile	0.00	0.69	0.17	2.72	45.06	7.02	21.24	1.02	1.01	0.29	2.48	0.43	0.37
Bay anchovy	unstaged	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bay anchovy	post-yolk sac larvae	0.00	0.00	0.65	2.97	4.14	58.11	3.06	0.00	0.00	0.00	0.00	0.29	0.00
Bay anchovy	yolk-sac larvae	0.00	0.00	0.00	0.35	0.00	1.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Damaged egg	fertilized egg	0.00	0.00	0.49	3.16	4.36	0.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Damaged egg	unstaged	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Damaged fish	unstaged	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Damaged fish	post-yolk sac larvae	0.00	0.00	0.42	0.14	2.31	0.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Feather blenny	juvenile	0.00	0.00	0.00	0.07	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Feather blenny	post-yolk sac larvae	0.00	0.00	0.12	1.44	0.23	0.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Feather blenny	yolk-sac larvae	0.00	0.00	0.00	0.07	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fundulus sp.	fertilized egg	0.00	0.00	0.00	0.04	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gizzard shad	fertilized egg	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Goby sp.	post-yolk sac larvae	0.00	0.00	0.00	1.82	0.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Green goby	juvenile	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Green goby	post-yolk sac larvae	0.00	0.00	0.00	0.00	0.17	0.11	0.15	0.00	0.00	0.00	0.00	0.00	0.00
Hogchoker	fertilized egg	0.00	0.00	0.00	2.95	2.32	0.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hogchoker	post-yolk sac larvae	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Naked goby	fertilized egg	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Naked goby	juvenile	0.00	0.00	0.00	0.07	4.62	0.72	1.29	0.00	0.00	0.00	0.00	0.00	0.00
Naked goby	post-yolk sac larvae	0.00	0.00	0.81	16.92	10.67	4.09	0.88	0.00	0.00	0.00	0.00	0.00	0.00

TABLE 2 CONTINUED

Species/Taxon	Life Stage	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Naked goby	yolk-sac larvae	0.00	0.00	0.00	0.36	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Northern Kingfish	post-yolk sac larvae	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00
Northern pipefish	juvenile	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00
Northern pipefish	post-yolk sac larvae	0.00	0.00	0.27	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rough silverside	fertilized egg	0.00	0.00	0.07	0.14	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rough silverside	juvenile	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rough silverside	post-yolk sac larvae	0.00	0.00	0.00	0.14	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rough silverside	yolk-sac larvae	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sciaenidae sp.	fertilized egg	0.00	0.00	1.88	39.02	173.65	156.27	0.44	0.00	0.00	0.00	0.00	0.00	0.00
Sciaenidae sp.	unstaged	0.00	0.00	0.00	0.00	2.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Silver perch	post-yolk sac larvae	0.00	0.00	0.00	0.00	0.12	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Skilletfish	juvenile	0.00	0.00	0.00	0.43	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Skilletfish	post-yolk sac larvae	0.00	0.00	4.44	3.11	0.17	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Skilletfish	yolk-sac larvae	0.00	0.00	0.06	0.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Spot	juvenile	0.58	0.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.60
Spot	post-yolk sac larvae	1.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07
Weakfish	juvenile	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Taxa		**2**	**4**	**11**	**11**	**9**	**9**	**7**	**2**	**2**	**3**	**2**	**3**	**3**
Total		**24.91**	**6.03**	**430.07**	**714.46**	**303.18**	**339.93**	**28.20**	**2.49**	**2.99**	**1.14**	**6.51**	**2.01**	**3.95**

TABLE 3 AVERAGE DENSITY AND PERCENT COMPOSITION OF ENTRAINED FISH AT CALVERT CLIFFS NUCLEAR POWER PLANT, MARCH 2006 -- MARCH 2007

Species/Taxon	Life Stage	Average No./100M^3	Percent	Cumulative Percent
Bay anchovy	fertilized egg	130.11	63.15	63.15
Sciaenidae sp.	fertilized egg	42.56	20.65	83.80
Bay anchovy	juvenile	8.26	4.01	87.82
Bay anchovy	post-yolk sac larvae	7.05	3.42	91.24
Atlantic menhaden	fertilized egg	6.16	2.99	94.22
Naked goby	post-yolk sac larvae	3.67	1.78	96.01
Damaged egg	fertilized egg	1.03	0.50	96.51
Atlantic menhaden	juvenile	0.95	0.46	96.97
Skilletfish	post-yolk sac larvae	0.94	0.45	97.43
Naked goby	juvenile	0.74	0.36	97.78
Hogchoker	fertilized egg	0.66	0.32	98.11
Atlantic silverside	post-yolk sac larvae	0.48	0.23	98.34
Damaged fish	post-yolk sac larvae	0.45	0.22	98.56
Atlantic croaker	juvenile	0.44	0.22	98.77
Spot	juvenile	0.34	0.17	98.94
Goby sp.	post-yolk sac larvae	0.31	0.15	99.09
Sciaenidae sp.	unstaged	0.27	0.13	99.22
Feather blenny	post-yolk sac larvae	0.26	0.13	99.35
Bay anchovy	yolk-sac larvae	0.21	0.10	99.45
Bay anchovy	adult	0.14	0.07	99.52
Atlantic silverside	yolk-sac larvae	0.13	0.06	99.58
Atherinopsidae sp.	fertilized egg	0.09	0.04	99.62
Atlantic silverside	juvenile	0.07	0.04	99.66
Skilletfish	yolk-sac larvae	0.06	0.03	99.69
Skilletfish	juvenile	0.06	0.03	99.72
Naked goby	yolk-sac larvae	0.05	0.03	99.74
Northern pipefish	post-yolk sac larvae	0.05	0.02	99.77
American eel	juvenile	0.04	0.02	99.79
Green goby	post-yolk sac larvae	0.04	0.02	99.81
Spot	post-yolk sac larvae	0.04	0.02	99.82
Atlantic silverside	unfertilized egg	0.03	0.01	99.84
Fundulus sp.	fertilized egg	0.03	0.01	99.85
Rough silverside	fertilized egg	0.03	0.01	99.87
Atlantic silverside	fertilized egg	0.02	0.01	99.88
Rough silverside	post-yolk sac larvae	0.02	0.01	99.89
Bay anchovy	unstaged	0.02	0.01	99.90
Atlantic croaker	post-yolk sac larvae	0.02	0.01	99.91
Silver perch	post-yolk sac larvae	0.02	0.01	99.92
Feather blenny	yolk-sac larvae	0.02	0.01	99.93
Atherinopsidae sp.	post-yolk sac larvae	0.02	0.01	99.94
Atlantic menhaden	yolk-sac larvae	0.02	0.01	99.94
Feather blenny	juvenile	0.01	0.01	99.95
Green goby	juvenile	0.01	0.01	99.96
Atlantic menhaden	post-yolk sac larvae	0.01	0.01	99.96
Naked goby	fertilized egg	0.01	0.004	99.96

