NATIONAL MARINE FISHERIES SERVICE
ENDANGERED SPECIES ACT
BIOLOGICAL OPINION

Agency:	Federal Highway Administration (FHWA) and Army Corps of Engineers (ACOE), Philadelphia District
Activity Considered:	I-95 Scudders Falls Bridge Improvement Project **F/NER/2009/00614**
Conducted by:	National Marine Fisheries Service Northeast Region
Date Issued:	June 11, 2010
Approved by:	[signature]

This constitutes the biological opinion (Opinion) of NOAA's National Marine Fisheries Service (NMFS) issued pursuant to Section 7 of the Endangered Species Act (ESA) of 1973, as amended, on the effects of the proposed I-95 Scudders Falls Bridge Improvement Project to be carried out by the Delaware River Joint Toll Bridge Commission in association with the Pennsylvania and New Jersey Departments of Transportation and to be authorized by the US Federal Highway Administration's and the US Army Corps of Engineers, Philadelphia District. This Opinion is based on information provided in the Biological Assessment dated September 2008, as modified by letter of September 10, 2009, additional information obtained during the consultation period, an Environmental Assessment dated October 2009, scientific papers and other sources of information. A complete administrative record of this consultation will be kept at the NMFS Northeast Regional Office. Formal consultation was initiated on February 17, 2009.

CONSULTATION HISTORY

Initial correspondence between the FHWA and NMFS on the proposed Scudders Falls Bridge Replacement Project began in 2003. In a letter dated February 24, 2004, NMFS responded to a letter requesting information on the presence of any species listed as threatened or endangered under NMFS jurisdiction in the project area. In this letter NMFS indicated that the federally endangered shortnose sturgeon (*Acipenser brevirostrum*) was known to spawn in the project area.

NMFS participated in an early coordination meeting and site visit in the summer of 2008. On October 6, 2008, NMFS received a BA from FHWA as well as a letter dated September 30, 2008 requesting the initiation of formal consultation. In a letter dated November 18, 2008, NMFS requested additional information on the scope of the proposed action as well as clarification on the roles of the Federal action agencies (i.e., FHWA and ACOE). Additional information was received on December 18, 2008 and February 17, 2009. As noted in the correspondence received on February 17, 2009, FHWA will be the lead Federal agency for purposes of Section 7 consultation.

On March 3, 2009, NMFS sent a letter to FHWA and ACOE indicating that all the information necessary to initiate consultation had been received. On May 21, 2009, the ACOE wrote a letter to FHWA indicating that as currently written, the ACOE had serious concerns with the Environmental Assessment (EA) prepared by the FHWA. Also in this letter ACOE indicated that they were not likely to approve the action as proposed. In response to concerns from ACOE and other State agencies, a meeting was held on July 17, 2009. At this meeting, in which NMFS participated by phone, the FHWA and the project sponsors proposed to modify the bridge construction project by using the temporary pile-supported trestle causeway construction methodology as opposed to the preferred alternative presented in the draft EA which would utilize earthen causeways. FHWA proposed to revise the draft EA and provide NMFS with a revised project description and revised BA.

On September 16, 2009, NMFS received supplemental information to the BA and a letter from FHWA describing the proposed modifications to the action. On September 29, 2009 NMFS received the revised draft EA. Also, on October 26, 2009, NMFS received confirmation from the ACOE that their concerns over the originally proposed causeway designs had been addressed by the applicant in the revised draft EA. The consultation period was extended to December 9, 2009 by mutual agreement of the FHWA, the ACOE and the applicants. A draft Biological Opinion was provided to the FHWA, the applicant, and the ACOE on November 25, 2009. Comments were received from FHWA on December 9, 2009 and comments from ACOE were received on December 14, 2009. A call was held between NMFS and FHWA on December 23, 2009 to discuss the comments. Additional information on the temporary and permanent habitat impacts and the likelihood of cofferdam overtopping was sent by FHWA and received by NMFS on March 23, 2010 and April 14, 2010. A subsequent revised draft Biological Opinion was provided to the FHWA, the applicant, and the ACOE on April 30, 2010 with comments received on May 4, 5, and 6, 2010. The consultation period was extended to June 15, 2010 by mutual agreement of the FHWA, the ACOE and the applicants.

DESCRIPTION OF THE PROPOSED ACTION

The I-95/Scudder Falls Bridge, which was constructed in 1959, carries Interstate 95 (I-95) over the Delaware River between Lower Makefield Township in Bucks County, Pennsylvania (PA) and Ewing Township, a suburb of Trenton, in Mercer County, New Jersey (NJ) (see Figure 1, Project Location Map). The Delaware River Joint Toll Bridge Commission (DRJTBC), in cooperation with the Federal Highway Administration (FHWA), the Pennsylvania Department of Transportation (PennDOT), and the New Jersey Department of Transportation (NJDOT), is proposing to replace the I-95/Scudder Falls Bridge which crosses over the Delaware River and to improve 4.4 miles of I-95 adjacent to the bridge. In addition to carrying out the proposed bridge replacement project in conjunction with the above mentioned transportation agencies, FHWA also has a role in authorizing the project. Additionally, Department of the Army authorizations pursuant to Section 10 of the Rivers and Harbors Act of 1899 (RHA) and Section 404 of the Clean Water Act (CWA) will be required from the Philadelphia District, US Army Corps of Engineers, to construct the project.

The applicant has applied for loan funds to be distributed through the US Department of

Transportation pursuant to the Transportation Infrastructure Finance and Innovation Act of 1998. A decision on funding will be made by the US DOT sometime in 2010.

As stated by FHWA, the purpose of the project is to alleviate recurring current and future traffic congestion and upgrade safety and traffic operational conditions on the I-95/Scudder Falls Bridge and adjoining highway segments in Pennsylvania and New Jersey. The project area extends 4.4 miles between the PA Route 332 (Newtown-Yardley Road) Interchange in Pennsylvania and the Bear Tavern Road (County Route 579) Interchange in New Jersey.

Roadway Improvements

From west to east, I-95 in the project area consists of two lanes in each direction between PA Route 332 and NJ Route 29 and three lanes in each direction east of NJ Route 29 to Bear Tavern Road. According to FHWA, this highway segment is operating over capacity during peak periods under existing conditions and is projected to operate well over capacity in 2030. FHWA has stated that the goal for the improvements in this segment of I-95 is to achieve a traffic level of service (LOS) of LOS D, considered to represent an acceptable traffic operating level in an urban environment, in the future year 2030. For this section of I-95, roadway improvements involve adding a travel lane in each direction for a total of three lanes in each direction, and providing adequate outside and inside shoulders in each direction. The existing 4 lane Scudder Falls Bridge will be demolished and replaced with a new 9 lane bridge. As proposed, the new bridge will include three travel lanes in each direction, two auxiliary lanes[1] in the northbound direction and one auxiliary lane in the southbound direction. The two auxiliary lanes are proposed to allow for safe merging of traffic getting on and off of I-95 from the interchanges at Taylorsville Road and NJ Route 29. Additional transitional engineering necessary to achieve the LOS D goal will be made along the approximately 1.5-mile section of I-95 extending east from NJ Route 29 to the Bear Tavern Road (County Route 579) Interchange.

The project also includes improvements to the Taylorsville Road Interchange in Pennsylvania and the NJ Route 29 Interchange in New Jersey to meet current highway and geometric design standards. Interchange improvements include reconfiguration, the addition/modification of acceleration and deceleration lanes and providing adequate spacing of ramp merges.

Bridge Design

Based on the preliminary design, the proposed new bridge is anticipated to be an eight span multigirder bridge supported on seven reinforced concrete hammerhead piers supported on spread footing foundations on rock (see Figure 2, Plan View). Of the seven piers, five will be directly founded within the river bed, and two will be upland of the Ordinary High Water (OHW) mark. The spread footings, estimated to be 20 ft wide by 160 ft long and 8 feet deep, will be topped with large rock (30 inch diameter nominal) for scour protection (see Figures 3 and 4). An alternative foundation system which may be employed would consist of drilled shafts foundations rather than spread footing foundations. This would entail multiple, equally-spaced six foot drilled shafts supporting a pile cap. The drilled shaft option is generally utilized in areas where spread footings do not provide adequate strength for the bridge. The pier stems for both

1 An auxiliary lane is defined as the portion of the roadway adjoining the traveled way for purposes supplementary to through-traffic movement such as speed change, weaving, and positioning drivers for entry or exit.

options would be similar and the drilled shaft option also would require scour protection similar to that for the spread footings. Details on the construction of the new bridge and demolition of the existing bridge are provided below.

Pre-Construction Surveys

During the final design phase, approximately ten soil borings (two per river pier) will be taken from the river bed to help determine the capacity of the river bottom to support either spread footings or drilled shafts for the piers. The boring operation will be performed outside of the March 15 – June 30 moratorium period and will consist of 4-inch diameter augers drilled to about 50 feet into the river beds to assess the material types. The soil boring operations will be performed from small portable work platforms in the river.

Construction of the New Bridge and Demolition of the Existing Bridge

This project will require two primary phases to construct the new bridge and demolish the existing; the first phase would construct the upstream, or northern side of the bridge while the second phase would demolish the existing bridge and construct the downstream, or southern side of the bridge. Based on the length of the structure, and type of construction, it is anticipated that a three to four year construction period will be required.

Construction of Cofferdams

To allow construction of the new bridge piers and demolition of the existing bridge piers to occur in the dry, cofferdams will be erected at the location of each new bridge pier and around each existing bridge pier. In total, five cofferdams will be installed to allow construction of the five new in-water bridge piers and six cofferdams will be installed surrounding each of the six existing in-water bridge piers. The cofferdams will be in use for several months each. It will take approximately four months to build the foundations and the piers. Each cofferdam will require approximately three to four weeks to construct; all installation and removal of cofferdams will occur outside of the March 15 – June 30 time period.

Cofferdams will be constructed of steel sheeting supported by lateral supports. The sheeting will be vibrated in to reduce noise when the substrate permits. The interlocking sheet piles are designed to provide a water tight working enclosure for the construction activities. There will be small amounts of groundwater leakage which will be evacuated with a sump pump so that construction can be conducted in dry conditions. Groundwater that may seep into the cofferdams will be de-watered through pumps and hoses. The hoses will outlet into sediment filter bags and traps before re-entering the river environment.

The cofferdams constructed for the new bridge piers (five) will encompass an area of about two feet wider, all around, than the size of the footing to allow for formwork, for a cofferdam area of about 26 feet x 166 feet per pier, for a total area of 21,580 square feet of temporary impact. Cofferdams constructed for existing pier removal (six) will be approximately 15 feet by 70 feet in size per pier, for a total area of 6,300 square feet of temporary impact.

Construction of Temporary Causeways
FHWA has stated that due to the narrow width of the existing bridge it is not possible to stage construction or demolition equipment on the existing bridge. Additionally, due to the shallow depths in the Delaware River at the project site, it is not possible to stage equipment from barges. The FHWA has proposed to construct temporary trestle causeways of a driven pile design. These causeways will extend from the shoreline to approximately the mid-point of the river and all access to the cofferdam work areas will occur from these causeways. While a total of four causeways will be needed, only one causeway will be in place at any time. All construction and removal of the causeways will occur outside of the March 15 – June 30 time period.

Construction of the new bridge will occur in phases. Once the deck is completed for the northern (upstream) side of the bridge, traffic will be shifted to the new bridge and the existing bridge will be demolished. Subsequently, construction of the southern side of the bridge will be completed. Once the erosion and sedimentation (E&S) measures are installed and traffic control established, the first causeway stage can be constructed. All causeways will be a driven pile bent design (see below). The causeway and cofferdams will be constructed outside of the March 15 – June 30 moratorium period.

As noted above, construction access within the Delaware River will be provided by use of four temporary causeways (two stages for each primary construction phase). Each causeway segment would extend across half of the river at a time, extending approximately 500 to 600 feet from either the Pennsylvania or New Jersey shore. Construction of the temporary trestle causeway will involve construction of short spans of approximately 25 feet with pile bents (row of piles connected by pile caps at top to support a load) and progressive construction from shoreline. The four stages of causeway construction are as follows (see also Figure 3 in Appendix A):

- Stage I would extend 550 feet along the upstream side of the bridge and across Park Island from the Pennsylvania side.
- Stage II would extend approximately 500 feet along the upstream side of the bridge from the New Jersey side.
- Stage III would extend approximately 600 feet along the downstream side of the bridge and across Park Island from the Pennsylvania side.
- Stage IV would extend approximately 500 feet along the downstream side of the bridge from the New Jersey side.

Approximately 22 to 36 pile bents would be required for each causeway stage. Each pile bent would be driven into the river bottom, and would disturb approximately 10 square feet of river bottom. The 22 to 36 bents Installed for each causeway stage correspond to approximately 210 to 340 square feet of river bottom disturbance at any one time. Upon removal of each trestle causeway stage, the bents would be removed to a depth of 3 feet below the river bottom, and the river bottom will be restored to its pre-construction condition.

Each causeway segment would have a working width of approximately 30 feet. In order to access each proposed bridge pier location, perpendicular extensions (causeway fingers) from the main causeway would be used. The causeway fingers also would be used to access the existing piers for demolition, in cases where the proposed piers do not overlap with the existing piers.

Construction of the trestle fingers to reach the bridge pier location will be accomplished from the completed trestle spans.

Bridge Construction

FHWA has identified the following activities that will be involved in construction of the Northern (upstream) portion of the new bridge:

- Install traffic control measures along I-95 for Phase 1. Maintain traffic flow along the existing bridge.
- Install erosion and sedimentation control measures in river and on land.
- Erect temporary causeway (Stages I and II) for construction of the new bridge from the causeway.
- Construct bridge piers from the causeway by dewatering pier area using cofferdam method.
- Remove cofferdam and stabilize river area in the vicinity of the newly constructed piers.
- Erect bridge superstructure (beams below the concrete deck) from causeway.
- Remove causeway, stabilize river area and restore to pre-construction condition.
- Complete bridge deck, paving, and finish work from the newly constructed bridge.
- Remove traffic control measures for Phase 1.

FHWA has identified the following activities that will be involved in construction of the Southern (downstream) portion of the new bridge and demolition of the existing bridge:

- Install traffic control measures along I-95 for Phase 2. Maintain traffic flow along the existing bridge.
- Maintain erosion and sedimentation control measures in river and on land.
- Erect temporary causeway (Stages III and IV) for demolition of the existing bridge and construction of the new bridge from the causeway.
- Begin demolition of existing bridge from the causeway and transport unsuitable material to an approved offsite location.
- Construct bridge piers from the causeway by dewatering pier area using cofferdam method.
- Remove cofferdam and stabilize river area in the vicinity of the newly constructed piers.
- Erect bridge superstructure (beams below the concrete deck) from causeway.
- Complete bridge deck, paving, and finish work from the newly constructed bridge.
- Remove traffic control measures for Phase 2.

Access to each causeway from land would be via temporary access roads from PA Route 32 (River Road) on the Pennsylvania side of the river, and from NJ Route 29 on the New Jersey side of the river. The construction sequence of the trestle would be as follows:

- Construct the access roadway to reach the river shoreline,
- Construct a temporary abutment for the first span of the trestle,
- Drive the piles for the first trestle bent and install bent cap,
- Erect the beams and construct the deck for first span,
- Move pile driving equipment to the constructed first span,

- Drive the pile for second trestle bent and install cap,
- Erect beams and construct the deck for second span,
- Move pile driving equipment to second span and continue as before until the appropriate length of the trestle is completed.

The new bridge construction will be constructed from the causeway and causeway fingers. FHWA anticipates that once the causeways and cofferdams are completed, all work can be accomplished throughout the year from the causeway, inside the cofferdams, and from the partially constructed bridge. For example, once the cofferdams are constructed, all pier construction can be accomplished inside the cofferdams and from the causeway. The steel erection for the bridge superstructure will be performed by delivering the beams via the existing I -95 bridge with the cranes placed on the causeway. Once the steel beams are erected, the remaining portions of the bridge, such as the deck, can be constructed from the new structure.

Demolition of Existing Bridge
Demolition of the existing bridge piers also will be accomplished from the causeway and causeway fingers. It is anticipated that the existing bridge will be demolished using various methods. As a first step, timber shielding will be placed between the existing girders, beams, and the edges to protect the workers and prevent debris from falling into the river.

The bridge deck will then be removed by saw cutting the concrete into manageable pieces for loading onto dump trucks. The deck will be removed from the existing bridge in a retreating manner. The beams and girders will be cut into pieces and loaded onto trucks with cranes placed on the existing bridge and on the causeway. The steel will be trucked off to a recycling center.

As noted above, demolition of the existing piers will occur within cofferdams. The existing piers are clad with stones with a reinforced concrete core. The stones will be removed first. The concrete core will then be demolished by hydraulic ram equipment, which creates a pulsing sensation that causes the existing concrete to crumble. The larger sections will be broken into smaller pieces and perhaps recycled onsite for use by the contractor for embankment and/or backfill material. The existing pier stems will be removed to a depth of two to three feet below the river bed elevation.

Removal of Cofferdams and Temporary Causeways
Once the piers have been constructed and the steel beams have been erected, the cofferdams will be removed either by pulling the sheets out of the river bed or by removing the portion of the sheets above the river bed. The causeway can then be removed in a retreating manner. As noted above, all causeway and cofferdam removal will occur outside of the March 15 – June 30 time frame.

In two of the stages, the causeway will also be used for part of the demolition of the existing bridge.

Spill Prevention
During final design, a Spill Prevention, Control and Countermeasure Plan (SPCP) will be developed to prevent spills from entering the river during construction. Additionally, an SPCP will be prepared to address spills from vehicles using the bridge when construction is completed. A variety of construction equipment is anticipated to be used in the construction of the bridge foundations, including but not limited to bulldozers, pile drivers, augers for possible drilled shaft construction, excavators, cranes, dump trucks, hydraulic rams, and de-watering pumps and hoses.

Stormwater Runoff
An Erosion and Sedimentation Control Plan (E&S) will be prepared for the project outlining Best Management Practices to be implemented during and after construction. A combination of stone and grass lined ditches will flank the majority of the mainline in PA to promote water quality and infiltration. Sediment basins are proposed for the interchange infield areas in both states, and will be converted to permanent bio-retention facilities to control additional stormwater runoff generated by the project. Straw bales will prevent sedimentation from entering the existing and proposed stormwater collection system along the mainline in NJ, and anywhere inlets may collect construction runoff.