TABLE 3 CONTINUED

Species/Taxon	Life Stage	Average No./100M^3	Percent	Cumulative Percent
Weakfish	juvenile	0.01	0.004	99.97
Rough silverside	juvenile	0.01	0.004	99.97
Atherinopsidae sp.	unstaged	0.01	0.004	99.98
Damaged egg	unstaged	0.01	0.004	99.98
Gizzard shad	fertilized egg	0.01	0.004	99.98
Northern Kingfish	post-yolk sac larvae	0.01	0.004	99.99
Northern pipefish	juvenile	0.01	0.004	99.99
Damaged fish	unstaged	0.01	0.004	99.99
Hogchoker	post-yolk sac larvae	0.01	0.003	100.00
Rough silverside	yolk-sac larvae	0.004	0.002	100.00

TABLE 4 AVERAGE DENSITY (COUNT/100M³) OF ICHTHYOPLANKTON ENTRAINED DURING DAYTIME AND NIGHTTIME HOURS AT CALVERT CLIFFS NUCLEAR POWER PLANT INTAKE

Species/Taxon	Life Stage	4/24/2006		5/23/2006		6/20/2006		7/24/2006		8/28/2006		3/19/2007	
		Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
American eel	juvenile	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atherinopsidae sp.	fertilized egg	0.00	0.00	0.00	0.29	0.30	0.90	0.00	0.43	0.00	0.00	0.00	0.00
Atherinopsidae sp.	unstaged	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atherinopsidae sp.	post-yolk sac larvae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atlantic croaker	juvenile	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atlantic croaker	post-yolk sac larvae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.14	0.00	0.00
Atlantic menhaden	fertilized egg	4.69	5.29	45.00	31.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atlantic menhaden	juvenile	0.00	0.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atlantic menhaden	post-yolk sac larvae	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.00
Atlantic menhaden	yolk-sac larvae	0.00	0.00	0.29	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atlantic silverside	fertilized egg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atlantic silverside	juvenile	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atlantic silverside	post-yolk sac larvae	0.00	0.00	0.28	2.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atlantic silverside	unfertilized egg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atlantic silverside	yolk-sac larvae	0.00	0.00	0.00	0.29	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.00
Bay anchovy	adult	0.00	0.00	0.00	0.59	0.00	0.00	0.00	0.42	0.00	0.00	0.00	0.24
Bay anchovy	fertilized egg	0.00	0.00	1170.00	1120.00	44.60	56.30	40.80	35.10	38.50	60.20	0.00	0.00
Bay anchovy	juvenile	0.00	0.88	0.00	0.57	0.00	0.29	293.00	121.00	0.29	4.25	0.00	0.00
Bay anchovy	unstaged	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bay anchovy	post-yolk sac larvae	0.00	0.00	0.58	0.00	0.87	1.76	0.00	0.00	58.90	237.00	0.00	0.00
Bay anchovy	yolk-sac larvae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.95	4.30	0.00	0.00
Damaged egg	fertilized egg	0.00	0.00	0.29	3.19	18.50	4.50	1.15	1.26	1.43	0.86	0.00	0.00
Damaged egg	unstaged	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Damaged fish	unstaged	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Damaged fish	post-yolk sac larvae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.43	0.29	0.00	0.00	0.00
Feather blenny	juvenile	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Feather blenny	post-yolk sac larvae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Feather blenny	yolk-sac larvae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.84	0.00	0.00
Fundulus sp.	fertilized egg	0.00	0.00	0.00	0.00	0.28	0.00	0.00	0.79	0.00	0.00	0.00	0.00
Gizzard shad	fertilized egg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Goby sp.	post-yolk sac larvae	0.00	0.00	0.00	0.00	0.00	0.90	0.00	0.43	0.00	0.00	0.00	0.00
Green goby	juvenile	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.42	0.00	0.00	0.00	0.00
Green goby	post-yolk sac larvae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.00	0.00
Hogchoker	fertilized egg	0.00	0.00	0.00	0.00	2.04	4.42	0.29	0.00	4.84	0.00	0.00	0.00

TABLE 4 CONTINUED

Species/Taxon	Life Stage	4/24/2006		5/23/2006		6/20/2006		7/24/2006		8/28/2006		3/19/2007	
		Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
Hogchoker	post-yolk sac larvae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.56	0.00	0.00
Naked goby	fertilized egg	0.00	0.00	0.00	0.00	0.00	0.60	0.00	0.00	0.00	0.00	0.00	0.00
Naked goby	juvenile	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.00
Naked goby	post-yolk sac larvae	0.00	0.00	0.00	0.00	1.18	3.50	1.45	0.84	4.94	4.60	0.00	0.00
Naked goby	yolk-sac larvae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Northern Kingfish	post-yolk sac larvae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Northern pipefish	juvenile	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Northern pipefish	post-yolk sac larvae	0.00	0.00	0.00	0.29	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rough silverside	fertilized egg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.00	0.00	0.00
Rough silverside	juvenile	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rough silverside	post-yolk sac larvae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rough silverside	yolk-sac larvae	0.00	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sciaenidae sp.	fertilized egg	0.00	0.00	1.17	4.07	74.20	17.00	22.70	25.80	8.43	150.00	0.00	0.00
Sciaenidae sp.	unstaged	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Silver perch	post-yolk sac larvae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.00
Skilletfish	juvenile	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Skilletfish	post-yolk sac larvae	0.00	0.00	5.77	4.05	0.00	0.29	0.00	0.00	0.58	0.27	0.00	0.00
Skilletfish	yolk-sac larvae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Spot	juvenile	0.00	1.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.85	0.97
Spot	post-yolk sac larvae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Weakfish	juvenile	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total		**4.69**	**8.78**	**1223.38**	**1167.16**	**142.26**	**91.05**	**359.68**	**186.93**	**127.73**	**464.30**	**1.85**	**1.21**

TABLE 5 LENGTH STATISTICS FOR FISH LARVAE COLLECTED DURING ENTRAINMENT STUDIES AT CALVERT CLIFFS NUCLEAR POWER PLANT INTAKE, MARCH 2006 – MARCH 2007

Species/Taxon	N	Min mm	Max mm	Avg mm	StDev mm
American eel	6	53	61	55.3	3.0
Atherinopsidae sp.	1	9.5	9.5	9.5	
Atlantic croaker	65	2	31	17.5	6.3
Atlantic menhaden	111	2	39	28.7	5.4
Atlantic silverside	91	3.7	20.3	8.2	3.7
Bay anchovy	1082	1.5	66	14.5	11.1
Feather blenny	41	2.5	11.6	3.6	1.5
Goby sp.	9	3	5.9	4.0	0.9
Green goby	8	7.6	14.1	10.2	2.0
Hogchoker	2	1.8	2.5	2.2	0.5
Naked goby	553	2	18.2	6.1	3.1
Northern Kingfish	1	12.9	12.9	12.9	
Northern pipefish	8	9.4	42	16.8	11.2
Rough silverside	5	5.2	16.4	9.6	4.1
Silver perch	3	2.9	7.5	4.5	2.6
Skilletfish	160	2.4	19	3.7	2.4
Spot	53	12.3	20.9	16.4	1.7
Weakfish	1	19.8	19.8	19.8	

TABLE 6 MONTHLY AND ANNUAL ENTRAINMENT ESTIMATES AT MAXIMUM FLOW FOR CALVERT CLIFFS NUCLEAR POWER PLANT INTAKE, MARCH 2006 – MARCH 2007