Stormwater runoff will also occur from the new bridge. The bridge deck section within the center third of the river will capture runoff and outlet through downspouts to the river below. The runoff from the outer thirds of the deck area of the bridge will be captured by scuppers on the bridge and piped back to the abutments where they will be connected to existing stormwater facilities off the bridge.

Freshwater Mussel Relocation
A survey of the freshwater mussels present in the study area was conducted in October 2004. The objective of the mussel survey was to determine if the tidewater mucket (*Leptodea ochracae*) and the yellow lampmussel (*Lampsilis cariosa*) are present in the bridge's immediate vicinity. Of the two target species, no live tidewater mucket or spent shell of this species were encountered. However, 64 live yellow lampmussel, the second target species, were found. Mussels were widely distributed, with individuals found in nearly every search area. A mussel mitigation plan will be further developed in conjunction with New Jersey DEP, Division of Fish and Wildlife. Mitigation options under consideration include pre-construction surveys, relocation to an upstream reach, collection of additional species survey data, or habitat enhancement. Mussel relocation efforts will be proposed to occur after June 30.

Special Permit Conditions
The following measures are being proposed by the applicants and will be incorporated into the project to minimize effects on aquatic resources in the Delaware River:

- In-river construction and removal of the four causeways and cofferdams will be scheduled outside the period March 15 through June 30.
- The steel sheeting that will be used to construct the cofferdams will be vibrated into the river bottom where physical conditions allow. Otherwise, it must be driven.
- Five cofferdams will allow construction of the new bridge piers "in the dry". Similarly, six cofferdams will allow demolition of the existing bridge piers "in the dry".

- Turbidity barriers and other erosion/sedimentation controls will reduce in-river sedimentation.
- Water quality will be monitored downstream of the causeways and cofferdams during their construction and removal to measure sedimentation.
- Some scuppers will be eliminated in construction of the new bridge, with the majority of the stormwater directed to land-based passive treatment.
- An SPCP will be developed to prevent spills from entering the river during construction.
- Additionally, an SPCP will be prepared to address spills from vehicles using the bridge when construction is completed.
- The riverbed in the project area will be monitored to ensure timely removal of all construction debris.

Action Area
The action area is defined in 50 CFR 402.02 as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." The action area for this consultation includes the area affected by the proposed bridge construction project, including the underwater area where sound and turbidity will be elevated above background levels due to associated construction. The action area, therefore, includes the 4.4 miles of I-95 where improvements will take place as well as the area within the Delaware River located within 1km reach of river on either side of the proposed bridge (approximately rkm 222.5-224.5).

STATUS OF AFFECTED SPECIES
NMFS has determined that the action being considered in this biological opinion may affect the following endangered or threatened species under NMFS' jurisdiction:

Fish
Shortnose sturgeon (*Acipenser brevirostrum*) Endangered

This section will focus on the status of the various species within the action area, summarizing information necessary to establish the environmental baseline and to assess the effects of the proposed action.

Shortnose Sturgeon
Shortnose sturgeon are listed throughout their range. As such, the status of the species as a whole will be discussed below. Additionally, information specific to the Delaware River population of shortnose sturgeon, which occurs in the action area, will be discussed in more detail.

Shortnose sturgeon life history
Shortnose sturgeon are benthic fish that mainly occupy the deep channel sections of large rivers. They feed on a variety of benthic and epibenthic invertebrates including mollusks, crustaceans (amphipods, chironomids, isopods), and oligochaete worms (Vladykov and Greeley 1963; Dadswell 1979 *in* NMFS 1998). Shortnose sturgeon have similar lengths at maturity (45-55 cm fork length) throughout their range, but, because sturgeon in southern rivers grow faster than those in northern rivers, southern sturgeon mature at younger ages (Dadswell et al. 1984).

Shortnose sturgeon are long-lived (30-40 years) and, particularly in the northern extent of their range, mature at late ages. In the north, males reach maturity at 5 to 10 years, while females mature between 7 and 13 years. Based on limited data, females spawn every three to five years while males spawn approximately every two years. The spawning period is estimated to last from a few days to several weeks. Spawning begins from late winter/early spring (southern rivers) to mid to late spring (northern rivers)[2] when the freshwater temperatures increase to 8-9ºC. Several published reports have presented the problems facing long-lived species that delay sexual maturity (Crouse et al. 1987; Crowder et al. 1994; Crouse 1999). In general, these reports concluded that animals that delay sexual maturity and reproduction must have high annual survival as juveniles through adults to ensure that enough juveniles survive to reproductive maturity and then reproduce enough times to maintain stable population sizes.

Total instantaneous mortality rates (Z) are available for the Saint John River (0.12 - 0.15; ages 14-55; Dadswell 1979), Upper Connecticut River (0.12; Taubert 1980b), and Pee Dee-Winyah River (0.08-0.12; Dadswell et al. 1984). Total instantaneous natural mortality (M) for shortnose sturgeon in the lower Connecticut River was estimated to be 0.13 (T. Savoy, Connecticut Department of Environmental Protection, personal communication). There is no recruitment information available for shortnose sturgeon because there are no commercial fisheries for the species. Estimates of annual egg production for this species are difficult to calculate because females do not spawn every year (Dadswell et al. 1984). Further, females may abort spawning attempts, possibly due to interrupted migrations or unsuitable environmental conditions (NMFS 1998). Thus, annual egg production is likely to vary greatly in this species. Fecundity estimates have been made and range from 27,000 to 208,000 eggs/female (Dadswell et al. 1984).

At hatching, shortnose sturgeon are blackish-colored, 7-11mm long and resemble tadpoles (Buckley and Kynard 1981). In 9-12 days, the yolk sac is absorbed and the sturgeon develops into larvae which are about 15mm total length (TL; Buckley and Kynard 1981). Sturgeon larvae are believed to begin downstream migrations at about 20mm TL. Laboratory studies suggest that young sturgeon move downstream in a 2-step migration; a 2 to 3-day migration by larvae followed by a residency period by young of the year (YOY), then a resumption of migration by yearlings in the second summer of life (Kynard 1997). Juvenile shortnose sturgeon (3-10 years old) reside in the interface between saltwater and freshwater in most rivers (NMFS 1998).

In populations that have free access to the total length of a river (e.g., no dams within the species' range in a river: Saint John, Kennebec, Altamaha, Savannah, Delaware and Merrimack Rivers), spawning areas are located at the farthest upstream reach of the river (NMFS 1998). In the northern extent of their range, shortnose sturgeon exhibit three distinct movement patterns. These migratory movements are associated with spawning, feeding, and overwintering activities. In spring, as water temperatures rise above 8ºC, pre-spawning shortnose sturgeon move from overwintering grounds to spawning areas. Spawning occurs from mid/late March to mid/late May depending upon location and water temperature. Sturgeon spawn in upper, freshwater areas and feed and overwinter in both fresh and saline habitats. Shortnose sturgeon spawning migrations are characterized by rapid, directed and often extensive upstream movement (NMFS

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2 For purposes of this consultation, Northern rivers are considered to include tributaries of the Chesapeake Bay northward to the St. John River in Canada. Southern rivers are those south of the Chesapeake Bay.

1998).

Shortnose sturgeon are believed to spawn at discrete sites within their natal river (Kieffer and Kynard 1996). In the Merrimack River, males returned to only one reach during a four year telemetry study (Kieffer and Kynard 1996). Squires (1982) found that during the three years of the study in the Androscoggin River, adults returned to a 1-km reach below the Brunswick Dam and Kieffer and Kynard (1996) found that adults spawned within a 2-km reach in the Connecticut River for three consecutive years. Spawning occurs over channel habitats containing gravel, rubble, or rock-cobble substrates (Dadswell et al. 1984; NMFS 1998). Additional environmental conditions associated with spawning activity include decreasing river discharge following the peak spring freshet, water temperatures ranging from 8 - 12º , and bottom water velocities of 0.4 to 0.7 m/sec (Dadswell et al. 1984; NMFS 1998). For northern shortnose sturgeon, the temperature range for spawning is 6.5-18.0ºC (Kieffer and Kynard in press). Eggs are separate when spawned but become adhesive within approximately 20 minutes of fertilization (Dadswell et al. 1984). Between 8° and 12°C, eggs generally hatch after approximately 13 days. The larvae are photonegative, remaining on the bottom for several days. Buckley and Kynard (1981) found week old larvae to be photonegative and form aggregations with other larvae in concealment.

Adult shortnose sturgeon typically leave the spawning grounds soon after spawning. Non-spawning movements include rapid, directed post-spawning movements to downstream feeding areas in spring and localized, wandering movements in summer and winter (Dadswell et al. 1984; Buckley and Kynard 1985; O'Herron et al. 1993). Kieffer and Kynard (1993) reported that post-spawning migrations were correlated with increasing spring water temperature and river discharge. Young-of-the-year shortnose sturgeon are believed to move downstream after hatching (Dovel 1981) but remain within freshwater habitats. Older juveniles tend to move downstream in fall and winter as water temperatures decline and the salt wedge recedes. Juveniles move upstream in spring and feed mostly in freshwater reaches during summer.

Juvenile shortnose sturgeon generally move upstream in spring and summer and move back downstream in fall and winter; however, these movements usually occur in the region above the saltwater/freshwater interface (Dadswell et al. 1984; Hall et al. 1991). Non-spawning movements include wandering movements in summer and winter (Dadswell et al. 1984; Buckley and Kynard 1985; O'Herron et al. 1993). Kieffer and Kynard (1993) reported that post-spawning migrations were correlated with increasing spring water temperature and river discharge. Adult sturgeon occurring in freshwater or freshwater/tidal reaches of rivers in summer and winter often occupy only a few short reaches of the total length (Buckley and Kynard 1985). Summer concentration areas in southern rivers are cool, deep, thermal refugia, where adult and juvenile shortnose sturgeon congregate (Flourney et al. 1992; Rogers and Weber 1994; Rogers and Weber 1995; Weber 1996). While shortnose sturgeon are occasionally collected near the mouths of rivers and often spend time in estuaries, they are not known to participate in coastal migrations and are rarely documented in their non-natal river.

The temperature preference for shortnose sturgeon is not known (Dadswell et al. 1984) but shortnose sturgeon have been found in waters with temperatures as low as 2 to 3ºC (Dadswell et al. 1984) and as high as 34ºC (Heidt and Gilbert 1978). However, temperatures above 28ºC are thought to adversely affect shortnose sturgeon. In the Altamaha River, temperatures of 28-30ºC during summer months create unsuitable conditions and shortnose sturgeon are found in deep cool water refuges.

Shortnose sturgeon are known to occur at a wide range of depths. A minimum depth of 0.6m is necessary for the unimpeded swimming by adults. Shortnose sturgeon are known to occur at depths of up to 30m but are generally found in waters less than 20m (Dadswell et al. 1984; Dadswell 1979). Shortnose sturgeon have also demonstrated tolerance to a wide range of salinities. Shortnose sturgeon have been documented in freshwater (Taubert 1980; Taubert and Dadswell 1980) and in waters with salinity of 30 parts-per-thousand (ppt) (Holland and Yeverton 1973; Saunders and Smith 1978). Mcleave et al. (1977) reported adults moving freely through a wide range of salinities, crossing waters with differences of up to 10ppt within a two hour period. The tolerance of shortnose sturgeon to increasing salinity is thought to increase with age (Kynard 1996). Shortnose sturgeon typically occur in the deepest parts of rivers or estuaries where suitable oxygen and salinity values are present (Gilbert 1989).

Status and Trends of Shortnose Sturgeon Rangewide

Shortnose sturgeon were listed as endangered on March 11, 1967 (32 FR 4001), and the species remained on the endangered species list with the enactment of the ESA in 1973. Although the original listing notice did not cite reasons for listing the species, a 1973 Resource Publication, issued by the US Department of the Interior, stated that shortnose sturgeon were "in peril…gone in most of the rivers of its former range [but] probably not as yet extinct" (USDOI 1973). Pollution and overfishing, including bycatch in the shad fishery, were listed as principal reasons for the species' decline. In the late nineteenth and early twentieth centuries, shortnose sturgeon commonly were taken in a commercial fishery for the closely related and commercially valuable Atlantic sturgeon (*Acipenser oxyrinchus*). More than a century of extensive fishing for sturgeon contributed to the decline of shortnose sturgeon along the east coast. Heavy industrial development during the twentieth century in rivers inhabited by sturgeon impaired water quality and impeded these species' recovery, possibly resulting in substantially reduced abundance of shortnose sturgeon populations within portions of the species' ranges (e.g., southernmost rivers of the species range: Santilla, St. Marys and St. Johns Rivers). A shortnose sturgeon recovery plan was published in December 1998 to promote the conservation and recovery of the species (see NMFS 1998). Shortnose sturgeon are listed as "vulnerable" on the IUCN Red List.

Although shortnose sturgeon are listed as endangered range-wide, in the 1998 recovery plan for this species, NMFS recognized 19 separate populations occurring throughout the range of the species. These populations are in New Brunswick Canada (1); Maine (2); Massachusetts (1); Connecticut (1); New York (1); New Jersey/Delaware (1); Maryland and Virginia (1); North Carolina (1); South Carolina (4); Georgia (4); and Florida (2). NMFS has not formally recognized distinct population segments (DPS)[3] of shortnose sturgeon under the ESA. Although

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3 The definition of species under the ESA includes any subspecies of fish, wildlife, or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature. To be considered a DPS, a population segment must meet two criteria under NMFS policy. First, it must be discrete, or separated, from other populations of its species or subspecies. Second, it must be significant, or essential, to the long-term conservation status of its species or subspecies. This formal legal procedure to designate DPSs for shortnose sturgeon has not been undertaken.

genetic information within and among shortnose sturgeon occurring in different river systems is largely unknown, life history studies indicate that shortnose sturgeon populations from different river systems are substantially reproductively isolated (Kynard 1997) and, therefore, should be considered discrete. The 1998 Recovery Plan indicates that while genetic information may reveal that interbreeding does not occur between rivers that drain into a common estuary, at this time, such river systems are considered a single population compromised of breeding subpopulations (NMFS 1998). A status review for this species is currently ongoing and no report is currently available.

Studies conducted since the issuance of the 1988 Recovery Plan have provided evidence that suggests that years of isolation between populations of shortnose sturgeon have led to morphological and genetic variation. Walsh et al. (2001) examined morphological and genetic variation of shortnose sturgeon in three rivers (Kennebec, Androscoggin, and Hudson). The study found that the Hudson River shortnose sturgeon population differed markedly from the other two rivers for most morphological features (total length, fork length, head and snout length, mouth width, interorbital width and dorsal scute count, left lateral scute count, right ventral scute count). Significant differences were found between fish from Androscoggin and Kennebec rivers for interorbital width and lateral scute counts which suggests that even though the Androscoggin and Kennebec rivers drain into a common estuary, these rivers support largely discrete populations of shortnose sturgeon. The study also found significant genetic differences among all three populations indicating substantial reproductive isolation among them and that the observed morphological differences may be partly or wholly genetic.

Grunwald et al. (2002) examined mitochondrial DNA (mtDNA) from shortnose sturgeon in eleven river populations. The analysis demonstrated that all shortnose sturgeon populations examined showed moderate to high levels of genetic diversity as measured by haplotypic diversity indices. The limited sharing of haplotypes and the high number of private haplotypes are indicative of high homing fidelity and low gene flow. The researchers determined that glaciation in the Pleistocene Era was likely the most significant factor in shaping the phylogeographic pattern of mtDNA diversity and population structure of shortnose sturgeon. The Northern glaciated region extended south to the Hudson River while the southern non-glaciated region begins with the Delaware River. There is a high prevalence of haplotypes restricted to either of these two regions and relatively few are shared; this represents a historical subdivision that is tied to an important geological phenomenon that reflects historical isolation. Analyses of haplotype frequencies at the level of individual rivers showed significant differences among all systems in which reproduction is known to occur. This implies that although higher level genetic stock relationships exist (i.e., southern vs. northern and other regional subdivisions), shortnose sturgeon appear to be discrete stocks, and low gene flow exists between the majority of populations.

Waldman et al. (2002) also conducted mtDNA analysis on shortnose sturgeon from 11 river systems and identified 29 haplotypes. Of these haplotypes, 11 were unique to northern, glaciated systems and 13 were unique to the southern non-glaciated systems. Only 5 were shared between them. This analysis suggests that shortnose sturgeon show high structuring and discreteness and that low gene flow rates indicated strong homing fidelity.

Wirgin et al. (2005), also conducted mtDNA analysis on shortnose sturgeon from 12 rivers (St. John, Kennebec, Androscoggin, Upper Connecticut, Lower Connecticut, Hudson, Delaware, Chesapeake Bay, Cooper, Peedee, Savannah, Ogeechee and Altamaha). This analysis suggested that most population segments are independent and that genetic variation among groups was high.

The best available information demonstrates differences in life history and habitat preferences between northern and southern river systems and given the species' anadromous breeding habits, the rare occurrence of migration between river systems, and the documented genetic differences between river populations, it is unlikely that populations in adjacent river systems interbreed with any regularity. This likely accounts for the failure of shortnose sturgeon to repopulate river systems from which they have been extirpated, despite the geographic closeness of persisting populations. This characteristic of shortnose sturgeon also complicates recovery and persistence of this species in the future because, if a river population is extirpated in the future, it is unlikely that this river will be recolonized. Consequently, this Opinion will treat the nineteen separate populations of shortnose sturgeon as subpopulations (one of which occurs in the action area) for the purposes of this analysis.

Historically, shortnose sturgeon are believed to have inhabited nearly all major rivers and estuaries along nearly the entire east coast of North America. The range extended from the St John River in New Brunswick, Canada to the Indian River in Florida. Today, only 19 populations remain ranging from the St. Johns River, Florida (possibly extirpated from this system) to the Saint John River in New Brunswick, Canada. Shortnose sturgeon are large, long lived fish species. The present range of shortnose sturgeon is disjunct, with northern populations separated from southern populations by a distance of about 400 km. The species is anadromous in the southern portion of its range (i.e., south of Chesapeake Bay), while northern populations are amphidromous (NMFS 1998). Population sizes vary across the species' range. From available estimates, the smallest populations occur in the Cape Fear (~8 adults; Moser and Ross 1995) and Merrimack Rivers (~100 adults; M. Kieffer, United States Geological Survey, personal communication), while the largest populations are found in the Saint John (~100,000; Dadswell 1979) and Hudson Rivers (~61,000; Bain et al. 1998). As indicated in Kynard 1996, adult abundance is less than the minimum estimated viable population abundance of 1000 adults for 5 of 11 surveyed northern populations and all natural southern populations. Kynard 1996 indicates that all aspects of the species' life history indicate that shortnose sturgeon should be abundant in most rivers. As such, the expected abundance of adults in northern and north-central populations should be thousands to tens of thousands of adults. Expected abundance in southern rivers is uncertain, but large rivers should likely have thousands of adults. The only river systems likely supporting populations of these sizes are the St John, Hudson and possibly the Delaware and the Kennebec, making the continued success of shortnose sturgeon in these rivers critical to the species as a whole. While no reliable estimate of the size of either the total species or the shortnose sturgeon population in the Northeastern United States exists, it is clearly below the size that could be supported if the threats to shortnose sturgeon were removed.

Threats to shortnose sturgeon recovery

The Shortnose Sturgeon Recovery Plan (NMFS 1998) identifies habitat degradation or loss (resulting, for example, from dams, bridge construction, channel dredging, and pollutant discharges) and mortality (resulting, for example, from impingement on cooling water intake screens, dredging and incidental capture in other fisheries) as principal threats to the species' survival.

Several natural and anthropogenic factors continue to threaten the recovery of shortnose sturgeon. Shortnose sturgeon continue to be taken incidentally in fisheries along the east coast and are probably targeted by poachers throughout their range (Dadswell 1979; Dovel et al. 1992; Collins et al. 1996). Bridge construction and demolition projects may interfere with normal shortnose sturgeon migratory movements and disturb sturgeon concentration areas. Unless appropriate precautions are made, internal damage and/or death may result from blasting projects with powerful explosives. Hydroelectric dams may affect shortnose sturgeon by restricting habitat, altering river flows or temperatures necessary for successful spawning and/or migration and causing mortalities to fish that become entrained in turbines.

Hydraulic dredges can cause sturgeon mortalities by entraining sturgeon in dredge dragarms and impeller pumps. Mechanical dredges have also been documented to capture shortnose sturgeon. Dredging operations may also impact shortnose sturgeon by destroying benthic feeding areas, disrupting spawning migrations, and filling spawning habitat with resuspended fine sediments. Shortnose sturgeon are susceptible to impingement on cooling water intake screens at power plants. Electric power and nuclear power generating plants can affect sturgeon by impinging larger fish on cooling water intake screens and entraining larval fish. The operation of power plants can have unforeseen and extremely detrimental impacts to water quality which can affect shortnose sturgeon. For example, the St. Stephen Power Plant near Lake Moultrie, South Carolina was shut down for several days in June 1991 when large mats of aquatic plants entered the plant's intake canal and clogged the cooling water intake gates. Decomposing plant material in the tailrace canal coupled with the turbine shut down (allowing no flow of water) triggered a low dissolved oxygen water condition downstream and a subsequent fish kill. The South Carolina Wildlife and Marine Resources Department reported that twenty shortnose sturgeon were killed during this low dissolved oxygen event.

Contaminants, including toxic metals, polychlorinated aromatic hydrocarbons (PAHs), pesticides, and polychlorinated biphenyls (PCBs) can have substantial deleterious effects on aquatic life including production of acute lesions, growth retardation, and reproductive impairment (Cooper 1989; Sinderman 1994). Ultimately, toxins introduced to the water column become associated with the benthos and can be particularly harmful to benthic organisms (Varanasi 1992) like sturgeon. Heavy metals and organochlorine compounds are known to accumulate in fat tissues of sturgeon, but their long term effects are not yet known (Ruelle and Henry 1992; Ruelle and Kennlyne 1993). Available data suggests that early life stages of fish are more susceptible to environmental and pollutant stress than older life stages (Rosenthal and Alderdice 1976).

Although there is scant information available on the levels of contaminants in shortnose sturgeon tissues, some research on other related species indicates that concern about the effects of contaminants on the health of sturgeon populations is warranted. Detectible levels of chlordane, DDE (1,1-dichloro-2, 2-bis(p-chlorophenyl)ethylene), DDT (dichlorodiphenyl-trichloroethane), and dieldrin, and elevated levels of PCBs, cadmium, mercury, and selenium were found in pallid sturgeon tissue from the Missouri River (Ruelle and Henry 1994). These compounds were found in high enough levels to suggest they may be causing reproductive failure and/or increased physiological stress (Ruelle and Henry 1994). In addition to compiling data on contaminant levels, Ruelle and Henry also determined that heavy metals and organochlorine compounds (i.e. PCBs) accumulate in fat tissues. Although the long term effects of the accumulation of contaminants in fat tissues is not yet known, some speculate that lipophilic toxins could be transferred to eggs and potentially inhibit egg viability. In other fish species, reproductive impairment, reduced egg viability, and reduced survival of larval fish are associated with elevated levels of environmental contaminants including chlorinated hydrocarbons. A strong correlation that has been made between fish weight, fish fork length, and DDE concentration in pallid sturgeon livers indicates that DDE increases proportionally with fish size (NMFS 1998).

Contaminant analysis was conducted on two shortnose sturgeon from the Delaware River in the fall of 2002. Muscle, liver, and gonad tissue were analyzed for contaminants (ERC 2002). Sixteen metals, two semivolatile compounds, three organochlorine pesticides, one PCB Aroclor, as well as polychlorinated dibenzo-p-dioxins (PCDDs), and polychlorinated dibenzofurans (PCDFs) were detected in one or more of the tissue samples. Levels of aluminum, cadmium, PCDDs, PCDFs, PCBs, DDE (an organochlorine pesticide) were detected in the “adverse affect” range. It is of particular concern that of the above chemicals, PCDDs, DDE, PCBs and cadmium, were detected as these have been identified as endocrine disrupting chemicals. Contaminant analysis conducted in 2003 of tissues from a shortnose sturgeon from the Kennebec River revealed the presence of fourteen metals, one semivolatile compound, one PCB Aroclor, Polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) in one or more of the tissue samples. Of these chemicals, cadmium and zinc were detected at concentrations above an adverse effect concentration reported for fish in the literature (ERC 2003). While no directed studies of chemical contamination in shortnose sturgeon have been undertaken, it is evident that the heavy industrialization of the rivers where shortnose sturgeon are found is likely adversely affecting this species.

During summer months, especially in southern areas, shortnose sturgeon must cope with the physiological stress of water temperatures that may exceed 28ºC. Flourney et al.(1992) suspected that, during these periods, shortnose sturgeon congregate in river regions which support conditions that relieve physiological stress (i.e., in cool deep thermal refuges). In southern rivers where sturgeon movements have been tracked, sturgeon refrain from moving during warm water conditions and are often captured at release locations during these periods (Flourney et al.1992; Rogers and Weber 1994; Weber 1996). The loss and/or manipulation of these discrete refuge habitats may limit or be limiting population survival, especially in southern river systems.

Pulp mill, silvicultural, agricultural, and sewer discharges, as well as a combination of non-point source discharges, which contain elevated temperatures or high biological demand, can reduce dissolved oxygen levels. Shortnose sturgeon are known to be adversely affected by dissolved oxygen levels below 5 mg/L. Shortnose sturgeon may be less tolerant of low dissolved oxygen levels in high ambient water temperatures and show signs of stress in water temperatures higher than 28ºC (Flourney et al. 1992). At these temperatures, concomitant low levels of dissolved oxygen may be lethal.

Status and Distribution of Shortnose Sturgeon in the Delaware River

Shortnose sturgeon occur in the Delaware River from the lower bay upstream to at least Lambertville, New Jersey (river mile 148). Tagging studies by O'Herron et al. (1993) found that the most heavily used portion of the river appears to be between river mile 118 below Burlington Island and river mile 137 at the Trenton Rapids. Hastings et al. (1987) used Floy T-anchor tags in a tag-and-recapture experiment from 1981 to 1984 to estimate the size of the Delaware River population in the Trenton to Florence reach. Population sizes by three estimation procedures ranged from 6,408 to 14,080 adult sturgeon. These estimates compare favorably with those based upon similar methods in similar river systems. This is the best available information on population size, but because the recruitment and migration rates between the population segment studied and the total population in the river are unknown, model assumptions may have been violated.

In the Delaware River, movement to the spawning grounds occurs in early spring, typically in late March[4], with spawning occurring through the end of April. Movement to the spawning areas is triggered in part by water temperature and fish typically arrive at the spawning locations when water temperatures are between 8-9ºC with most spawning occurring when water temperatures are between 10 and 15ºC. Until recently, actual spawning (i.e., fertilized eggs or larvae) had not been documented in this area; however, the concentrated use of the Scudders Falls region in the spring by large numbers of mature male and female shortnose sturgeon indicated that this is the major spawning area (O'Herron et al. 1993). The same area was identified as a likely spawning area based on the collection of two ripe females in the spring of 1965 (Hoff 1965). The capture of early life stages (eggs and larvae) in this region in the spring of 2008 confirms that this area of the river is used for spawning and as a nursery area (ERC 2009). During the spawning period, males remain on the spawning grounds for approximately a week while females only stay for a few days (O'Herron and Hastings 1985). After spawning, which typically ceases by the time water temperatures reach 15ºC (although sturgeon have been reported on the spawning grounds at water temperatures as high as 18ºC), shortnose sturgeon move rapidly downstream to the Philadelphia area.

Shortnose sturgeon eggs generally hatch after approximately 9-12 days (Buckley and Kynard 1981). The larvae are photonegative, remaining on the bottom for several days. Buckley and Kynard (1981) found week old larvae to be photonegative and form aggregations with other larvae in concealment. Larvae are expected to begin swimming downstream at 9-14 days old

4 Based on US Geological Survey (USGS) water temperature data for the Delaware River at the Trenton gage (USGS gage 01463500; the site closest to the Scudders Falls area), for the period 2003-2009, mean daily water temperature reached 8°C sometime between March 26 (2006) and April 21 (2007), with temperatures typically reaching 8°C in the last few days of March. During this period, mean water temperatures at Trenton reached 10°C between March 28 (2004) and April 22 (2007) and 15ºC between April 15 (2006) and May 4 (2007). There is typically a three to four week period with mean daily temperatures between 8 and 15°C.

(Richmond and Kynard 1995). Larvae are expected to be less than 20mm TL at this time (Richmond and Kynard 1995). This initial downstream migration generally lasts two to three days (Richmond and Kynard 1995). Studies (Kynard and Horgan 2002) suggest that larvae move approximately 7.5km/day during this initial 2 to 3 day migration. Laboratory studies indicate that young sturgeon move downstream in a 2-step migration: the initial 2-3 day migration followed by a residency period of the Young of the Year (YOY), then a resumption of migration by yearlings in the second summer of life (Buckley and Kynard 1981).

No studies have been conducted on juveniles in the Delaware River. As shortnose sturgeon demonstrate nearly identical migration patterns in all rivers, it is likely that juveniles in the Delaware River exhibit similar migration patterns to sturgeon in other river systems. As such, it is likely that yearlings are concentrated in the upper Delaware River above Philadelphia.

As noted above, due to limited information on juvenile shortnose sturgeon, it is difficult to ascertain their distribution and nursery habitat (O'Herron 2000, pers. comm.). In other river systems, older juveniles (3-10 years old) occur in the saltwater/freshwater interface (NMFS 1998). In these systems, juveniles moved back and forth in the low salinity portion of the salt wedge during summer. In the Delaware River the oligohaline/fresh interface can range from as far south as Wilmington, Delaware, north to Philadelphia, Pennsylvania, depending upon meteorological conditions such as excessive rainfall or drought. As a result, it is possible that in the Delaware River, juveniles could range from Artificial Island (river mile 54) to the Schuylkill River (river mile 92) (O'Herron 2000, pers. comm.). The distribution of juveniles in the river is likely highly influenced by flow and salinity. In years of high flow (for example, due to excessive rains or a significant spring runoff), the salt wedge will be pushed seaward and the low salinity reaches preferred by juveniles will extend further downriver. In these years, shortnose sturgeon juveniles are likely to be found further downstream in the summer months. In years of low flow, the salt wedge will be higher in the river and in these years juveniles are likely to be concentrated further upstream.

O'Herron believes that if juveniles are present within this range they would likely aggregate closer to the downstream boundary in the winter when freshwater input is normally greater (O'Herron 2000, pers. comm.). Research in other river systems indicates that juveniles are typically found over silt and sand/mud substrates in deep water of 10-20m. Juvenile sturgeon primarily feed in 10 to 20 meter deep river channels, over sand-mud or gravel-mud bottoms (Pottle and Dadswell 1979). However, little is known about the specific feeding habits of juvenile shortnose sturgeon in the Delaware River.

As noted above, after spawning, adult shortnose sturgeon migrate rapidly downstream to the Philadelphia area (RM 100). After adult sturgeon migrate to the area around Philadelphia, many adults return upriver to between river mile 127 and 134 within a few weeks, while others gradually move to the same area over the course of the summer (O'Herron 1993). By the time water temperatures have reached 10°C, typically by mid-November[5], adult sturgeon have

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5 Based on information from the USGS gage at Philadelphia (01467200) during the 2003-2008 time period, mean water temperatures reached 10°C between October 29 (2005 and 2006) and November 14 (2003). In the spring, mean water temperature reached 10°C between April 2 (2006) and April 21 (2009).

returned to the overwintering grounds around Duck Island and Newbold Island. These patterns are generally supported by the movement of radio-tagged fish in the region between river mile 125 and river mile 148 as presented by Brundage (1986). Based on water temperature data collected at the USGS gage at Philadelphia, in general, shortnose sturgeon are expected to be at the overwintering grounds between early November and mid-April. Adult sturgeon overwinter in dense sedentary aggregations in the upper tidal reaches of the Delaware between river mile 118 and 131. The areas around Duck Island and Newbold Island seem to be regions of intense overwintering concentrations. However, unlike sturgeon in other river systems, shortnose sturgeon in the Delaware do not appear to remain as stationary during overwintering periods. Overwintering fish have been found to be generally active, appearing at the surface and even breaching through the skim ice (O'Herron 1993). Due to the relatively active nature of these fish, the use of the river during the winter is difficult to predict. However, O'Herron et al. (1993) found that the typical overwintering movements are fairly localized and sturgeon appear to remain within 1.24 river miles of the aggregation site (O'Herron and Able 1986). Investigations with video equipment by the ACOE in March 2005 (Versar 2006) documented two sturgeon of unknown species at Marcus Hook and 1 sturgeon of unknown species at Tinicum. Gillnetting in these same areas caught only one Atlantic sturgeon and no shortnose sturgeon. Video surveys of the known overwintering area near Newbold documented 61 shortnose sturgeon in approximately 1/3 of the survey effort. This study supports the conclusion that the vast majority of shortnose sturgeon overwinter near Duck and Newbold Island but that a limited number of shortnose sturgeon occur in other downstream areas, including Marcus Hook, during the winter months. The overwintering location of juvenile shortnose sturgeon is not known but believed to be on the freshwater side of the oligohaline/fresh water interface (O'Herron 1990). In the Delaware River, the oligohaline/freshwater interface occurs in the area between Wilmington, Delaware and Marcus Hook, Pennsylvania (O'Herron 1990).

Shortnose sturgeon appear to be strictly benthic feeders (Dadswell 1984). Adults eat mollusks, insects, crustaceans and small fish. Juveniles eat crustaceans and insects. While shortnose sturgeon forage on a variety of organisms, in the Delaware River, sturgeon primarily feed on the Asiatic river clam (*Corbicula manilensis*). *Corbicula* is widely distributed at all depths in the upper tidal Delaware River, but it is considerably more numerous in the shallows on both sides of the river than in the navigation channels. Foraging is heaviest immediately after spawning in the spring and during the summer and fall, and lighter in the winter.

Historically, sturgeon were relatively rare below Philadelphia due to poor water quality. Since the 1990s, the water quality in the Philadelphia area has improved leading to an increased use of the lower river by shortnose sturgeon. Few studies have been conducted to document the use of the river below Philadelphia by sturgeon. Brundage and Meadows (1982) have reported incidental captures in commercial gillnets in the lower Delaware. During a study focusing on Atlantic sturgeon, Shirey et al. (1999) captured 9 shortnose sturgeon in 1998. During the June through September study period, Atlantic and shortnose sturgeon were found to use the area on the west side of the shipping channel between Deep Water Point, New Jersey and the Delaware-Pennsylvania line. The most frequently utilized areas within this section were off the northern and southern ends of Cherry Island Flats in the vicinity of the Marcus Hook Bar. A total of 25 shortnose sturgeon have been captured by Shirey in this region of the river from 1992 - 2004, with capture rates ranging from 0-10 fish per year (Shirey 2006). Shortnose sturgeon have also been documented on the trash racks of the Salem nuclear power plant in Salem, New Jersey at Artificial Island. The intakes for this plant are located in Delaware Bay. While the available information does not identify the area below Philadelphia as a concentration area for adult shortnose sturgeon, it is apparent that this species does occur in the lower Delaware River and upper Delaware Bay.

In May 2005, a one-year survey for juvenile sturgeon in the Delaware River in the vicinity of the proposed Crown Landing LNG project was initiated. The objective of the survey was to obtain information on the occurrence and distribution of juvenile shortnose and Atlantic sturgeon near the proposed project site to be located near RM 78, approximately 20 miles south of Philadelphia. Sampling for juvenile sturgeon was performed using trammel nets and small mesh gill nets. The nets were set at three stations, one located adjacent to the project site, one at the upstream end of the Marcus Hook anchorage (approximately 2.7 miles upstream of the project site, at RM 81), and one near the upstream end of the Cherry Island Flats (at RM 74; approximately 3.8 miles downstream of the site). Nets were set within three depth ranges at each station: shallow (<10 feet at MLW), intermediate (10-20 feet at MLW) and deep (20-30+ feet at MLW). Each station/depth zone was sampled once per month. Nets were fished for at least 4 hours when water temperatures were less than 27°C and limited to 2 hours when water temperature was greater than 27°C. The sampling from April through August 2005 yielded 3,014 specimens of 22 species, including 3 juvenile shortnose sturgeon. Juvenile shortnose sturgeon were collected one each during the June, July and August sampling events. Two of the shortnose sturgeon were collected at RM 78 and one was taken at the downstream sampling station at RM 74. Total length ranged from 311-367mm. During the September – December sampling, one juvenile shortnose sturgeon was caught in September at RM 78 and one in November at the same location. One adult shortnose sturgeon was captured in October at RM 74. All of the shortnose sturgeon were collected in deep water sets (greater than 20 feet). These depths are consistent with the preferred depths for foraging shortnose sturgeon juveniles reported in the literature (NMFS 1998). The capture of an adult in the Cherry Island Flats area (RM 74) is consistent with the capture location of several adult sturgeon reported by Shirey et al. 1999 and Shirey 2006.