Species/Life Stage	2006										2007			Total Annual Estimate	80% Confidence Interval (+/-)
	March	April	May	June	July	August	September	October	November	December	January	February	March		
American eel-juvenile	0	224,200	147,300	0	0	0	0	0	0	0	0	155,500	1,158,200	1,685,200	1,294,000
Atherinopsidae sp.-fertilized egg	0	0	134,100	629,400	2,398,100	0	0	0	0	0	0	0	0	3,161,600	2,393,000
Atherinopsidae sp.-N/A	0	114,800	153,000	0	0	0	0	0	0	0	0	0	0	267,800	317,800
Atherinopsidae sp.-post-yolk sac larvae	0	0	641,900	0	0	0	0	0	0	0	0	0	0	641,900	416,400
Atlantic croaker-juvenile	0	0	0	0	0	0	2,394,000	5,965,600	7,429,000	2,258,400	13,009,570	1,969,800	0	33,026,370	14,760,000
Atlantic croaker-post-yolk sac larvae	0	0	0	0	0	522,000	832,000	0	0	0	0	0	0	1,354,000	846,800
Atlantic menhaden-fertilized egg	0	37,291,000	163,392,000	19,210,000	0	0	0	0	0	0	0	0	0	219,893,000	112,900,000
Atlantic menhaden-juvenile	15,170,000	17,718,500	601,200	0	0	0	0	0	0	0	0	0	0	33,489,700	20,140,000
Atlantic menhaden-post-yolk sac larvae	0	0	0	157,100	0	0	0	0	0	0	0	490,900	0	648,000	612,800
Atlantic menhaden-yolk-sac larvae	0	116,000	422,600	0	0	0	0	0	0	0	0	0	0	538,600	452,000
Atlantic silverside-fertilized egg	0	0	333,600	520,600	0	0	0	0	0	0	0	0	0	854,200	532,600
Atlantic silverside-juvenile	0	0	0	1,896,600	0	0	0	0	0	2,118,000	0	0	0	4,014,600	2,474,000
Atlantic silverside-post-yolk sac larvae	0	113,300	11,137,300	5,514,480	272,800	0	0	0	0	0	0	0	0	17,037,880	8,506,000
Atlantic silverside-unfertilized egg	0	0	1,196,000	0	0	0	0	0	0	0	0	0	0	1,196,000	1,242,000
Atlantic silverside-yolk-sac larvae	0	0	2,412,100	2,375,760	0	0	0	0	0	0	0	0	0	4,787,860	3,170,000
Bay anchovy-adult	0	229,700	268,200	0	193,400	0	0	0	0	0	2,073,000	2,026,810	2,286,000	7,077,110	2,986,000
Bay anchovy-fertilized egg	0	1,143,000	1,655,223,000	2,626,240,000	157,796,600	471,060,000	25,870,000	0	0	0	0	0	0	4,937,332,600	1,876,000,000
Bay anchovy-juvenile	0	2,659,700	560,800	8,956,700	201,904,000	29,529,400	73,447,000	9,532,000	4,153,500	1,425,000	9,106,000	1,694,300	1,459,100	344,427,500	222,900,000
Bay anchovy-N/A	0	0	0	0	791,400	0	0	0	0	0	0	0	0	791,400	939,000
Bay anchovy-post-yolk sac larvae	0	0	2,293,100	12,092,000	16,174,800	213,347,600	88,760,000	0	0	0	0	981,800	0	333,649,300	213,800,000
Bay anchovy-yolk-sac larvae	0	0	0	1,111,000	0	6,076,000	3,472,000	0	0	0	0	0	0	10,659,000	10,380,000
Damaged egg-fertilized egg	0	0	2,256,200	12,935,600	15,946,700	5,925,900	599,400	0	0	0	0	0	0	37,663,800	14,570,000
Damaged egg-N/A	0	227,600	0	0	0	0	0	0	0	0	0	0	0	227,600	290,700
Damaged fish-N/A	0	0	0	221,300	0	0	0	0	0	0	0	0	0	221,300	294,500
Damaged fish-post-yolk sac larvae	0	0	1,453,200	978,300	9,694,500	3,234,600	76,200	0	0	0	0	0	0	15,436,800	7,394,000
Feather blenny-juvenile	0	0	0	226,100	147,700	110,800	0	0	0	0	0	0	0	484,600	438,200
Feather blenny-post-yolk sac larvae	0	0	377,300	5,835,900	888,500	2,379,000	0	0	0	0	0	0	0	9,480,700	5,085,000
Feather blenny-yolk-sac larvae	0	0	0	298,800	0	386,500	220,900	0	0	0	0	0	0	906,200	723,500
Fundulus sp.-fertilized egg	0	0	0	148,300	912,700	0	0	0	0	0	0	0	0	1,061,000	536,600
Gizzard shad-fertilized egg	0	0	299,100	0	0	0	0	0	0	0	0	0	0	299,100	310,500
Goby sp.-post-yolk sac larvae	0	0	0	7,538,600	4,162,100	0	0	0	0	0	0	0	0	11,700,700	7,482,000
Green goby-juvenile	0	0	0	0	466,200	0	0	0	0	0	0	0	0	466,200	328,500
Green goby-post-yolk sac larvae	0	0	0	0	724,700	393,900	621,250	0	0	0	0	0	0	1,739,850	809,400
Hogchoker-fertilized egg	0	0	0	11,619,900	9,343,000	2,221,000	1,269,000	0	0	0	0	0	0	24,452,900	11,440,000
Hogchoker-post-yolk sac larvae	0	0	0	0	0	255,300	145,900	0	0	0	0	0	0	401,200	431,700
Naked goby-fertilized egg	0	0	0	312,700	0	0	0	0	0	0	0	0	0	312,700	312,100
Naked goby-juvenile	0	0	0	218,500	20,136,800	3,288,200	4,746,000	0	0	0	0	0	0	28,389,500	15,240,000
Naked goby-post-yolk sac larvae	0	0	2,640,000	67,824,000	43,988,000	16,553,000	5,712,000	0	0	0	0	0	0	136,717,000	55,750,000
Naked goby-yolk-sac larvae	0	0	0	1,369,300	0	518,700	0	0	0	0	0	0	0	1,888,000	1,291,000
Northern Kingfish-post-yolk sac larvae	0	0	0	0	0	0	445,700	74,290	0	0	0	0	0	519,990	678,000
Northern pipefish-juvenile	0	0	0	0	0	0	445,700	74,290	0	0	0	0	0	519,990	678,000
Northern pipefish-post-yolk sac larvae	0	0	1,172,800	600,700	0	0	0	0	0	0	0	0	0	1,773,500	883,500
Rough silverside-fertilized egg	0	0	331,600	597,700	0	130,100	74,360	0	0	0	0	0	0	1,133,760	766,900
Rough silverside-juvenile	0	0	0	310,200	0	0	0	0	0	0	0	0	0	310,200	322,000
Rough silverside-post-yolk sac larvae	0	0	0	520,600	272,800	0	0	0	0	0	0	0	0	793,400	481,400
Rough silverside-yolk-sac larvae	0	0	133,500	0	0	0	0	0	0	0	0	0	0	133,500	158,400
Sciaenidae sp.-fertilized egg	0	0	7,052,200	140,240,000	576,867,900	771,370,000	43,218,000	0	0	0	0	0	0	1,538,748,100	502,300,000
Sciaenidae sp.-N/A	0	0	0	0	9,761,000	0	0	0	0	0	0	0	0	9,761,000	11,580,000
Silver perch-post-yolk sac larvae	0	0	0	0	545,400	131,700	75,240	0	0	0	0	0	0	752,340	500,800
Skilletfish-juvenile	0	0	0	1,569,600	551,900	0	0	0	0	0	0	0	0	2,121,500	1,246,000
Skilletfish-post-yolk sac larvae	0	0	21,840,000	11,899,300	685,300	937,300	223,400	0	0	0	0	0	0	35,585,300	17,160,000
Skilletfish-yolk-sac larvae	0	0	299,100	2,153,000	0	0	0	0	0	0	0	0	0	2,452,100	2,257,000
Spot-juvenile	379,400	2,243,800	0	0	0	0	0	0	0	0	0	0	9,532,500	12,155,700	8,678,000
Spot-post-yolk sac larvae	758,700	303,500	0	0	0	0	0	0	0	0	0	77,780	311,100	1,451,080	1,313,000
Weakfish-juvenile	0	0	312,700	0	0	0	0	0	0	0	0	0	0	312,700	324,600
Total	16,308,100	62,385,100	1,877,083,900	2,946,122,040	1,074,626,300	1,528,371,000	252,648,050	15,646,180	11,582,500	5,801,400	24,188,570	7,396,890	14,746,900	7,836,906,930	2,024,000,000