Brundage compiled a report presenting an analysis of telemetry data from receivers located at Torresdale RM 93, Tinicum RM 86, Bellevue RM 73 and New Castle RM 58 during April through December 2003. The objective of the study was to provide information on the occurrence and movements of shortnose sturgeon in the general vicinity of the proposed Crown Landing LNG facility. A total of 60 shortnose sturgeon had been tagged with ultrasonic transmitters: 30 in fall 2002, 13 in early summer 2003 and 13 in fall 2003. All fish tagged were adults tagged after collection in gill nets in the upper tidal Delaware River, between RM 126-132. Of the 60 tagged sturgeon, 39 (65%) were recorded at Torresdale, 22 (36.7%) were recorded at Tinicum, 16 (26.7%) at Bellevue and 18 (30%) at New Castle. The number of tagged sturgeon recorded at each location varied with date of tagging. Of the 30 sturgeon tagged in fall 2002, 26 were recorded at Torresdale, 17 at Tinicum, 11 at Bellevue and 13 at New Castle. Only two of the 13 tagged in fall 2003 were recorded, both at Torresdale only. Brundage concludes that seasonal movement patterns and time available for dispersion likely account for this variation, particularly for the fish tagged in fall 2003. Eleven of the 30 shortnose sturgeon tagged in fall 2002 and 5 of the 17 fish tagged in summer 2003 were recorded at all four locations. Some of the fish evidenced rapid movements from one location sequentially to the next in upstream and/or downstream direction. These periods of rapid sequential movement tended to occur in the spring and fall, and were probably associated with movement to summer foraging and overwintering grounds, respectively. As a group, the shortnose sturgeon tagged in summer 2003 occurred a high percentage of time within the range of the Torresdale receiver. The report concludes that the metrics indicate that the Torresdale Range of the Delaware River is utilized by adult shortnose sturgeon more frequently and for greater durations than the other three locations. Of the other locations, the New Castle Range appears to be the most utilized region. At all ranges, shortnose were detected throughout the study period, with most shortnose sturgeon detected in the project area between April and October. The report indicates that most adult shortnose sturgeon used the Torresdale to New Castle area as a short-term migratory route rather than a long-term concentration or foraging area. Adult sturgeon in this region of the river are highly mobile, and as noted above, likely using the area as a migration route.

Information on the use of the river by juveniles is lacking and the information available is extremely limited (i.e., 5 captures). As evidenced by the Crown Landing study, juvenile shortnose sturgeon have been documented between RM 81-74 from June – November. Due to the limited geographic scope of this study, it is difficult to use these results to predict the occurrence of juvenile shortnose sturgeon throughout the action area. However, the April – August time frame is when flows in the Delaware River are highest and the time when the action area is likely to experience the low salinity levels preferred by juveniles (FERC 2005). Beginning in August, flows decrease and the salt wedge begins to move upstream, which may preclude juveniles from occurring in the action area. Based on this information, it is likely that juvenile shortnose sturgeon are present in the action area at least during the April – August time frame. The capture of juvenile shortnose sturgeon in the RM 81-74 range in November of 2005 suggests that if water conditions are appropriate, juveniles may also be present in this area through the fall. While it is possible, based on habitat characteristics, that this area of the river is used as an overwintering site for juveniles, there is currently no evidence to support this presumption.

In 2005, the ACOE conducted investigations to determine the use of the Marcus Hook region by sturgeon. Surveys for the presence of Atlantic and shortnose sturgeon were conducted between March 4 and March 25, 2005 primarily using a Video Ray® Explorer submersible remotely operated vehicle (ROV). The Video Ray® was attached to a 1.0 x 1.0 x 1.5 meter aluminum sled which was towed over channel bottom habitats behind a 25-foot research boat. All images captured by the underwater camera were transmitted through the unit's electronic tether and recorded on video cassettes. A total of 43 hours of bottom video were collected on 14 separate survey days. Twelve days of survey work were conducted at the Marcus Hook, Eddystone, Chester, and Tinicum ranges, while two separate days of survey work were conducted up river near Trenton, New Jersey, at an area known to have an over wintering population of shortnose sturgeon.

The sled was generally towed on the bottom parallel to the centerline of the channel and into the current at 0.8 knots. Tow track logs were maintained throughout the survey and any fish seen on the ROV monitor was noted. Boat position during each video tow was recorded every five minutes with the vessel's Furuno GPS. The Sony digital recorder recorded a time stamp that could be matched with the geographic coordinates taken from the on-board GPS. Digital tapes were reviewed in a darkened laboratory at normal or slow speed using a high quality 28-inch television screen as a monitor. When a fish image was observed the tape was slowed and advanced frame by frame (30 images per second were recorded by the system). The time stamp where an individual fish was observed was recorded by the technician. Each fish was identified to the lowest practical taxon (usually species) and counted. A staff fishery biologist reviewed questionable images and species identifications. Distances traveled by the sled between time stamps were calculated based on the GPS coordinates recorded in the field during each tow. Total fish counts between the recorded coordinates within a particular tow were converted to observed numbers per 100 meters of tow track.

Limited 25-foot otter trawling and gillnet sets were conducted initially to provide density data, and later to provide ground truth information on the fish species seen in the video recording. Large boulders and other snags that tore the net and hung up the vessel early on in the study prompted abandoning this effort for safety reasons given the high degree of tanker traffic in the lower Delaware River. The trawl net was a 7.6-m (25-foot) experimental semi-balloon otter trawl with 44.5-mm stretch mesh body fitted with a 3.2-mm stretch mesh liner in the cod end. Otter trawls were generally conducted for five minutes unless a snag or tanker traffic caused a reduction in tow time. Experimental gillnets were periodically deployed throughout the survey period in the Marcus Hook area. One experimental gillnet was 91.4-m in length and 3-m deep and was composed of six 15.2-m panels of varying mesh size. Of the six panels in each net, two panels were 50.8-mm stretch mesh, 2 panels were 101.6-mm stretch mesh and two panels were 152.4-mm stretch mesh. Another gillnet was 100 m in length and consisted of four 25 x 2-m panels of 2.5-10.2-cm stretched monofilament mesh in 2.5 cm increments. Gill nets were generally set an hour before slack high or low water and allowed to fish for two hours as the nets had to be retrieved before maximum currents were reached.

Turbidity in the Marcus Hook region of the Delaware River limited visibility to about 18 inches in front of the camera. However, despite the reduced visibility, several different fish species were recorded by the system including sturgeon. In general, fish that encountered the sled between the leading edge of the sled runners were relatively easy to distinguish. The major fish species seen in the video images were confirmed by the trawl and gillnet samples. In the Marcus Hook project area, a total of 39 survey miles of bottom habitat were recorded in twelve separate survey days. Eight different species were observed on the tapes from a total of 411 fish encountered by the camera. White perch, unidentified catfish, and unidentified shiner were the most common taxa observed. Three unidentified sturgeon were seen on the tapes, two in the Marcus Hook Range, and one in the Tinicum Range. Although it could not be determined if these sturgeon were Atlantic or shortnose, gillnetting in the Marcus Hook anchorage produced one juvenile Atlantic sturgeon that was 396 mm in total length, 342 mm in fork length, and weighed 250 g.

Water clarity in the Trenton survey area was much greater (about 6 feet ahead of the camera) and large numbers of shortnose sturgeon were seen in the video recordings. In a total of 7.9 survey miles completed in two separate days of bottom imaging, 61 shortnose sturgeons were observed. To provide a comparative measure of project area density (where visibility was limited) to up river densities (where visibility was greater), each of the 61 sturgeon images were classified as to whether the individual fish was observed between the sled runners or whether they were seen ahead of the sled. Real time play backs of video recordings in the upriver sites indicated that the sturgeon did not react to the approaching sled until the cross bar directly in front of the camera was nearly upon it. Thirty of the 61 upstream sturgeon images were captured when the individual fish was between the runners. Using this criterion, approximately 10 times more sturgeon were encountered in the upriver area relative to the project site near Marcus Hook where three sturgeons were observed. Using the number of sturgeon observed per 100 meters of bottom surveyed, the relative sturgeon density in the project area was several orders of magnitude less than those observed in the Trenton area. As calculated in the report, the relative density of unidentified sturgeon in the Marcus Hook area was 0.005 fish per 100 meters while the densities of shortnose sturgeon between the sled runners in the upriver area was 0.235 fish per 100 meters.

The results of the video sled survey in the Marcus Hook project area confirmed that sturgeons are using the area in the winter months. However, sturgeon relative densities in the project area were much lower than those observed near Trenton, New Jersey, even when the upriver counts were adjusted for the higher visibility (i.e., between runner sturgeon counts). The sturgeons seen near Trenton were very much concentrated in several large aggregations, which were surveyed in multiple passes on the two sampling dates devoted to this area. The lack of avoidance of the approaching sled seen in the upriver video recordings where water clarity was good suggests that little to no avoidance of the sled occurred in the low visibility downriver project area. Video surveys in the downriver project area did not encounter large aggregations of sturgeon as was observed in the upstream survey area despite having five times more sampling effort than the upstream area. This suggests that sturgeons that do occur in the Marcus Hook area during the winter are more dispersed and that the overall number of shortnose sturgeon occurring in this area in the winter months is low.

Shortnose Sturgeon in the Action Area

As explained above, the action area for this consultation is limited to the area within the Delaware River where effects of the proposed action will be experienced. The action area is defined as the area located between river km 222.5 and 224.5.

Adult shortnose sturgeon are expected to be in the action area during the spring of each year while spawning. This is expected to coincide with the time period when water temperatures are between 8 and 15ºC, although some adults may still be present when water temperatures are as high as 18ºC. The adult shortnose sturgeon that are present are expected to spawn in a portion of the Delaware River that includes the action area. Potential spawning habitat in the Delaware River has been identified as a 17 km stretch of the river extending from approximately Lambertville to the Trenton Rapids (ERC 2008, Brundage 1986, O' Herron et al. 1993). The existing I-95 bridge is located approximately 15 km downstream of Lambertville. Adult shortnose sturgeon are only known to occur in this region of the Delaware River while spawning. This has been confirmed by radio tracking studies completed by Brundage and O'Herron (ERC 2008). Eggs are expected to be restricted to the spawning grounds due to their demersal and adhesive qualities and therefore, to the extent that spawning occurs in the action area, eggs are likely to be present in the action area. Larval shortnose sturgeon are also expected to occur throughout the action area for several weeks following the spawning period. The presence of eggs and larvae in the action area has been confirmed by recent sampling for shortnose sturgeon early life stages as reported in ERC 2008.

The adult population of shortnose sturgeon in the Delaware River has been estimated at approximately 9,500. Adult shortnose sturgeon do not typically spawn every year. Females are likely to spawn every three years and males every two years. It has been estimated that in an average year, approximately one-third of the adult population will spawn. However, as evidenced by studies reported by Kynard, if environmental conditions are not appropriate, spawning may not occur at all in a given year, or only a very few individuals may spawn. While it is impossible to predict the number of adult shortnose sturgeon likely to be present in the action area in a given year, up to 3,100 adults may spawn in the Delaware River each year. As the action area represents approximately 11% of the available spawning habitat (2 km of an available 17km stretch), and assuming that adults are distributed evenly over the available spawning habitat, it is reasonable to expect that up to approximately 340 adults may be present in the action area in a given spawning season. It is reasonable to assume that adults would be evenly distributed throughout the 17km stretch as substrate suitable for spawning (i.e., cobbles) is well distributed throughout the area and shortnose sturgeon are not known to form aggregations in one particular area while spawning.

It is equally difficult to predict the number of eggs and larvae likely to be present in the action area as the number is dependent not only on the number of spawning adults but the successful hatching of eggs and development of larvae. However, based on fecundity estimates (Dadswell et al. 1984), it is estimated that each spawning female will produce 94,000 eggs. While the overall sex ratio of the adult population is likely to be near 1:1, sex ratio on the spawning ground may favor males although spawning females are less mobile than males making them less susceptible to gillnet gear which may skew estimates in favor of males (Kieffer and Kynard in review-b). While no information on the sex-ratio of spawning adults in the Delaware River is available, males were most abundant in the available estimates for the Hudson River (2.5:1, Pekovitch 1979), Connecticut River (3.5:1, Taubert 1980, and 3:1, Buckley and Kynard 1985b), and Savannah River (3.5:1, Collins and Smith 1997), with an overall average of 3.3 males per female. Assuming that similar sex ratios are present in the Delaware River, it is likely that approximately 1/3 of the spawning adults are female; as such, there could be approximately 1,000 adult females spawning each year, resulting in the deposition of approximately 94 million eggs in a given spawning season. As noted above, approximately 11% of spawning adults may spawn in the action area, resulting in approximately 10 million eggs deposited in the action area in a given year. As only a small fraction of the eggs are expected to develop into viable larvae, the number of larvae is expected to be considerably less.

As explained above, shortnose sturgeon have been documented to spawn between 8 and 18°C, with the majority of spawning occurring when water temperatures are between 8 and 15°C. Based on water temperature data in the action area from 2003-2009 (see page 17), water temperatures are expected to be between 8 and 15°C for a 2-3 week period between March 26 and May 4 each year. Temperatures typically reach 18°C in early May, and even in cooler years (such as 2007) water temperatures in the action area reached 18°C by May 15. These estimates of spawning dates are supported by recent work by Brundage and O'Herron (ERC 2008) which reported that adults were first detected at the spawning grounds in late March, with peak-spawning likely occurring in mid-April, with some spawning continuing into May.

An acoustic telemetry receiver was deployed at Yardley, just downstream of the existing I-95 bridge (rkm 224), from November 5, 2007 through June 1, 2008. Thirteen tagged adult shortnose sturgeon were detected by this receiver between March 30 and April 24 with residence time ranging from 1-20 days, with an average of 10.5 days. Additionally, twelve shortnose sturgeon were detected by active tracking during this time period, with detections ranging from just upstream of the Calhoun Street Bridge (rkm 216.5) to upstream of the Washington Crossing Bridge (rkm 228.8).

Shortnose sturgeon eggs generally hatch after approximately 9-12 days (Buckley and Kynard 1981). The larvae are photonegative, remaining on the bottom for several days. Larvae are expected to begin swimming downstream at 9-14 days old (Richmond and Kynard 1995). Larvae are expected to be less than 20mm TL at this time (Richmond and Kynard 1995). This initial downstream migration generally lasts two to three days (Richmond and Kynard 1995). Studies (Kynard and Horgan 2002) suggest that larvae move approximately 7.5km/day during this initial 2 to 3 day migration. Even for eggs spawned at the upstream limit of the action area, this would bring larvae outside the action area within the first day of migration. In the Delaware River, shortnose sturgeon early life stages have been documented at water depths ranging from 0.5-2.4m and current velocities ranging from 0.64-1.71 m/sec, over well flushed cobble substrates (ERC 2008). These conditions are consistent with the habitats in which sturgeon eggs and larvae have been documented in other river systems in the northeast (Dadswell 1979, Taubert 1980, Washburn and Gillis Assoc. 1981, Kieffer and Kynard 1996).

Based on this information, adult shortnose sturgeon are likely to occur within the action area between March 26 and May 15 of any year. Depending on the date of spawning, eggs may be present from March 26 through May 27 (i.e., 12 days after the last day of spawning) and larvae may be present from April 4 (i.e., 9 days after the earliest spawning) through June 11 (i.e., 14 days after the last day off egg hatching). It is important to note that while in any given year these various life stages may be present in the action area between March 20 and June 11, there is typically less than 50 days a year when shortnose sturgeon of any life stage are likely to be present in the action area; this is due to the fact that spawning takes place over a two to three week period and all larvae are expected to swim away from the action area within 26 days of spawning. Shortnose sturgeon are not known to occur in the action area outside of this March – June time frame.

ENVIRONMENTAL BASELINE

Environmental baselines for biological opinions include the past and present impacts of all state, federal or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early Section 7 consultation, and the impact of state or private actions that are contemporaneous with the consultation in process (50 CFR 402.02). The environmental baseline for this Opinion includes the effects of several activities that may affect the survival and recovery of the listed species in the action area. The activities that shape the environmental baseline in the action area of this consultation generally include: dredging operations, water quality, scientific research, shipping and other vessel traffic and fisheries, and recovery activities associated with reducing those impacts.

The Scudder Falls (I-95) Bridge (the Bridge) crosses the Delaware River approximately seven miles above the head-of-tide, a river reach that is free-flowing (non-tidal). As noted above, the action area is limited to the 4.4 miles of I-95 that will be modified as well as a 1 km area on either side of the existing bridge; thus, the action area includes the area within the Delaware River ranging from rkm 222.5-224.5.

Most of the substrate in the study area is a coarse mixture of gravel, cobbles, and boulders containing interstitial sand and small deposits of sand located downstream of larger cobbles and boulders. One exception is a small band of silt and sand located along the east shoreline of Park Island, which grades to include gravel and some cobble under the existing bridge. Current velocity is low only in this particular area, also. The other area of differing substrate conditions is located along the river's west shoreline downstream of the bridge where occasional outcrops of bedrock are present.

Federal Actions that have Undergone Formal or Early Section 7 Consultation
NMFS has undertaken several ESA section 7 consultations to address the effects of actions authorized, funded or carried out by Federal agencies with action areas covering various portions of the Delaware River. However, NMFS has not conducted any formal or early section 7 consultations for actions with action areas consistent with the action area for this consultation.

Scientific Studies
Shortnose sturgeon in the Delaware River have been the focus of a long history of scientific research, beginning in approximately 1962 and has included work in the action area. As a result of techniques associated with these sampling studies, shortnose sturgeon have been subjected to capturing, handling, and tagging. It is possible that research in the action area may have influenced and/or altered the migration patterns, reproductive success, foraging behavior, and survival of shortnose sturgeon. Through 2001, Environmental Research and Consulting Inc. (principal investigators John O'Herron and Hal Brundage) reported the captures, handling and tagging of over 3000 shortnose sturgeon. Eleven accidental shortnose sturgeon mortalities were reported during that time.