TABLE 7 MEAN VALUES OF WATER QUALITY PARAMETERS TAKEN WITH ENTRAINMENT COLLECTIONS AT THE CALVERT CLIFFS NUCLEAR POWER PLANT INTAKE, MARCH 2006 -- MARCH 2007

Sampling Date	Temperature	Salinity	Dissolved Oxygen	pH	Conductivity
	Degrees C	ppt	mg/L	pH units	µs/cm³
03/30/06	8.1	14.8	7.9	7.8	16581
04/06/06	10.7	12.8	9.5	8.2	15435
04/13/06	11.6	15.0	9.3	8.0	18332
04/18/06	14.7	13.0	7.5	ND	ND
04/24/06	15.6	16.0	8.7	7.9	21398
05/01/06	15.4	13.4	8.2	8.2	18057
05/08/06	16.5	13.2	8.9	8.3	18306
05/15/06	18.4	14.5	8.7	8.3	20813
05/23/06	21.1	14.2	5.4	ND	22125
05/30/06	19.2	13.6	5.6	7.5	19903
06/05/06	21.8	13.3	7.6	8.1	20687
06/12/06	21.9	13.6	7.1	8.2	21122
06/20/06	21.5	14.3	1.4	7.4	21911
06/28/06	24.5	12.7	6.6	8.1	20656
07/03/06	25.6	10.3	3.4	7.2	17609
07/10/06	24.9	11.1	1.0	7.3	18669
07/17/06	27.6	8.5	5.9	8.1	15462
07/24/06	26.6	9.5	1.2	7.4	16757
07/31/06	28.2	9.2	5.4	7.9	16620
08/07/06	27.7	11.3	2.2	7.4	19115
08/14/06	26.4	ND	ND	7.2	ND
08/21/06	26.8	13.4	4.6	8.0	22877
08/28/06	27.5	13.5	4.7	7.8	23527
09/11/06	24.0	14.3	4.3	7.7	23038
09/25/06	22.4	14.9	7.4	6.6	23310
10/09/06	19.7	14.9	7.9	7.8	21908
10/26/06	15.4	18.5	8.6	7.9	24321
11/06/06	13.1	16.8	9.9	8.0	21149
11/27/06	11.6	13.6	8.9	8.2	16788
12/05/06	10.1	14.1	9.5	7.3	23294
12/18/06	9.0	14.7	12.8	7.6	24196
01/11/07	8.5	15.1	7.6	8.3	17017
01/22/07	6.6	11.6	11.8	8.2	12679
02/08/07	2.8	11.1	13.5	8.2	10920
02/19/07	1.6	14.2	12.3	8.2	13263
03/05/07	3.9	13.2	13.9	8.0	13256
03/12/07	4.9	12.8	13.0	8.1	13268
03/19/07	5.4	12.4	10.4	7.9	13071
03/26/07	6.6	12.0	10.5	7.7	12951

ND=No Data due to Equipment malfunction

TABLE 8 MONTHLY AVERAGE DENSITY (NO./100M^3) OF ENTRAINED FISH AT CALVERT CLIFFS NUCLEAR POWER PLANT BAFFLE WALL, APRIL 2006 - JANUARY 2007

Species/Taxon	Life Stage	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Atherinopsidae sp.	fertilized egg	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atherinopsidae sp.	post-yolk sac larvae	0.00	0.71	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00
Atlantic menhaden	fertilized egg	0.00	23.91	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00
Atlantic menhaden	post-yolk sac larvae	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atlantic menhaden	yolk-sac larvae	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atlantic silverside	fertilized egg	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atlantic silverside	post-yolk sac larvae	0.00	1.31	0.58	0.04	0.00	0.00	0.00	0.00	0.00	0.00
Atlantic silverside	yolk-sac larvae	0.00	0.34	1.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bay anchovy	fertilized egg	0.00	360.31	936.89	9.50	28.27	0.00	0.00	0.00	0.00	0.00
Bay anchovy	juvenile	0.00	0.00	0.15	0.06	0.04	0.00	0.00	0.00	0.00	0.00
Bay anchovy	post-yolk sac larvae	0.00	0.81	6.05	1.96	47.89	1.73	0.00	0.00	0.00	0.00
Bay anchovy	yolk-sac larvae	0.00	0.00	1.51	0.06	2.47	0.00	0.00	0.00	0.00	0.00
Damaged egg	fertilized egg	0.04	0.00	0.00	0.12	0.11	0.00	0.00	0.00	0.00	0.00
Damaged fish	unstaged	0.00	0.62	0.00	0.00	1.30	0.00	0.00	0.00	0.00	0.00
Damaged fish	post-yolk sac larvae	0.00	1.07	4.30	1.09	3.61	0.29	0.15	0.00	0.00	0.00
Damaged fish	yolk-sac larvae	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Feather blenny	juvenile	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00
Feather blenny	post-yolk sac larvae	0.00	0.81	2.37	0.41	0.29	0.00	0.00	0.00	0.00	0.00
Feather blenny	yolk-sac larvae	0.00	0.00	0.07	0.00	0.07	0.00	0.00	0.00	0.00	0.00
Fundulus sp.	fertilized egg	0.00	0.00	0.00	1.65	0.00	0.00	0.00	0.00	0.00	0.00
Gizzard shad	post-yolk sac larvae	0.00	0.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Goby sp.	juvenile	0.00	0.00	0.00	0.35	0.00	0.00	0.00	0.00	0.00	0.00
Goby sp.	post-yolk sac larvae	0.00	0.00	0.00	1.26	0.14	0.15	0.00	0.00	0.00	0.00
Green goby	post-yolk sac larvae	0.00	0.00	0.04	0.06	0.00	0.00	0.00	0.00	0.00	0.00
Hogchoker	fertilized egg	0.00	0.00	3.65	0.58	0.07	0.00	0.00	0.00	0.00	0.00
Hogchoker	post-yolk sac larvae	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00
Hogchoker	yolk-sac larvae	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hyporhamphus Sp.	yolk-sac larvae	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00
Naked goby	juvenile	0.00	0.00	0.00	6.64	0.00	0.00	0.00	0.00	0.00	0.00
Naked goby	post-yolk sac larvae	0.00	1.39	37.36	1.17	2.88	0.00	0.00	0.00	0.00	0.00
Naked goby	yolk-sac larvae	0.00	0.00	0.15	0.00	0.22	0.00	0.00	0.00	0.00	0.00
Northern pipefish	juvenile	0.00	0.00	0.19	0.06	0.00	0.00	0.00	0.00	0.15	0.00
Northern pipefish	post-yolk sac larvae	0.00	0.52	0.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rough silverside	fertilized egg	0.00	0.00	0.88	0.24	0.00	0.00	0.00	0.00	0.00	0.00
Sciaenidae sp.	fertilized egg	0.00	0.72	45.67	33.43	107.90	0.00	0.00	0.00	0.00	0.00
Silver perch	post-yolk sac larvae	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00
Skilletfish	juvenile	0.00	0.00	0.07	0.41	0.00	0.00	0.00	0.00	0.00	0.00
Skilletfish	post-yolk sac larvae	0.00	2.22	4.52	0.18	0.07	0.14	0.00	0.00	0.00	0.00
Skilletfish	yolk-sac larvae	0.00	0.18	0.22	0.06	0.00	0.00	0.00	0.00	0.00	0.00
Weakfish	juvenile	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00
Total Taxa		**1**	**9**	**12**	**13**	**7**	**3**	**1**	**0**	**1**	**0**
Total		**0.04**	**395.90**	**1046.34**	**59.50**	**195.74**	**2.31**	**0.15**	**0.00**	**0.15**	**0.00**

TABLE 9 AVERAGE DENSITY AND PERCENT COMPOSITION OF ENTRAINED FISH AT CALVERT CLIFFS NUCLEAR POWER PLANT BAFFLE WALL, APRIL 2006 -- JANUARY 2007

Species/Taxon	Life Stage	Average No./100M^3	Percent	Cumulative Percent
Bay anchovy	fertilized egg	178.43	78.75	78.75
Sciaenidae sp.	fertilized egg	24.53	10.83	89.58
Bay anchovy	post-yolk sac larvae	7.28	3.21	92.79
Naked goby	post-yolk sac larvae	5.43	2.40	95.19
Atlantic menhaden	fertilized egg	3.75	1.65	96.84
Damaged fish	post-yolk sac larvae	1.35	0.60	97.44
Naked goby	juvenile	1.04	0.46	97.90
Skilletfish	post-yolk sac larvae	0.96	0.42	98.32
Hogchoker	fertilized egg	0.56	0.25	98.56
Feather blenny	post-yolk sac larvae	0.52	0.23	98.79
Bay anchovy	yolk-sac larvae	0.51	0.22	99.02
Atlantic silverside	post-yolk sac larvae	0.28	0.13	99.14
Damaged fish	unstaged	0.26	0.11	99.26
Fundulus sp.	fertilized egg	0.26	0.11	99.37
Goby sp.	post-yolk sac larvae	0.22	0.10	99.47
Atlantic silverside	yolk-sac larvae	0.18	0.08	99.55
Rough silverside	fertilized egg	0.15	0.06	99.62
Northern pipefish	post-yolk sac larvae	0.15	0.06	99.68
Atherinopsidae sp.	post-yolk sac larvae	0.13	0.06	99.74
Gizzard shad	post-yolk sac larvae	0.10	0.04	99.78
Skilletfish	juvenile	0.07	0.03	99.81
Skilletfish	yolk-sac larvae	0.06	0.03	99.84
Goby sp.	juvenile	0.06	0.02	99.87
Naked goby	yolk-sac larvae	0.05	0.02	99.89
Northern pipefish	juvenile	0.04	0.02	99.90
Damaged egg	fertilized egg	0.04	0.02	99.92
Bay anchovy	juvenile	0.03	0.01	99.93
Feather blenny	yolk-sac larvae	0.02	0.01	99.94
Hogchoker	post-yolk sac larvae	0.02	0.01	99.95
Damaged fish	yolk-sac larvae	0.02	0.01	99.96
Atlantic menhaden	yolk-sac larvae	0.01	0.01	99.96
Green goby	post-yolk sac larvae	0.01	0.01	99.97
Atherinopsidae sp.	fertilized egg	0.01	0.01	99.98
Atlantic silverside	fertilized egg	0.01	0.004	99.98
Atlantic menhaden	post-yolk sac larvae	0.01	0.004	99.98
Hyporhamphus Sp.	yolk-sac larvae	0.01	0.004	99.99
Feather blenny	juvenile	0.01	0.004	99.99
Weakfish	juvenile	0.01	0.004	100.00
Hogchoker	yolk-sac larvae	0.01	0.004	100.00
Silver perch	post-yolk sac larvae	0.004	0.002	100.00