Currently, only one valid research permit for shortnose sturgeon in the Delaware River is in place (Permit No. 1486, issued December 22, 2004 to Mr. Hal Brundage). This permit authorizes the capture, handling and tagging of 1,750 adult and juvenile shortnose sturgeon annually. Internal ultrasonic tagging, Floy T-bar tagging, PIT tagging and tissue and genetic sampling is authorized for a subset of the captured fish including work in the action area. The permit also authorizes the accidental mortality of up to 25 adult and 25 juvenile shortnose sturgeon over the five year life of the permit. A Biological Opinion was completed on December 21, 2004 which concluded that this action may adversely affect but is not likely to jeopardize the continued existence of shortnose sturgeon. This permit is valid for five years.

Non-Federally Regulated Actions

Contaminants and Water Quality
Point source discharges (i.e., municipal wastewater, industrial or power plant cooling water or waste water) and compounds associated with discharges (i.e., metals, dioxins, dissolved solids, phenols, and hydrocarbons) contribute to poor water quality and may also impact the health of sturgeon populations. The compounds associated with discharges can alter the pH or receiving waters, which may lead to mortality, changes in fish behavior, deformations, and reduced egg production and survival. Sources of contamination in the action area include atmospheric loading of pollutants, stormwater runoff from coastal development, groundwater discharges, and industrial development.

Contaminants have been detected in Delaware River fish. PCBs have been detected in elevated levels in several species of fish. Large portions of the Delaware River are bordered by highly industrialized waterfront development. Sewage treatment facilities, refineries, manufacturing plants and power generating facilities directly intake water from or discharge water to the Delaware River. These activities cause large temperature variations, as well as discharging heavy metals, dioxin, dissolved solids, phenols and hydrocarbons into the waterway. Such discharges may alter the pH of the water and may eventually result in water quality conditions leading to fish mortality.

Several characteristics of shortnose sturgeon life history including long life span, extended residence in estuarine habitats, and being a benthic omnivore, predispose this species to long term, repeated exposure to environmental contaminants and bioaccumulation of toxicants (Dadswell 1979). Toxins introduced to the water column become associated with the benthos and can be particularly harmful to benthic organisms (Varanasi 1992) like sturgeon. Heavy metals and organochlorine compounds are known to accumulate in fat tissues of sturgeon, but their long term effects are not yet known (Ruelle and Henry 1992; Ruelle and Keenlyne 1993). Available data suggest that early life stages of fish are more susceptible to environmental and pollutant stress than older life stages (Rosenthal and Alderdice 1976). Although there have not been any studies to assess the impact of contaminants on shortnose sturgeon, elevated levels of environmental contaminants, including chlorinated hydrocarbons, in several other fish species are associated with reproductive impairment (Cameron et al. 1992; Longwell et al. 1992), reduced egg viability (Von Westernhagen et al. 1981; Hansen 1985; Mac and Edsall 1991), and reduced survival of larval fish (Berlin et al. 1981; Giesy et al. 1986). Some researchers have speculated that PCBs may reduce the shortnose sturgeon’s resistance to fin rot (Dovel et al. 1992).

Although there is scant information available on levels of contaminants in shortnose sturgeon tissues, some research on other, related species indicates that concern about effects of contaminants on the health of sturgeon populations is warranted. Detectable levels of chlordane, DDE, DDT, and dieldrin, and elevated levels of PCBs, cadmium, mercury, and selenium were found in pallid sturgeon tissue from the Missouri River (US Fish and Wildlife Service 1993).

These compounds may affect physiological processes and impede a fish's ability to withstand stress. PCBs are believed to adversely affect reproduction in pallid sturgeon (Ruelle and Keenlyne 1993). Ruelle and Henry (1992) found a strong correlation between fish weight ($r = 0.91$, $p < 0.01$), fish fork length ($r = 0.91$, $p < 0.01$), and DDE concentration in pallid sturgeon livers, indicating that DDE concentration increases proportionally with fish size.

Contaminant analysis was conducted on two shortnose sturgeon from the Delaware River in the fall of 2002. Muscle, liver, and gonad tissue were analyzed for contaminants (ERC 2002). Sixteen metals, two semivolatile compounds, three organochlorine pesticides, one PCB Aroclor, as well as polychlorinated dibenzo-p-dioxins (PCDDs), and polychlorinated dibenzofurans (PCDFs) were detected in one or more of the tissue samples. Levels of aluminum, cadmium, PCDDs, PCDFs, PCBs and DDE (an organochlorine pesticide) were detected in the "adverse affect" range. It is of particular concern that of the above chemicals, PCDDs, DDE, PCBs and cadmium, were detected as these have been identified as endocrine disrupting chemicals. While no directed studies of chemical contamination in shortnose sturgeon in the Delaware River have been undertaken, it is evident that the heavy industrialization of the Delaware River is likely to be adversely affecting this population.

The Delaware Department of Natural Resources issues National Pollutant Discharge Elimination System permits for discharges in the State of Delaware. NMFS receives copies of draft permits during the Public Notice period and provides comments to the State with the goal of assuring that any permits issued do not have more than a minor detrimental effect on listed species in the receiving waters.

Global Climate Change

There is a large and growing body of literature on past, present, and future impacts of global climate change induced by human activities - frequently referred to in layman's terms as "global warming." Some of the likely effects commonly mentioned are sea level rise, increased frequency of severe weather events, and change in air and water temperatures. The Environmental Protection Agency's climate change webpage provides basic background information on these and other measured or anticipated effects (see www. epa.gov/climatechange/index.html). Activities in the action area that may have contributed to global warming include the combustion of fossil fuels by vessels and vehicles transiting over the bridge.

The impact of climate change on shortnose sturgeon is likely to be related to changes in water temperatures, potential changes to salinity in rivers, and the potential decline of forage. These changes may affect the distribution of species and the fitness of individuals and populations due to the potential loss of foraging opportunities, displacement from ideal habitats and potential increase in susceptibility to disease (Elliot and Simmonds 2007). A decline in reproductive fitness as a result of global climate change could have profound effects on the abundance and distribution of shortnose sturgeon in the action area, and throughout their range. As there is no information available on the effects of global climate change on shortnose sturgeon in the action area or the Delaware River generally, the actual effects of past and present activities influencing global climate change are uncertain.

Private and Commercial Vessel Operations

Private and commercial vessels, including fishing vessels, operating in the action area of this consultation also have the potential to interact with shortnose sturgeon. However, due to the shallow depths in the action area, few vessels occur in the action area. The effects of fishing vessels, recreational vessels, or other types of commercial vessels on listed species may involve disturbance or injury/mortality due to collisions or entanglement in anchor lines. It is important to note that minor vessel collisions may not kill an animal directly, but may weaken or otherwise affect it so it is more likely to become vulnerable to effects such as entanglements. Listed species may also be affected by fuel oil spills resulting from vessel accidents. Fuel oil spills could affect animals directly or indirectly through the food chain. Fuel spills involving fishing vessels are common events. However, these spills typically involve small amounts of material that are unlikely to adversely affect listed species. Larger oil spills may result from accidents, although these events would be rare and involve small areas. No direct adverse effects on shortnose sturgeon resulting from fishing vessel fuel spills have been documented.

Non-Federally Regulated Fishery Operations

Unauthorized take of shortnose sturgeon is prohibited by the ESA. However, shortnose sturgeon are taken incidentally in anadromous fisheries along the East Coast and are probably targeted by poachers (NMFS 1998). The incidental take of shortnose sturgeon in the river has not been well documented due to confusion over distinguishing between Atlantic sturgeon and shortnose sturgeon. The incidental take of shortnose sturgeon on the Hudson River has been documented in commercial shad fisheries as well as recreational hook and line fisheries. Although, commercial fisheries are prohibited in Pennsylvania state waters, New Jersey and Delaware do permit commercial fisheries to operate in designated portions of the Delaware River (Miller 2000, pers. Comm.; Boriek 2000, pers. comm.). American shad, eel, and blue crab are the species targeted by commercial fisherman, however, in the action area the level of commercial fishing is very minimal (Miller 2000, pers. Comm.; Boriek 2000, pers. comm.). Recreational hook and line fisheries, that target largemouth bass, striped bass, white catfish and channel catfish, are permitted throughout the River (Coughman 2000, pers. comm.; Boriek 2000, pers. comm.). There are no reported mortalities of shortnose sturgeon from the gillnet fishery for American shad (R. Allen, 2008, NJ Bureau of Marine Fisheries, pers. comm.). While there have been few documented incidental takes of shortnose sturgeon in fisheries in the Delaware River, it is possible that unreported incidental takes have occurred in recreational hook and line fisheries and commercial fisheries operating in the action area (Coughman 2000, pers. comm.). Almost every year between late March and early April during the American shad fishing season, the NJ Division of Fish and Wildlife receives reports from hook and line anglers of foul hooked and released shortnose sturgeon in the vicinity of Scudder’s Falls (M. Boriek, 2008, NJ Bureau of Freshwater Fisheries, pers. comm.).

In Spring 2006, a NJ Division of Fish and Wildlife Conservation Officer discovered a shortnose sturgeon in an angler’s car trunk. The angler had caught the sturgeon while bottom fishing in Trenton City. A Conservation Officer observed the angler as he carried the fish in a plastic bag, then placed the bag in the trunk of his car. The officer apprehended the bag, took pictures of the fish, then released it live (B. Herrighty, 2007, NJ Division of Fish and Wildlife Conservation

Officer, pers. comm.). Images of the fish were distributed to staff of the Division's Bureau's of Freshwater and Marine Fisheries, and the Endangered and Nongame Species Program, who confirmed it to be a shortnose sturgeon. It is likely that other incidents similar to this have occurred and gone undetected.

Summary and synthesis of the Status of Species and Environmental Baseline sections

The Status of the Species and Environmental Baseline, taken together, establish a "baseline" against which the effects of the proposed action are analyzed to determine whether the action—the proposed authorization of the Scudder Falls Bridge Replacement Project by the FHWA and ACOE - is likely to jeopardize the continued existence of the species. To the extent available information allows, this "baseline" (which does not include the future effects of the proposed action) would be compared to the backdrop plus the effects of the proposed action. The difference in the two trajectories would be reviewed to determine whether the proposed action is likely to jeopardize the continued existence of the species. This section synthesizes the Status of the Species and the Environmental Baseline sections as best as possible given that some information on shortnose sturgeon is quantified, yet much remains qualitative or unknown.

Summary of status of shortnose sturgeon
Historically, shortnose sturgeon are believed to have inhabited nearly all major rivers and estuaries along nearly the entire east coast of North America. Today, only 19 populations remain. The present range of shortnose sturgeon is disjunct, with northern populations separated from southern populations by a distance of about 400 km. Population sizes range from under 100 adults in the Cape Fear and Merrimack Rivers to tens of thousands in the St. John and Hudson Rivers. As indicated in Kynard 1996, adult abundance is less than the minimum estimated viable population abundance of 1000 adults for 5 of 11 surveyed northern populations and all natural southern populations. The only river systems likely supporting populations close to expected abundance are the St John, Hudson and possibly the Delaware and the Kennebec (Kynard 1996), making the continued success of shortnose sturgeon in these rivers critical to the species as a whole.

Population sizes of the Delaware River population by three estimation procedures ranged from 6,408 to 14,080 adult sturgeon. This is the best available information on population size, but because the recruitment and migration rates between the population segment studied and the total population in the river are unknown, model assumptions may have been violated. Based on comparison to older population estimates, NMFS assumes that this population is increasing or at worst is stable.

While no reliable estimate of the size of either the shortnose sturgeon population in the Northeastern US or of the species throughout its range exists, it is clearly below the size that could be supported if the threats to shortnose sturgeon were removed. Additionally, several historic populations have been extirpated. Based on the number of adults in population for which estimates are available, there are at least 104,662 adult shortnose sturgeon, including 18,000 in the Saint John River in Canada. Based on the best available information, NMFS believes that the status of shortnose sturgeon throughout their range is at best stable, with gains in populations such as the Hudson, Delaware and Kennebec, offsetting the continued decline of southern river populations, and at worst declining. The lack of information on the status of populations such as that in the Chesapeake Bay, as well as the lack of information on juveniles in nearly all rivers, add uncertainty to determination on the status of this species as a whole.

EFFECTS OF THE ACTION

This section of an Opinion assesses the direct and indirect effects of the proposed action on threatened and endangered species or critical habitat, together with the effects of other activities that are interrelated or interdependent (50 CFR 402.02). Indirect effects are those that are caused later in time, but are still reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend upon the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration (50 CFR 402.02). This Opinion examines the likely effects (direct and indirect) of the proposed action on shortnose sturgeon in the action area and their habitat within the context of the species current status, the environmental baseline and cumulative effects. No interrelated or interdependent activities have been identified.

As explained above, adult shortnose sturgeon are expected to be in the project area only during the spawning season, which typically lasts from late March into mid-May when river water temperature is in the range of 8-18°C. Sturgeon eggs are expected to be in the project area from late March through late May, with larvae present from early April through mid-June. After mid-June, all larvae are expected to have moved downstream into tidal waters outside of the action area.

As explained above, the proposed project will involve three to four years of construction in the action area. In addition to the bridge improvement project, the action also includes improvements along 4.4 miles of I-95. However, with the exception of the bridge component of the project, all other aspects of the project will be restricted to upland areas. As shortnose sturgeon are restricted to the waters of the Delaware River, and effects of the roadway improvements will not affect the waters of the Delaware River where shortnose sturgeon occur, no shortnose sturgeon will be exposed to effects of the roadway improvement project. Therefore, the discussion of effects of the proposed action presented below will focus on effects of the bridge replacement and demolition. Effects of the action include: disturbance of sediment associated with the pre-construction surveys, noise and vibration associated with the installation and removal of cofferdams and piles, loss of access to benthic habitat, noise and disturbance on top of the causeways and within the cofferdams during construction and demolition, overtopping of the cofferdams during high flow events, relocation of mussels away from the action area, and impacts on water quality.

Pre-construction Surveys

As explained above, ten test holes will be drilled within the action area. Two holes will be drilled at the site of each of the five in-water piers to determine sediment type and stability. An area approximately 4 inches in diameter will be disturbed at each sample site. The equipment used for drilling will result in underwater noise. Available noise estimates associated with benthic sampling equipment indicate that underwater noise associated with this type of equipment can be expected at 65 dB (BBL 2003). Sampling may also result in a small amount of turbidity in the immediate area surrounding the drill hole. However, any suspended sediment is expected to settle out quickly. As all sampling will occur outside of the time of year when shortnose sturgeon will be present in the action area, no shortnose sturgeon will be exposed to effects of the pre-construction sampling. Additionally, as the areas to be sampled are extremely small (i.e., 4 inches in diameter), the disturbance of the sediment is not likely to alter the habitat in any way that would changes its suitability as spawning or nursery habitat. As such, all effects of the pre-construction surveys will be insignificant and discountable.

Installation and Removal of Cofferdams and Piles

As explained above, a total of 11 cofferdams will be installed with 6 cofferdams installed to surround the existing bridge piers and five installed to support the installation of the 5 new in-water piers in the dry. Cofferdams will consist of driven steel sheet piles supported by interior lateral supports. FHWA anticipates installing the sheet piles by vibration, but an impact hammer may be necessary. All cofferdams will be installed outside of the March 15 – June 30 time period. As explained in the "Description of the Action" section, cofferdams and causeways will be installed and removed in stages, with no more than 6 cofferdams and 1 causeway present at any time.

The installation of sheet piles via pile driving can produce underwater sound pressure waves that can affect aquatic species. The available literature indicates that the single strike of a steel sheet pile results in a sound exposure level (SEL[6]) up to about 178 dB re 1 μPa^2-sec at a distance of 10 meters from the source. However, if a vibratory hammer is used to install the sheet piles, sound exposure levels are 10-20 dB lower (Jones & Stokes 2007). These levels are dependent not only on the pile and hammer characteristics, but also on the geometry and boundaries of the surrounding underwater and benthic environment. Thus, depending on the type of hammer and the characteristics of the site, sound levels of 158 – 178 dB are expected within 10 meters of the site of pile driving. As the distance from the source increases, underwater sound levels produced by pile driving are known to dissipate rapidly. Using data from Illingworth and Rodkin, Inc. (2007), a conservative literature estimate of an attenuation rate of 5 to 20 dB per doubling of distance is expected when installing steel sheet piles. Therefore, sound levels are expected to be fully attenuated within 1000 meters of the pile face.

Piles will also be driven for the construction of the temporary pile supported trestle causeways, with 22-36 piles installed for each of the four causeways. Causeway piles will be 24 inch diameter steel pipe piles. The available literature indicates that the single strike of a steel pile of this size results in a sound exposure level (SEL) up to about 177 dB re 1 μPa^2-sec at a distance of 5 meters from the source. However, if a vibratory hammer is used to install the piles, sound exposure levels are 10-20 dB lower (Jones & Stokes 2007). These levels are dependent not only on the pile and hammer characteristics, but also on the geometry and boundaries of the surrounding underwater and benthic environment. Thus, depending on the type of hammer and the characteristics of the site, sound levels of 157 – 177 dB are expected within 5 meters of the site of pile driving. As the distance from the source increases, underwater sound levels produced

6 The SEL is defined as that level which, lasting for one second, has the same acoustic energy as the transient and is expressed as dB re: 1μPa^2•sec

by pile driving are known to dissipate rapidly. Using data from Illingworth and Rodkin, Inc. (2007), a conservative literature estimate of an attenuation rate of 5 to 20 dB per doubling of distance is expected when installing steel piles. Therefore, sound levels are expected to be fully attenuated within 1000 meters of the pile being driven.

Pile driving affects fish through underwater noise and pressure which can cause effects to hearing and air containing organs, such as the swim bladder. Effects to fish can range from temporary avoidance of an area to death due to injury of internal organs. The type and size of pile, type of installation method (i.e., vibratory vs. hammer), type and size of fish (smaller fish are more often impacted), and distance from the sound source (i.e., sound dissipates over distance so noise levels are greater closer to the source) all contribute to the likelihood of effects to an individual fish. The available literature on effects of pile driving on aquatic species is difficult to summarize due to inconsistent methods of measuring underwater sound, the diversity of pile driving methods and receiving substrates, and the differing tolerances of aquatic species to underwater noise. Generally, however, the larger the pile and the closer a fish is to the pile, the greater the likelihood of effects.