TABLE 10 AVERAGE DENSITY (COUNT/100M^3) OF ICHTHYOPLANKTON ENTRAINED DURING DAYTIME AND NIGHTTIME HOURS AT CALVERT CLIFFS NUCLEAR POWER PLANT BAFFLE WALL

Species/Taxon	Life Stage	4/24/2006		5/23/2006		6/20/2006		7/24/2006		8/28/2006	
		Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
Atherinopsidae sp.	fertilized egg	0.00	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.00
Atherinopsidae sp.	post-yolk sac larvae	0.00	0.00	2.97	0.58	0.00	0.00	0.00	0.00	0.00	0.00
Atlantic menhaden	fertilized egg	0.00	0.00	12.80	18.50	0.00	0.00	0.00	0.00	0.00	0.00
Atlantic menhaden	post-yolk sac larvae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atlantic menhaden	yolk-sac larvae	0.00	0.00	0.00	0.88	0.00	0.00	0.00	0.00	0.00	0.00
Atlantic silverside	fertilized egg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atlantic silverside	post-yolk sac larvae	0.00	0.00	2.08	0.58	0.00	0.00	0.00	0.45	0.00	0.00
Atlantic silverside	yolk-sac larvae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bay anchovy	fertilized egg	0.00	0.00	1150.00	866.00	44.80	286.00	58.90	1.61	77.30	6.91
Bay anchovy	juvenile	0.00	0.00	0.00	0.00	0.00	0.57	0.00	0.00	0.00	0.29
Bay anchovy	post-yolk sac larvae	0.00	0.00	0.58	0.00	0.00	5.20	0.00	0.00	4.16	151.00
Bay anchovy	yolk-sac larvae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.86	15.90
Damaged egg	fertilized egg	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.00
Damaged fish	N/A	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.00	1.19	0.00
Damaged fish	post-yolk sac larvae	0.00	0.00	1.79	0.28	0.29	0.00	0.00	0.00	0.00	0.00
Damaged fish	yolk-sac larvae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Feather blenny	juvenile	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Feather blenny	post-yolk sac larvae	0.00	0.00	0.00	0.00	0.30	0.58	0.00	0.00	0.00	0.00
Feather blenny	yolk-sac larvae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fundulus sp.	fertilized egg	0.00	0.00	0.00	0.00	0.00	0.00	3.08	0.00	0.00	0.00
Gizzard shad	post-yolk sac larvae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Goby sp.	juvenile	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Goby sp.	post-yolk sac larvae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.19	0.00	1.15
Green goby	post-yolk sac larvae	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.00	0.00	0.00
Hogchoker	fertilized egg	0.00	0.00	0.00	0.00	10.20	5.99	0.00	0.00	0.00	0.59
Hogchoker	post-yolk sac larvae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.59	0.58
Hogchoker	yolk-sac larvae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hyporhamphus Sp.	yolk-sac larvae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Naked goby	juvenile	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Naked goby	post-yolk sac larvae	0.00	0.00	0.00	0.00	0.00	3.16	0.00	0.00	0.00	0.29
Naked goby	yolk-sac larvae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Northern pipefish	juvenile	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.00	0.00	0.00
Northern pipefish	post-yolk sac larvae	0.00	0.00	0.00	0.60	0.00	0.58	0.00	0.00	0.00	0.00
Rough silverside	fertilized egg	0.00	0.00	0.00	0.00	0.00	0.58	0.00	0.00	0.00	0.00
Sciaenidae sp.	fertilized egg	0.00	0.00	0.39	5.04	54.40	109.00	7.15	10.80	7.71	346.00
Silver perch	post-yolk sac larvae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29
Skilletfish	juvenile	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Skilletfish	post-yolk sac larvae	0.00	0.00	0.89	1.76	0.00	0.00	0.00	0.00	0.00	0.00
Skilletfish	yolk-sac larvae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Weakfish	juvenile	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total		**0.29**	**0.00**	**1171.51**	**894.79**	**109.98**	**412.23**	**69.13**	**15.05**	**95.10**	**523.00**