Popper et al. (2006) have proposed a set of criteria for injury to fish exposed to pile driving. They propose that pile strikes which result in an SEL of 187 dB re 1 μPa as measured 10 meters from the source are expected to produce injuries to fish. As different fish species demonstrate differing sensitivities to sound levels and there is little information on the effects of underwater noise on shortnose sturgeon, it is difficult to determine whether this criterion is appropriate for shortnose sturgeon. While no studies have been conducted on the effects of pile driving on shortnose sturgeon, two studies have been conducted on the effects of blasting on this species. Both activities produce sound waves that would act similarly in the water column, making effects comparable. Moser (1999) studied the effects of rock blasting in Wilmington Harbor on caged hatchery reared shortnose sturgeon. A study done in the Cooper River, South Carolina, by Collins and Post (2001) tested the use of blasting caps to possibly repel shortnose sturgeon from a blasting site. These studies indicate that mortality of shortnose sturgeon only occurred when recorded sound levels were 234dB. At sound levels between 196-229 dB, some shortnose sturgeon were temporarily stunned. These studies suggest that, consistent with the recommendations by Popper et al. 2006, exposure of shortnose sturgeon to sound levels below 187dB is unlikely to result in effects to this species. Sound levels associated with the driving of steel sheet piles (i.e., 178 dB within 10 meters of the piles being driven) and steel pipe piles (i.e., 177 dB within 5 meters of the piles being driven) are below the range that could negatively affect shortnose sturgeon.

As noted above, cofferdams will be constructed outside of the March 15 – June 30 time period. As explained in the "Status of the Species" section above (see p. 23-25), shortnose sturgeon are only likely to be present in the action area between late March and mid June. As no shortnose sturgeon are likely to occur in the action area when piles will be drive, no shortnose sturgeon are likely to be exposed to underwater noise associated with the driving of sheet piles. Based on this information, it is extremely unlikely that any shortnose sturgeon will be affected by noise associated with the driving of steel sheet piles.

The installation and removal of sheet piles for cofferdams and piles for causeway construction will disturb bottom sediments. However, little increase in sedimentation or turbidity is expected to result from these construction activities. Additionally, as piles will be installed outside of the time of year when shortnose sturgeon are likely to occur in the action area, no shortnose sturgeon will be exposed to any suspended sediment associated with the installation of piles. Similarly, as the piles will be removed outside of the time of year when shortnose sturgeon are likely to be present in the action area, no shortnose sturgeon will be exposed to any suspended sediment resulting from the removal of the piles. As effects to shortnose sturgeon from pile installation and removal are extremely unlikely to occur, any effects of pile driving and removal will be discountable.

As all other activities associated with the construction of the temporary causeways will occur above the water line where shortnose sturgeon do not occur and will occur outside of the time of year when shortnose sturgeon are present in the action area, any effects to shortnose sturgeon from other activities associated with the construction of the temporary causeways is extremely unlikely.

Loss of Access to Benthic Habitat
The installation of cofferdams and trestle causeways, as well as the construction of the new bridge piers, will result in the temporary and permanent loss of spawning habitat in the action area. Four causeways will be constructed through the life of the project, but each causeway will be removed before the next is built. It is anticipated that a three to four year construction period will be required and it is likely that one causeway will be in place throughout most of this period. Additionally, a total of eleven cofferdams will be installed (five for permanent piers and six for removal of existing piers); however, the maximum number of cofferdams that will be in place at any one time is six.

Based on preliminary engineering, FHWA has estimated the anticipated footprint of the cofferdams and pile supported trestle causeways. Each of the cofferdams installed for construction of the new bridge piers has an anticipated footprint of approximately 26 feet wide and 166 feet long, covering a river bottom surface area of 4,316 square feet (0.099 acres) that will be dewatered to allow pier construction. Each of the cofferdams installed around the existing piers is anticipated to be approximately 15 feet wide and 70 feet long covering a river bottom surface area of approximately 1,050 square feet (0.024 acres). The maximum number of cofferdams at one time is six, which will be in place during Stage II of construction (three for proposed piers and three for demolition of existing piers). Based on the preliminary design engineering, the total area of benthic habitat impacted by the presence of cofferdams at any one time is expected to be no more than 16,098 square feet or 0.37 acres (i.e., the total area occupied by 3 cofferdams for new pier construction and 3 cofferdams for existing pier demolition). The piles associated with the trestle causeways will also preclude access to a small amount of benthic habitat. As explained above, no more than one trestle causeway will be in place at any time. The FHWA has reported the following estimated benthic footprint of each causeway: Stage I – 0.007 acres, Stage II – 0.005 acres, Stage III – 0.008 acres, and, Stage IV – 0.006 acres; no more than 210-340 square feet of benthic habitat will be occupied by piles per Stage. As noted above, these footprint estimates are based on preliminary engineering; however, FHWA has indicated that while the final engineering may result in a slightly larger footprint for each cofferdam and causeway due to unanticipated site conditions or minor modifications to the project design, at no time would the area impacted by the cofferdam and causeway be greater than 0.75 acres.

In addition to the temporary loss of access to habitat during the construction period when the cofferdams are in place, the area where the five new bridge piers will be placed will represent a permanent loss of benthic habitat. Based on the preliminary engineering, FHWA has indicated that each permanent pier is expected to cover an approximately 3,200 square foot area of the river bottom, a total of approximately 16,000 square feet of benthic habitat will be permanently lost. The six existing in water piers will be removed, thus restoring access to the approximately 4,250 square feet of river bottom occupied by the existing piers. The habitat in the area where the piers will be removed will be restored by regrading and replacing cobble and rocks to mimic adjacent areas. Therefore, at the end of the project, there will be a net permanent loss of approximately 0.27 acres of benthic habitat (0.37 acres for the new bridge piers minus the 0.10 acres where the old piers were removed) as compared to pre-construction conditions. As noted above, these footprint estimates are based on preliminary engineering; however, FHWA has indicated that while the final engineering may result in a slightly larger footprint for each pier due to unanticipated site conditions or minor modifications to the project design, the final area of permanent loss will be no greater than 0.50 acres.

In summary, a total of eleven cofferdams and four trestle causeways will be constructed; however, as no more than six cofferdams and one causeway will be present at any one time, no more than 0.75 acres will be temporarily impacted at any given time during any given construction phase. Additionally, five new bridge piers will be constructed which will result in a permanent loss of benthic habitat; however, approximately 4,285 square feet (0.10 acres) of river bottom that will be gained after removal of six existing piers, resulting in a permanent loss of no more than 0.50 acres of benthic habitat. To assess the effects of the loss of temporary access to benthic habitat within the cofferdams and within the benthic footprint of the causeway and the effects of the loss of permanent access to benthic habitat where the new bridge piers will be installed, NMFS has considered the effects on spawning adults and early life stages of shortnose sturgeon.

As explained above (see p. 23-25), spawning in the Delaware River occurs over at least a 7 mile reach from Trenton Rapids to Scudders Falls, with recent research suggesting that this reach may extend an additional 4 miles upstream to Lambertville (ERC 2008). Most of the substrate in this area is a coarse mixture of gravel, cobbles, and boulders containing interstitial sand and small deposits of sand located downstream of larger cobbles and boulders, which is considered suitable habitat for spawning shortnose sturgeon. Researchers have indicated that it is appropriate to assume that spawning occurs throughout this reach. In order to determine what percentage of the bottom in the seven mile long river reach extending from the head of tide to Scudder Falls might be temporarily lost to causeway and cofferdam construction and permanently lost to replacement of the six existing in-river piers with five larger proposed in-river piers, the area of this river reach was computed using an average river width of 1,000 feet. This area is approximately 848.5 acres. The river bottom areas temporarily or permanently lost are summarized in Table 1 below.

	River Bottom Area (Acres)	Percent of Total 7 mi Spawning Reach (848.5 acres)
Trestle Causeways		
Stage I	0.007	0.0008
Stage II	0.005	0.0006
Stage III	0.008	0.0009
Stage IV	0.006	0.0007
Cofferdams –new bridge piers		
One	0.099	0.012
Cofferdams – existing pier demolition		
One	0.024	0.003
Max cofferdams at any one time (3 new piers, 3 existing piers)	0.369	0.044
Max Temporary Habitat Loss		
6 cofferdams and 1 causeway	0.75	0.088
Permanent Piers		
One	0.074	0.009
Five (total)	0.370	0.044
Remove and restore 6 old piers	0.10	0.012
Maximum Net benthic habitat lost	0.50	0.059

As explained above, at any time, only one causeway will be in place. Based on preliminary design, the causeways will impact 0.005-0.008 acres of river bottom at one time. Each cofferdam installed for new bridge pier construction will impact approximately 0.099 acres of river bottom and each cofferdam installed surrounding an existing bridge pier will impact 0.024 acres of river bottom. The maximum number of cofferdams in place at one time will be six (3 for new construction and 3 surrounding existing piers). FHWA has indicated that the maximum area where access to benthic habitat will be precluded at any one time during construction is 0.75 acres.

As explained above, spawning adults are likely to occur in the action area for a two to three week period when water temperatures are between 8 and 18°C. Based on habitat characteristics in the action area (i.e., depth, water velocity, and substrate type), spawning is likely to occur throughout the action area which represents approximately 18% (150 acres of 848.5 acres) of the available spawning habitat in the Delaware River. The area that will be temporarily lost due to the presence of the cofferdams and causeways (no more than 0.75 acres) represents approximately 0.5% of the action area and 0.088% of the available spawning habitat in the Delaware River. The presence of the pile supported trestle causeways and the cofferdams will preclude adults from spawning in these areas; however, due to the small amount of bottom habitat impacted by these structures and the fact that access to upstream areas will not be precluded by the presence of these structures, the causeways and cofferdams will not preclude them from spawning in other parts of the action area.

The loss of access to no more than 0.75 acres of river bottom during any one spawning season over the four year construction period could affect individual shortnose sturgeon by causing them to expend additional energy to seek out alternate spawning locations within the action area. It is important to note that due to the presence of existing bridge piers (the I-95 bridge as well as other bridges) and islands within the action area and the entirety of the spawning grounds, as well as the lack of uniform substrate, shortnose sturgeon likely expend some amount of energy normally to seek out places to spawn that meet their criteria for water depth, velocity and substrate type. However, the presence of the cofferdams and trestle causeway will further restrict the available spawning habitat within the action area and therefore, will temporarily decrease the available suitable habitat both in the action area and over the entirety of the spawning grounds. Thus, spawning adults will need to make modifications to their normal movements on the spawning grounds in order to find suitable spawning locations. These modifications to normal behaviors are likely to be limited to additional movements, and therefore additional energy expenditure, to maneuver around these temporary structures and seek out other available suitable habitat. However, as the area encompassed by any one cofferdam or causeway is small (i.e., maximum size of any one temporary structure is approximately 26 feet by 166 feet), any alterations to behavior are expected to be limited in temporal and geographic scope. As such, any additional energy expenditure caused by a lack of access to benthic habitat associated with project activities is likely to be small and is not likely to affect the ability of an individual adult to spawn. Therefore, while these behavioral changes may affect the energy budget of an individual, these effects are likely to be small enough that they will not affect the reproductive fitness of any spawning individual.

The loss of access to 0.75 acres of river bottom during any one spawning season over the four year construction period is not expected to affect the ability of any individual shortnose sturgeon to spawn within the action area, nor is it expected to reduce the quantity or viability of any eggs or larvae produced. As such, while individual adults may be affected by having to expend additional energy to make additional movements within the action area due to the inability to access the benthic habitat within the cofferdams and where the trestle causeways will be in place, there is not expected to be any reduction in spawning adults, eggs or larvae within the action area resulting from the temporary loss of access to this habitat. This is due to the small percentage of lost habitat compared to the available spawning habitat, the small duration of any extra movements required in both spatial and temporal extent, and the small amount of additional energy required to make the additional movements required to maneuver around the structures and seek out nearby suitable spawning habitat. As spawning adults do not forage on the spawning grounds, the loss of access to this habitat will not affect the ability of shortnose sturgeon to forage successfully in the action area.

The FHWA is proposing to require the restoration of habitat in the areas where the trestle causeways were installed as well as where the existing bridge piers are demolished. Restoration of bottom topography will ensure that depths and water velocities in the area are consistent with surrounding areas within the action area. Additionally, the restoration of substrates to be consistent with surrounding areas will be required. While it is impossible to predict whether shortnose sturgeon will spawn in these restored areas, after the cofferdams and trestle causeways are removed there will nothing precluding shortnose sturgeon from spawning at these sites and it is likely that if the substrate is of the appropriate size and if water depths and velocities are appropriate, these restored areas will be used for shortnose sturgeon spawning following restoration. Therefore, it is appropriate to consider these effects temporary.

The construction of the five new bridge piers will result in permanent losses of benthic habitat in the action area. As noted above, following the construction of the new bridge, shortnose sturgeon will not be able to access the river bottom where the new bridge piers will be present; at the same time, shortnose sturgeon will have access to the newly restored habitat resulting from the removal of the six existing bridge piers (0.10 acres), resulting in a net loss of no more than 0.50 acres of benthic habitat compared to conditions prior to construction of the new bridge. The presence of the new bridge piers will cause spawning adults to make modifications to their normal movements on the spawning grounds in order to find suitable spawning locations. These modifications to normal behaviors are likely to be limited to additional movements, and therefore additional energy expenditure, to maneuver around these temporary structures and seek out other available suitable habitat. However, as the area encompassed by any one bridge pier is small (i.e., approximately 20 feet by 160 feet), any alterations to behavior are expected to be limited in temporal and geographic scope. As such, any additional energy expenditure caused by a lack of access to benthic habitat associated with project activities is likely to be small and is not likely to affect the ability of an individual adult to spawn. Therefore, while these behavioral changes may affect the energy budget of an individual, these effects are likely to be small enough that they will not affect the reproductive fitness of any spawning individual.

The permanent loss of access to no more than 0.50 acres of river bottom is not expected to affect the ability of any individual shortnose sturgeon to spawn within the action area, nor is it expected to reduce the quantity or viability of any eggs or larvae produced. This is due to the small percentage of the available spawning habitat that this loss represents (0.059%) and the ability of sturgeon to navigate around the bridge piers and seek out suitable spawning habitat. As such, while individual adults may be affected by having to expend additional energy to make additional movements within the action area due to the inability to access the benthic habitat within the cofferdams and where the trestle causeways will be in place, there is not expected to be any reduction in spawning adults, eggs or larvae within the action area resulting from the temporary loss of access to this habitat. This is due to the small percentage of lost habitat compared to the available spawning habitat, the small duration of any extra movements required in both spatial and temporal extent, and the small amount of additional energy required to make the additional movements required to maneuver around the structures and seek out nearby suitable spawning habitat. As spawning adults do not forage on the spawning grounds, the permanent loss of access to this habitat will not affect the ability of shortnose sturgeon to forage successfully in the action area.

Effects of Ongoing Construction

While all cofferdams and piles for the trestle causeways will be installed outside of the March 15 – June 30 time period, construction of the new bridge piers and demolition of the existing bridge piers will be ongoing within the cofferdams and from the trestle causeway during this time. Installation of the bridge piers and demolition of the existing bridge piers will occur in the dry within the confines of the cofferdams. While this will result in noise, there is expected to be minimal transmission of this noise to the underwater area where shortnose sturgeon will be present due to the need for noise to transmit through the steel walls. The potential for elevated noise to be experienced within the underwater area is further reduced as sound from one environment (air or water) is not easily transmitted across the air-water interface (Akamatsu, et. al. 2002, as referenced in Popper 2003).

Noise will also be generated by equipment operating on the trestle causeway. However, as noted above, noise is not easily transmitted across the air-water interface. As such, any increase in underwater noise associated with work ongoing within the cofferdams or from the causeways will be insignificant.

Construction ongoing within the cofferdams will include sediment disturbing activities. However, as the joints of the cofferdams are expected to be water tight, there is not expected to be any increase in suspended sediment outside of the cofferdams. As impacts of noise and suspended sediment are expected to be insignificant, it is unreasonable to expect that ongoing construction within the cofferdams or from the causeways will affect the ability of any individual shortnose sturgeon to spawn successfully or that it would affect the successful development of any eggs and larvae spawned in the action area.

Entrapment of Shortnose Sturgeon in the Cofferdams

As explained above, cofferdams will be constructed outside of the time of year when shortnose sturgeon are likely to be present in the action area. As such, there is no potential for shortnose sturgeon to become entrapped within the cofferdams during construction. Additionally, as the cofferdam steel sheeting will be driven to bedrock, all joints will be tightly sealed, and the top of the cofferdam will be above the water line, it is anticipated that spawning adults as well as shortnose sturgeon eggs and larvae will be precluded from entering the enclosed cofferdam areas.

While in general the design of the cofferdams will preclude shortnose sturgeon from becoming entrapped, the potential exists for the cofferdams to be overtopped during periods of high flow. The top of the cofferdam will be designed to be approximately 14 feet above the stream bed. The FHWA has indicated that in theory, overtopping would occur with a storm event greater than 1.4 years, when river flows would exceed approximately 61,725 cfs. The FHWA has reported that the monthly mean high flow for the years 1997 to 2006 (based on nearby USGS gauging station) was approximately 25,000 cfs. During this 10-year period, peak annual streamflow exceeded the

1.4 year design flows of 61,725 cfs approximately once per year, and half of these occurrences were outside the March 15 to June 30 period when shortnose sturgeon are not likely to be present. However, during the most recent three year period for which complete information is available (2003, 2005, 2006), river flows exceeded 61,725 cfs more often than the historical average. In 2003, this flow was exceeded once during the March 15- June 30 time period and three other times during the year; in 2005, this flow was exceeded twice during the March 15-June 30 time period and two other times during the year; and, in 2006, this flow was not exceeded during the March 15 – June 30 time period but was exceeded two other times during the year. FHWA has indicated that this three year time period is best expected to represent the flow levels expected during the four year construction period. Based on this information, it is likely that cofferdams are likely to be overtopped two to four times per year during the four year construction period with 0-2 of these events occurring each year during the March 15 – June 30 time frame. Therefore, in each of the four years when cofferdams will be present, overtopping events are likely to occur no more than twice annually during the March 15 – June 30 time frame.

It is unlikely that adult shortnose sturgeon would be trapped within an overtopped cofferdam during high river flow. This is due to the benthic nature of this species and the ability of adult sturgeon to actively avoid being carried downstream during a storm event. Therefore, even if water flows were high enough to cause overtopping of cofferdams during the time of year when shortnose sturgeon adults were present, shortnose sturgeon adults are expected to avoid any cofferdams, and it is extremely unlikely that any adults will be entrapped within any cofferdam present in the action area.

Shortnose sturgeon eggs are demersal and adhesive and remain within interstial spaces until hatching. As eggs are subjected to normal spring water fluctuations and are able to remain in place, it is unlikely that any eggs would be dislodged by normal high flow events, be suspended within the water column and entrapped within any cofferdam present in the action area.

Shortnose sturgeon larvae have limited swimming ability and are present within the water column. As such, this life stage is most vulnerable to passive transport during high flow events. A high flow event during the time of year when larvae are present could result in the movement of larvae through the action area. As larvae have limited mobility it is reasonable to expect that some number of shortnose sturgeon larvae would be entrapped within the cofferdam.

Once high flow conditions subside, any cofferdams overtopped and filled with river water will be pumped out to restore dry conditions. The FHWA has indicated that in such an instance, a pump with at least 4 inch clearance would be used.

As explained above, water flows in the action area greater than 61,725 cfs are likely to cause overtopping of the cofferdams. FHWA has determined that based on historic river conditions, flows sufficient to cause overtopping are likely to occur two to four times per year during the four year construction period with no more two of these high flow events likely to occur annually in the March 15 – June 30 time period. As explained above, adult shortnose sturgeon and shortnose sturgeon eggs are unlikely to become entrapped in an overtopped cofferdam; however, if a high flow event occurred during the time period when larvae were present, shortnose sturgeon larvae are vulnerable to being entrapped in the cofferdams.

Larvae will occur in the action area for a limited time period each year. Depending on water conditions in a particular year, spawning can occur over a few days or over a three to four week period, with larvae present approximately 9-12 days after eggs are laid. As spawning occurs over a period of several days to a few weeks, larvae will also be present in the action area for a similar length of time. It is difficult to quantify the number of shortnose sturgeon larvae that may be affected by this action as the number of shortnose sturgeon larvae entrapped in a cofferdam would be a function of the number of larvae present upstream of the cofferdam on the day that high flows sufficient for overtopping occurred, which is unknowable. However, as spawning is likely to occur over at least a 7 mile area and over a two-three week period with the development of larvae occurring subsequently, not all larvae produced in a given spawning season are likely to be present in the action area on any given day. This is due to the staggered nature of spawning (i.e., not all sturgeon will spawn on the same day) and the relatively large geographic area over which spawning will occur (i.e., some larvae would be present downstream of the cofferdams and not subject to entrapment).

A high flow event sufficient to cause overtopping is likely to be the result of a storm. As such, water levels will rise relatively rapidly. The rising waters will have increased velocity and many larvae are likely to be flushed out of the action area prior to river waters reaching a height where they could flow into the cofferdams. Larvae would become entrapped as river waters recede and water is trapped within the cofferdam. In a worst case scenario, a high flow event would occur approximately 2 weeks after the peak of spawning when the greatest number of larvae are likely to be present in the action area. Even in this case, few larvae are likely to become entrapped within the cofferdams. This is due to the hydraulic conditions associated with a high flow event which are likely to minimize the number of larvae present in the action area as well as the small footprint of the cofferdams compared to the footprint of the area where larvae could be present. As explained above, spawning takes place over at least an 848.5 acre area, of which, in the worst case, when six cofferdams are present covering no more than 0.75 acres which is approximately 0.088% of the available spawning habitat. Thus, assuming that: (1) as flows subside larvae are evenly distributed over the 848.5 acre spawning ground; and, (2) that all larvae have an equal potential for entrapment; no more than 0.088% of larvae that were present in the action area at the time of the high flow event would be entrapped in the cofferdams. As explained above, up to two overtopping events may occur each year during the time of year when shortnose sturgeon could be present. Shortnose sturgeon larvae will be present on the action area for up to a four week period between early April and the end of June. If both high flow events occurred during this period when larvae were present in the action area, both events could result in the entrapment of larvae in the cofferdams.

Water filled cofferdams will be pumped out with water discharged back into the river. Any shortnose sturgeon larvae present within the cofferdam would enter the pump and be discharged back into the river. The pump that would be used would have at least a 4” (101mm) clearance between any moving parts and would be designed to pump small solids. Shortnose sturgeon larvae in the action area are expected to be approximately 20mm TL (.79”). Based on analysis done by Taft *et al*. on alewife and yellow perch larvae (which are of similar size to shortnose sturgeon larvae), approximately 10% of the shortnose sturgeon larvae that would pass through the pump are likely to be killed. Thus, most (90%) larvae would likely pass safely through the pump and be discharged back into the river.

If one overtopping event happened in a given year when larvae were present in the action area, using the information above, and assuming the worst case that 0.088% of the larvae produced that year were entrapped and that 10% of those larvae were killed during pumping operations, no more than 0.0088% of the larvae produced in that year would be killed due to entrapment in a cofferdam and subsequent entrainment in the dewatering pump. If two overtopping events happened in a given year when larvae were present in the action area, using the information above, and assuming the worst case that twice as many larvae were entrapped as compared to a single overtopping event (i.e., 0.176%), and that 10% of those larvae were killed during pumping operations, no more than 0.0176% of the larvae produced in that year would be killed due to entrapment in a cofferdam and subsequent entrainment in the dewatering pump.

Water Quality
As part of the proposed action, the applicant will implement erosion control measures as well as a storm water pollution prevention plan and a spill reduction plan. As explained above, there is not likely to be any increase in suspended sediment outside of the cofferdams due to the water tight nature of the seals. Water discharges associated with the proposed action include the discharge of ground water pumped out of the cofferdam and storm water discharged from the construction site and the new bridge deck. Additionally, water quality could be affected by unforeseen circumstances such as oil or chemical spills.

Oil or chemical spills could occur either as a release from construction equipment or other accidental discharge. An oil or chemical spill would be an unintended, unpredictable event. Aquatic species, including shortnose sturgeon, are known to be negatively impacted by exposure to oil and other petroleum products. Depending on the chemical spilled, negative effects could also occur. Without an estimate of the amount of oil released it is difficult to predict the likely effects on listed species. Similarly, without an estimate of the amount of chemical released as well as information on the particular chemical, it is difficult to predict the likely effects on shortnose sturgeon. The applicant is required to develop an oil and chemical spill response plan which would ensure rapid response to any spill. As the effects of a spill are likely to be localized and temporary, any exposure of shortnose sturgeon is similarly expected to be localized and temporary. Additionally, should a response be required by the US EPA or the USCG, there would be an opportunity for NMFS to conduct a consultation with the lead Federal agency on the spill response.

While the cofferdams will be water tight and impervious to seepage of river water, ground water may seep up into the cofferdams. In order to allow construction within the cofferdams to occur in the dry, this water will be pumped out. The applicant has indicated that ground water seepage will be pumped to a central area where it will be treated, likely by passing through filters, and then discharged back in to the river. As this discharge will consist solely of filtered ground water, which is not known to be contaminated, and no the water will not be exposed to any contaminants prior to discharge into the river, this discharge will not impact the water quality in the action area. As such, any effects of this discharge on shortnose sturgeon will be insignificant and discountable.

Mussel Relocation
Yellow lampmussel may be relocated from the footprint of the causeways and proposed new piers to a river reach located upstream of the bridge project, as one of several potential mitigation options to be determined between the applicant and the New Jersey Department of Environmental Protection, Division of Fish and Wildlife. Limited sedimentation can be expected from hand-excavation of the river bottom surface in search of mussels. All mussel relocation activities will occur outside of the March 15 – June 30 time period when no shortnose sturgeon are likely to occur in the action area. As such, no shortnose sturgeon will be exposed to any effects of suspended sediment associated with mussel relocation.

Shortnose sturgeon adults feed on shellfish including mussels. Relocating yellow lampmussels will reduce the available forage in the action area. However, as shortnose sturgeon adults do not feed while on the spawning grounds, this reduction in forage will not affect spawning adults.

CUMULATIVE EFFECTS
Cumulative effects are defined in 50 CFR §402.02 as those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation.

Several features of the shortnose sturgeon's natural history, including delayed maturation, non-annual spawning (Dadswell et al. 1984; Boreman 1997), and long life-span, affect the rate at which recovery can proceed. The effects of future state and private activities in the action area that are reasonably certain to occur during the dredging operations are recreational and commercial fisheries, pollutants, and development and/or construction activities resulting in excessive water turbidity and habitat degradation.

Impacts to shortnose sturgeon from non-federal activities are largely unknown in this river. It is possible that occasional recreational and commercial fishing for anadromous fish species may result in incidental takes of shortnose sturgeon. However, positive identification and distinction between Atlantic sturgeon and shortnose sturgeon are difficult and therefore, historically, takes have not been quantified. Pollution from point and non-point sources has been a major problem in this river system, which continues to receive discharges from sewer treatment facilities and paper production facilities (metals, dioxin, dissolved solids, phenols, and hydrocarbons). Contaminants introduced into the water column or through the food chain, eventually become associated with the benthos where bottom dwelling species like shortnose sturgeon are particularly vulnerable.

Scientific Studies
It is likely that additional scientific studies will be conducted on shortnose sturgeon in the action area. Continued capturing, handling, tagging, and tracking of shortnose sturgeon may affect their migration, reproduction, foraging, and survival.

Contaminants and Water Quality
Contaminants associated with the action area are directly linked to industrial development along the waterfront. PCB's, heavy metals, and waste associated with point source discharges and refineries are likely to be present in the future due to continued operation of industrial facilities. In addition many contaminants such as PCB's remain present in the environment for prolonged periods of time and thus would not disappear even if contaminant input were to decrease. It is likely that shortnose sturgeon will continue to be affected by contaminants in the action area in the future.

Industrialized waterfront development will continue to impact the water quality in and around the action area. Refineries, sewage treatment facilities, manufacturing plants, and generating facilities present in the action area are likely to continue to operate. Excessive water turbidity, water temperature variations and increased shipping traffic are likely with continued future operation of these facilities. As a result, shortnose sturgeon foraging and/or distribution in the action area may be adversely affected.

Fisheries
Incidental take of shortnose sturgeon is likely with the continued operation of hook and line and commercial fisheries in the Delaware River. There have been no documented takes in the action area; however, there is always the potential for this to occur when fisheries are known to operate in the presence of shortnose sturgeon. Thus, the operation of these hook and line fisheries and commercial fisheries could result in future shortnose sturgeon mortality and/or injury.

Impacts to shortnose sturgeon from non-federal activities are unknown in this river. It is possible that occasional recreational and commercial fishing for anadromous fish species may result in incidental takes of shortnose sturgeon. However, positive identification and distinction between Atlantic sturgeon and shortnose sturgeon are difficult and therefore, historically, takes have not been quantified. Pollution from point and non-point sources has been a major problem in this river system, which continues to receive discharges from sewer treatment facilities and industrial facilities. Contaminants introduced into the water column or through the food chain, eventually become associated with the benthos where bottom dwelling species like shortnose sturgeon are particularly vulnerable.

As noted above, impacts to listed species from all of these activities are largely unknown. However, NMFS has no information to suggest that the effects of future activities in the action area will be any different from effects of activities that have occurred in the past.

INTEGRATION AND SYNTHESIS OF EFFECTS
In the effects analysis outlined above, NMFS considered potential effects from the following sources: (1) roadway improvements along I-95; (2) pre-construction surveys; (3) installation and removal of piles associated with the cofferdams and trestle causeways; (4) ongoing construction within cofferdams; (5) overtopping of cofferdams; and, (6) water quality effects.

Shortnose sturgeon
Shortnose sturgeon are endangered throughout their entire range. This species exists as nineteen

separate populations that show no evidence of interbreeding. The shortnose sturgeon residing in the Delaware River form one of these nineteen populations.

NMFS has determined that the proposed bridge replacement project will result in some short-term adverse effects to adult shortnose sturgeon; these adverse effects will be limited to changes in normal behavior on the spawning grounds resulting from the presence of the cofferdams and trestle causeways which will preclude adults from accessing no more than 0.75 acres of benthic habitat during bridge construction. These changes in normal behavior will result in additional expenditures of energy while seeking out suitable spawning habitat. However, due to the small footprint of each of these structures and the small percentage of the available spawning habitat in the action area (0.50%) and the even smaller percentage of the spawning grounds that these structures represent (0.088%), any changes in normal behavior and additional energy expended is not expected to result in any reduction in the number of eggs spawned or in the successful development of those eggs and larvae.

Additionally, following the construction of the bridge, short term adverse effects to adult shortnose sturgeon will continue due to the permanent loss of no more than 0.50 acres of benthic habitat where the new bridge piers will be installed. These adverse effects will be limited to changes in normal behavior on the spawning grounds resulting from the presence of the bridge piers which will preclude adults from accessing approximately 0.50 acres of benthic habitat. The permanent loss of 0.50 acres of benthic habitat is a very small percentage of the available spawning habitat in the action area (0.33%) and an even smaller percentage of the Delaware River spawning grounds in their entirety (0.059%). Any change in normal behavior and additional energy expended is not expected to result in any reduction in the number of eggs spawned or in the successful development of those eggs and larvae. As these behavioral changes will be limited to just the time it takes the individual to navigate around these structures, which will be of short duration, no chronic or lethal effects are expected.

The action is likely to result in the mortality of no more than 0.0704% of the larvae spawned during the four year construction period. These adverse effects will result from entrapment in cofferdams during high flow events (greater than 61,725 cfs) that result in overtopping of cofferdams. During the four year construction period, no more than two overtopping events per year are likely to occur during the March 15 – June 30 time period, with no more than two events resulting in the entrapment of shortnose sturgeon larvae annually, and with no more than 0.176% of the larvae spawned in a given year entrapped in cofferdams. Once river levels recede, water in the cofferdams will be pumped out. Based on assumptions outlined in the Opinion above, no more than 0.176% of the larvae spawned in a given year when an overtopping event occurs are likely to become entrapped and of these larvae only 10% are likely to be killed. Therefore, in the worst case, in a year when two overtopping events occur when larvae are present in the action area, 0.0176% of the larvae spawned are likely to die as a result of entrapment in a cofferdam and subsequent passage through the dewatering pump. As explained in the "Effects of the Action" section above, overtopping resulting in entrapment of larvae is expected to occur no more than twice per year over the four year construction period. As such, of the larvae spawned over the four year construction period, in the worst case, if two overtopping events occurred when larvae were present in the action area each year of construction, no more than 0.704% are likely to become entrapped in a cofferdam and with a 10% mortality rate due to passage through the dewatering pump, 0.0704% are likely to die. As explained in the "Effects of the Action" section, all other effects on shortnose sturgeon and their habitat are likely to be insignificant or discountable.

While the action is likely to result in the mortality of no more than 0.0704% of the larvae spawned in the Delaware River over the 4 year construction period, this number represents a very small percentage of the total number of larvae produced over that time span by the shortnose sturgeon population in the Delaware River, which is believed to be increasing, and an even smaller percentage of the total larval production by the population of shortnose sturgeon rangewide. It is also important to note that this mortality estimate is considered to be a worst case scenario and is based on conservative assumptions outlined in the "Effects of the Action" section above. Additionally, mortalities are only expected to occur in two of the four years when construction will be occurring in the action area. The best available population estimates indicate that there are between 6,000 -14,000 adult shortnose sturgeon in the Delaware River and an unknown number of juveniles. Based on the number of adults in the population, at least 2,000 adults are likely to spawn every year (one-third of the adult population), resulting in millions of eggs and hundreds of thousands of larvae. The death of 0.0176% of the larvae spawned in each of the four years of the construction period, would affect the ultimate size of these year classes of shortnose sturgeon. However, as early life stages naturally experience high levels of mortality the loss of a small percentage of larvae is not equivalent to the loss of a similar percentage of juveniles or adults. While the loss of larvae will have an effect on the number of juvenile and eventually the number of adult sturgeon in a particular year class, the reduction in size would be extremely small. As shortnose sturgeon are long lived species, there are up to at least 30 year classes in a population at a particular time. It is unlikely that these extremely small losses in larvae for four year classes would be detectable at the population level. Therefore, the loss of these shortnose sturgeon will not have a detectable effect on the number of shortnose sturgeon in the population compared to the number that would have been present absent the proposed action or in the species as a whole.

This action is expected to have an undetectable reduction in reproduction of shortnose sturgeon in the Delaware River because, while it will result in behavioral changes for adults spawning in the action area, these changes are not expected to result in a reduction in the reproductive fitness of any adult and it would not result in a reduction in the number of spawning adults or the number of eggs or larvae produced in a given year. Additionally, any reduction in the number of adults resulting from the loss of 0.0704% of the larvae spawned over the four year construction period is likely to be undetectable, and therefore any future reduction in the number of spawning adults resulting from this extremely small percentage of larvae would be undetectable.

The proposed action is not likely to reduce distribution because while the action will preclude access to some benthic habitat in the action area (0.75 acres temporarily and 0.5 acres permanently), this benthic habitat represents an extremely small percentage of the available benthic habitat in the action area (0.5% of 150 acres) and an even smaller percentage of the available spawning habitat in the Delaware River (0.088% of 848.5 acres). Further, the action will not impede shortnose sturgeon from migrating to or from any seasonal concentration areas, including foraging, spawning or overwintering grounds in the Delaware River. The action is also not expected to reduce the river by river distribution of shortnose sturgeon. Additionally as the number of shortnose sturgeon likely to be killed as a result of the proposed action is extremely small (0.0704% of the larvae spawned over the four year construction period), there is not likely to be a loss of any unique genetic haplotypes and therefore, it is unlikely to result in the loss of genetic diversity.

While generally speaking, the loss of a small number of individuals from a subpopulation or species may have an appreciable effect on the numbers, reproduction and distribution of the species, this is likely to occur only when there are very few individuals in a population, the individuals occur in a very limited geographic range or the species has extremely low levels of genetic diversity. This situation is not likely in the case of shortnose sturgeon because: the species is widely geographically distributed, it is not known to have low levels of genetic diversity (see status of the species section above), and there are thousands of shortnose sturgeon spawning each year.