TABLE 11 LENGTH STATISTICS FOR FISH LARVAE COLLECTED DURING ENTRAINMENT STUDIES AT CALVERT CLIFFS NUCLEAR POWER PLANT BAFFLE WALL, APRIL 2006 – JANUARY 2007

Species/Taxon	N	Min mm	Max mm	Avg mm	StDev mm
Atherinopsidae sp.	12	3.1	6.5	5.1	1.1
Atlantic menhaden	4	1.1	5.2	2.6	1.8
Atlantic silverside	55	3.3	11.5	5.4	1.8
Bay anchovy	471	2	14.9	4.8	1.9
Damaged fish	6	2.5	5.2	3.9	0.9
Feather blenny	62	2.5	13.2	4.0	2.1
Gizzard shad	8	3.9	4.8	4.4	0.3
Goby sp.	19	2.5	5.5	3.5	1.0
Green goby	2	5.4	7.6	6.5	1.6
Hogchoker	5	1.9	3.1	2.5	0.5
Hyporhamphus Sp.	1	5.9	5.9	5.9	
Naked goby	266	2.1	17.8	5.9	4.0
Northern pipefish	23	10	65	19.9	17.2
Silver perch	1	3.1	3.1	3.1	
Skilletfish	125	2.3	22	4.0	4.0
Weakfish	1	15.8	15.8	15.8	

TABLE 12. MEAN VALUES OF WATER QUALITY PARAMETERS TAKEN WITH ENTRAINMENT COLLECTIONS AT THE CALVERT CLIFFS NUCLEAR POWER PLANT BAFFLE WALL, APRIL 2006 -- JANUARY 2007

Sampling Date	Temperature	Salinity	Dissolved Oxygen	pH	Conductivity
	Degrees C	ppt	mg/L	pH units	µs/cm³
04/06/06	10.8	13.2	11.5	8.3	15993
04/13/06	11.5	15.8	8.9	8.0	19102
04/18/06	14.0	12.2	9.8	8.1	16048
04/24/06	16.5	14.4	9.2	8.2	19750
05/01/06	15.8	13.9	9.6	8.2	18775
05/08/06	17.1	13.0	9.1	8.4	18270
05/15/06	18.4	14.6	8.5	8.4	20967
05/23/06	18.3	15.4	8.2	8.1	22031
05/30/06	20.5	13.5	7.2	7.9	20405
06/05/06	22.2	13.2	8.1	8.2	20836
06/12/06	22.4	12.8	7.5	8.5	20213
06/20/06	22.1	14.2	3.1	7.5	22093
06/28/06	24.9	10.7	8.1	8.2	20438
07/03/06	26.3	9.4	5.8	8.0	16528
07/10/06	25.3	10.7	1.8	7.0	17880
07/17/06	27.7	6.9	6.4	8.3	15435
07/24/06	27.1	9.0	3.2	7.7	16022
07/31/06	28.5	8.7	5.7	8.1	15971
08/07/06	29.5	8.7	4.4	8.2	16203
08/14/06	26.9	ND	ND	7.7	ND
08/21/06	27.4	17.9	6.5	8.2	29026
08/28/06	27.7	13.5	5.5	7.8	22501
09/11/06	24.1	13.0	6.7	8.0	21270
09/25/06	22.4	18.1	7.3	8.0	27810
10/09/06	19.4	13.2	9.2	8.2	19488
10/26/06	15.6	17.6	9.7	7.9	23352
11/27/06	11.4	12.6	10.8	ND	15503
12/05/06	10.1	14.7	10.6	8.4	17321
12/18/06	9.1	14.6	12.9	8.4	16821
01/11/07	8.3	13.8	12.2	8.7	15665
01/22/07	6.6	11.3	12.5	7.3	12340

ND = No Data Equipment Malfunction

Enclosure 1
UN#08-037

Supplemental Responses to Aquatic RAIs

Attachment 2

TELEPHONE/VISIT RECORD

TELEPHONE/VISIT RECORD

DATE: 3/5/2008	TIME: 1445	**TALKED**/MET WITH: Lou Chiarella
PROJECT/FILE NUMBER: 8093-07-6565		TITLE: New England Field Office Supervisor
PROJECT NAME: Calvert Cliffs Nuclear Power Plant		COMPANY: National Oceanic and Atmospheric Administration National Marine Fisheries Service
MACTEC REPRESENTATIVE WHO **PLACED**/RECEIVED CALL: Rani Reece		STREET ADDRESS: One Blackburn Drive
PHONE CALL: X MEETING		CITY/STATE/ZIP: Gloucester, MA 01930
MEETING LOCATION: NA		PHONE: (978) 281-9277 FAX: (978) 281-9301

SUBJECT/PURPOSE OF CALL OR VISIT:

Determine if shapefiles of essential fish habitat (EFH) in the Chesapeake Bay are available.

DISCUSSED/NOTES:

Mr. Chiarella informed Rani that shapefiles were not yet available for the Chesapeake Bay EFH. He instructed her on how to use the information at http://www.nero.noaa.gov/hcd/webintro.html to determine the species specific EFH in the Chesapeake Bay. Mr. Chiarella noted that the king mackerel, Spanish mackerel, and cobia had an "overly broad designation". He stated "don't worry about those."

ACTION REQUIRED: NA FOLLOW-UP CALL: NO

ROUTE TO Project File	SIGNATURE Rani Reece

Enclosure 1
UN#08-037

Supplemental Responses to Aquatic RAIs

Attachment 3

Storm Water Management Plan

April 2008