Based on the information provided above, the mortality of no more than 0.0704% of the larvae spawned in the Delaware River over the 4 year construction period will not appreciably reduce the likelihood of survival (i.e., it will not increase the risk of extinction faced by this species) for this species given that: (1) the population trend of shortnose sturgeon in the Delaware River is increasing; (2) the death of 0.0704% of larvae spawned over a four year time period represents an extremely small percentage of the number of shortnose sturgeon in the Delaware River and a even smaller percentage of the species as a whole; (3) the loss of these shortnose sturgeon will not change the status or trends of the species as a whole; (4) the loss of these shortnose sturgeon is likely to have an undetectable effect on reproductive output of the Delaware River population of shortnose sturgeon or the species as a whole; and, (5) the action will have no effect on the distribution of shortnose sturgeon.

Section 4(a)(1) of the ESA requires listing of a species if it is in danger of extinction throughout all or a significant portion of its range (i.e., "endangered"), or likely to become in danger of extinction throughout all or a significant portion of its range in the foreseeable future (i.e., "threatened") because of any of the following five listing factors: (1) The present or threatened destruction, modification, or curtailment of its habitat or range, (2) overutilization for commercial, recreational, scientific, or educational purposes, (3) disease or predation, (4) the inadequacy of existing regulatory mechanisms, (5) other natural or manmade factors affecting its continued existence. Recovery of a species occurs when listing it as an endangered or threatened species is no longer warranted.

As explained above, the proposed action will not appreciably reduce the likelihood of survival of shortnose sturgeon. For the following reasons, the action will not appreciably reduce the likelihood of recovery: (1) it is not expected to modify, curtail or destroy the range of the species since it will result in an extremely small reduction in the number of shortnose sturgeon in any geographic area and since it will not affect the overall distribution of shortnose sturgeon other than to cause minor temporary adjustments in movements in the action area; (2) the proposed action will not utilize shortnose sturgeon for recreational, scientific or commercial purposes, affect the adequacy of existing regulatory mechanisms to protect this species, or affect their continued existence; (3) the effects of the proposed action will not hasten the extinction timeline or otherwise increase the danger of extinction since the action will cause the mortality of only an extremely small percentage of the shortnose sturgeon in the Delaware River and an even smaller percentage of the species as a whole and these mortalities are not expected to result in the reduction of overall reproductive fitness for the species as a whole. It is important to note that currently the Delaware River population is on a recovery trajectory, with population numbers increasing. While no recovery criteria have been developed for the Delaware River population or for shortnose sturgeon as a whole, NMFS has considered the specific factors that likely lead to the decline of shortnose sturgeon in the Delaware River and would presumably need to be remedied to provide for recovery, with the primary factors being the loss of adults through commercial harvest and the loss of habitat due to extremely poor water quality, particularly below Philadelphia. The proposed action will not result in the mortality of any adults and an extremely small percentage of eggs and larvae and as explained above, is not likely to result in a detectable difference in the number of sturgeon in the Delaware population. Additionally, the proposed action will not contribute to water quality conditions that affect the distribution of shortnose sturgeon in the action area or throughout the Delaware River. Ultimately, to recover, this population must experience increased recruitment. While the proposed action will result in the loss of an extremely small number of larvae, it will not affect the reproductive fitness of any individuals and will not result in any detectable reduction in the strength of any subsequent year class. As such, it will not have a measurable effect on recruitment. For the reasons outlined herein, the proposed action will not appreciably reduce the likelihood that shortnose sturgeon can be brought to the point at which they are no longer listed as endangered or threatened. Based on the analysis presented herein, the proposed action, resulting in temporary effects to movements of adult shortnose sturgeon in the action area and the mortality of no more than 0.0704% of the larvae spawned over the four year construction period, is not likely to appreciably reduce the survival and recovery of this species.

CONCLUSION

After reviewing the best available information on the status of endangered and threatened species under NMFS jurisdiction, the environmental baseline for the action area, the effects of the action, and the cumulative effects, it is NMFS' biological opinion that the proposed action may adversely affect but is not likely to jeopardize the continued existence of shortnose sturgeon. Because no critical habitat is designated in the action area, none will be affected by the proposed action.

INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. NMFS interprets the term "harm" as an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding or sheltering (50 CFR §222.102). The term "harass" has not been defined by NMFS; however, it is commonly understood to mean to annoy or bother. In addition, legislative history helps elucidate Congress' intent: "[take] includes harassment, whether intentional or not. This would allow, for example, the Secretary to regulate or prohibit the activities of birdwatchers where the effect of those activities might disturb the birds and make it difficult for them to hatch or raise their young" (HR Rep. 93-412, 1973). Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

Amount or Extent of Incidental Take

As explained in the accompanying Opinion, the proposed action is likely to result in adverse effects to adult shortnose sturgeon by precluding them from accessing certain areas on the spawning grounds and causing them to alter their normal behaviors will on the spawning grounds to avoid temporary and permanent structures. The proposed action is likely to result in adverse effects to larvae by resulting in the entrapment of larvae within cofferdams and the subsequent mortality of larvae from being pumped out of the cofferdams.

Amount of Extent of Incidental Take of Adults

The proposed action has the potential to affect shortnose sturgeon adults by precluding them from certain areas of benthic habitat on the spawning grounds and causing them to alter their normal behaviors and expend additional energy to seek out suitable spawning habitat as a result of being precluded from accessing benthic habitat temporarily occupied by the cofferdams and trestle causeway and permanently occupied by the new bridge piers. As explained in the "Effects of the Action" section of the accompanying Opinion, at any given time during the construction period, no more than 0.75 acres of benthic habitat will be occupied by cofferdams or piles, representing the temporary loss of 0.50% of benthic habitat within the action area. Also as explained in the "Effects of the Action" section of the accompanying Opinion, the replacement of the six existing bridge piers with five new bridge piers will result in the permanent loss of 0.50 acres of benthic habitat within the action area, representing the permanent loss of 0.33% of benthic habitat within the action area. As explained in the "Effects of the Action" section of the Opinion, shortnose sturgeon adults only occur in the action area for a two to three week period from late March through mid May while spawning in. As such, effects to adults will be limited to this time period. Construction will occur over a four year time period; during this time period cofferdams and piles will preclude access to no more than 0.75 acres of spawning habitat at any given time. Additionally, bridge construction resulting in the replacement of the 7 existing in-water piers with 5 new in-water piers will permanently preclude access to approximately 0.50 acres of spawning habitat. This will result in the alteration of normal behaviors as individuals will need to navigate around these temporary and permanent structures and expend additional energy seeking out suitable spawning habitat.

The temporary exposure of shortnose sturgeon to the cofferdams and trestle causeway and the permanent exposure of shortnose sturgeon to the new bridge piers will be considered harassment because exposure to these structures on the spawning grounds will disturb shortnose sturgeon by precluding them from accessing benthic habitat and will interrupt their normal behaviors (i.e., seeking out suitable spawning habitat and migrating through the action area). Any shortnose sturgeon present in the action area will be exposed to these structures and avoidance behaviors are likely to result in the expenditure of additional energy. The number of shortnose sturgeon present in the action area in a given year is impossible to predict; however, as one-third of adult females and one-half of adult males are likely to spawn in a given year, and population estimates suggest there are 6,000-14,000 adults in the Delaware River population, 2500 – 6,800 adults are expected to spawn annually in the Delaware River (assuming a 1:1 sex ratio), and it is likely that, due to the location of the action area within the spawning grounds, nearly all of these adults could be present in the action area during a particular spawning season while either migrating to or from upstream spawning sites or spawning within the action area. Therefore, the proposed action is likely to result in harassment to all adult shortnose sturgeon present in the action area in a given year. This will occur during construction while individuals are disturbed by the presence of temporary structures as well as post-construction when individuals are disturbed by permanent structures. Shortnose sturgeon are expected to seek and find suitable alternative spawning locations within the action area. Neither injury or mortality nor harm are anticipated due to the extent of available habitat in the action area and the Delaware River spawning grounds and the small spatial and temporal extent of any modifications to normal behaviors and accompanying energy expenditures. While shortnose sturgeon may experience temporary impairment of essential behavior patterns, no significant impairment resulting in injury (i.e., "harm") is likely due to: the temporary nature of any effects, the large amount of suitable habitat with adequate conditions for spawning, the ability of shortnose sturgeon to maneuver around the cofferdams, trestle causeways and bridge piers without significantly delaying spawning, and, because there is not expected to be any reduction in the number or viability of any eggs or larvae.

Despite the use of the best available scientific information, NMFS cannot quantify the precise number of fish that are likely to be taken. Because both the distribution of shortnose sturgeon throughout the Delaware River and the numbers of fish that are likely to be in the action area during the spawning season are highly variable and there is no precise estimate of the total population size or the number of individuals spawning in a given year, and because incidental take is indirect and likely to occur from effects to habitat, the amount of take resulting from harassment is difficult, if not impossible, to estimate. In addition, because shortnose sturgeon are aquatic species who spend the majority of their time on the bottom and because the time an individual spends in the action area is short, the likelihood of discovering take attributable to this proposed action is very limited. In such circumstances, NMFS uses a surrogate to estimate the extent of take. The surrogate must be rationally connected to the taking and provide an obvious threshold of exempted take which, if exceeded, provides a basis for reinitiating consultation. For this proposed action, the spatial and temporal extent of the benthic area from which shortnose sturgeon will be precluded from accessing provides a surrogate for estimating the amount of incidental take.

Extent of Take of Adults – During Construction

During construction shortnose sturgeon adults will be precluded from accessing the benthic habitat within cofferdams as well as the benthic habitat where the piles associated with the trestle causeways will be installed. Construction will occur in phases, with the number of cofferdams and piles variable within these phases; however, at any given time no more than 1 causeway consisting of no more than 36 24-inch diameter piles, and no more than 6 cofferdams are likely to be present. Based on the number and size of cofferdams and number and size of piles present during each phase of construction, shortnose sturgeon will be precluded from benthic habitats of no more than 0.75 acres for each of four spawning seasons.

The extent of take will be limited to those areas identified above. As such, during the construction period, NMFS will consider take to have been exceeded when upon review of the reports provided on actual construction of the cofferdams and piles, the data indicates that the amount of benthic habitat from which shortnose sturgeon have been excluded is greater than the area indicated above or that impacts have extended beyond four spawning seasons (i.e., if the area where piles were installed or cofferdams were present is not restored to pre-construction conditions or if construction continues for more than four spawning seasons).

Extent of Take of Adults – Post Construction
Following construction and restoration of areas where cofferdams and piles had been present, shortnose sturgeon adults will be precluded from accessing the benthic habitat where the new bridge piers have been constructed. Based on the number and size of the bridge piers, the replacement of six existing piers with five new piers will result in shortnose sturgeon being permanently precluded from approximately 0.50 acres of benthic habitat. As such, once the final bridge design is available, plans will be reviewed to determine if construction per the final design drawings is likely to result in greater than 0.50 acres of permanent habitat loss. Other opportunities to determine if take has been exceeded will include NMFS review of reports following the removal of existing piers and subsequent habitat restoration efforts and as-built surveys for each new bridge pier. NMFS will consider take to have been exceeded when upon review at any of these stages, the data indicates that the amount of benthic habitat from which shortnose sturgeon have been excluded is greater than the area indicated above.

Amount or Extent of Take of Larvae
The proposed action has the potential to result in the entrapment of larvae within cofferdams and subsequent mortality of some larvae pumped through the dewatering pump. As explained in the "Effects of the Action" section of the accompanying Opinion, FHWA has estimated that river flows greater than 61,725 cfs are likely to cause overtopping of cofferdams. While adult shortnose sturgeon are likely to have sufficient swimming ability to avoid entrapment in cofferdams and demersal eggs are not likely to be swept downstream in such a high flow event, larvae present in the water column are vulnerable to being swept downstream and becoming entrapped within a cofferdam. In order for a high flow event to result in the entrapment of larvae in a cofferdam, the event would have to occur during the limited time of year when shortnose sturgeon larvae are likely to be present in the action area, which is limited to no more than a 3-4 week time period within the late March to late June time period each year. The FHWA has indicated that based on available flow data for the Delaware River, flows sufficient to cause overtopping are likely to occur up to four times per year during the four year construction period, but no more than two overtopping events per year are likely to occur during the time of year when shortnose sturgeon are likely to be present in the action area. No more than two overtopping events per year are likely to result in the entrapment of larvae.

The capture of shortnose sturgeon within the cofferdams will disturb shortnose sturgeon and their normal behaviors will be interrupted (i.e., it will temporarily prevent them drifting and/or swimming uninterrupted over a distance of approximately 6.5 km/day). Additionally, larvae captured in a cofferdam will be pumped through a dewatering pump where they could be injured or killed. The best available information, outlined in the Opinion, indicates that based on the type of pump to be used, no more than 10% of larvae passed through the pump will be killed.

Any shortnose sturgeon present in the action area or upstream of the action area will be vulnerable to capture in the cofferdams. The number of shortnose sturgeon larvae present in the action area in a given year is impossible to predict; similarly, the number of shortnose sturgeon larvae on a given date when an overtopping event occurs is impossible to predict. However, based on the number of adult shortnose sturgeon spawning in the Delaware River in a given year (see above), millions of eggs are likely to be produced. Naturally high mortality of eggs means that only a percentage of the eggs will develop into viable larvae; however, hundreds of thousands of larvae are likely to be present in a given year. Based on assumptions outlined in the Opinion, NMFS has estimated that up to 0.088% of the larvae spawned in a given year could be captured in a cofferdam during a high flow event where cofferdams are overtopped, and that entrapment is likely to occur no more than twice per year over the four year construction period, with a total percentage of no more than 0.176% of the larvae spawned in a given year captured in a cofferdam each year, with no more than 10% of these larvae being killed. Therefore, NMFS has estimated that for each of the four years of construction, no more than 0.0176% of the larvae spawned in a given year would be killed due to being pumped out of an overtopped cofferdam. In the worst case that two overtopping events occurred when larvae were present during each year of construction, a total of 0.0704% of the larvae produced over the four year construction period could be killed due to entrapment in cofferdams and subsequent mortality due to passage through the dewatering pump.

Despite the use of the best available scientific information, NMFS cannot quantify the precise number of larvae that are likely to be taken by capture. Because both the distribution and numbers of larvae in the action area during an overtopping event is likely to be highly variable and a function of the number of spawning adults in a given year as well as the timing of the overtopping event, and because incidental take is indirect and likely to occur from effects to habitat, the amount of take resulting from harassment is difficult, if not impossible, to estimate. In addition, because shortnose sturgeon larvae are very small (20mm) and impossible to observe with the naked eye, the likelihood of discovering take attributable to capture in cofferdams is very limited. In such circumstances, NMFS uses a surrogate to estimate the extent of take. The surrogate must be rationally connected to the taking and provide an obvious threshold of exempted take which, if exceeded, provides a basis for reinitiating consultation. For this proposed action, the spatial extent of the cofferdams and the temporal extent of any overtopping provides a surrogate for estimating the amount of incidental take from capture.

During construction, no more than 0.75 acres of benthic habitat will be occupied by cofferdams. Based on information on historic flow conditions in the action area, overtopping is expected to occur no more than twice per year during the March 15 – June 30 time period, in the worst case, larvae could be present during both overtopping events. The extent of take will be limited to the benthic area occupied by cofferdams during an overtopping event occurring when shortnose sturgeon larvae are likely to be present in the action area (April 4 – June 11, based on historic water temperature data). As such, during the construction period, NMFS will consider take to have been exceeded when upon review of the reports provided after an overtopping event, the data indicates that the amount of benthic habitat within overtopped cofferdams is greater than the area indicated above or that more than two overtopping events occurred annually.

NMFS believes this level of incidental take is reasonable given the seasonal distribution and abundance of shortnose sturgeon in the action area and the best available information on the amount and type of habitat likely to be impacted by the proposed action. In the accompanying biological opinion, NMFS determined that this level of anticipated take is not likely to result in jeopardy to the species.

Reasonable and Prudent Measures

NMFS believes the following reasonable and prudent measures are necessary and appropriate to minimize and monitor incidental take of the Delaware River population of shortnose sturgeon:

1. The FHWA will monitor water temperature data to ensure that the no in-water work occur outside of cofferdams beginning when mean daily water temperature is 8°C and ending 28 days after mean daily water temperature reaches 18°C. Based on historic water temperature data, this time period is expected to encompass approximately March 26 – June 11.
2. The FHWA will develop and implement a debris management plan during all phases of construction.
3. The FHWA will undertake pre-construction surveys in the area where cofferdams and piles will be installed.
4. The FHWA will, to the extent feasible, restore habitat in the action area to pre-construction conditions once the construction is complete.
5. The FHWA will monitor shortnose sturgeon migrations to and from the action area.
6. The FHWA will develop a water quality monitoring plan to be implemented during the time of year when shortnose sturgeon are likely to be present in the action area.
7. The FHWA will monitor the cofferdams during the time of year when shortnose sturgeon are likely to be present in the action area to detect any overtopping.
8. The FHWA will report any sightings or interactions with shortnose sturgeon to NMFS in a prompt manner.

Terms and Conditions

In order to be exempt from prohibitions of section 9 of the ESA, FHWA and ACOE, as well as the applicant, must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

1. To implement RPM #1, the FHWA will work with NMFS and ACOE to develop a water temperature monitoring plan. FHWA will ensure that this plan is fully implemented. This plan will include a requirement to field test the USGS gage at Trenton to ensure that temperature recordings at this gage are an accurate measure of water temperature at the project site. If the USGS gage is not a reliable indicator of water temperature at the project site, FHWA will require water temperature monitoring at the project site sufficient to document mean daily water temperature at the site.

2. To implement RPM #1, the FHWA will monitor water temperature data from March 1 – July 15. This data will be used to compare against historic data and ensure that the March 15 – June 30 work moratorium for in-water work encompasses the time of year when shortnose sturgeon are likely to be present in the action area. A report on water temperature monitoring will be provided to NMFS prior to November 1 of each year. This report will include information on the daily mean water temperature at the project site throughout the March 1 – July 15 time frame as well as reporting the dates when water temperature reached 8°C, 10°C, 15°C, and 18°C and a calculation of the date when shortnose sturgeon were no longer likely to be present in the action area (i.e., 28 days after mean daily water temperature reached 18°C).

3. To implement RPM #1, the FHWA will monitor water temperature data in accordance with Term and Condition #1. The FHWA will ensure that at least 28 days have passed since the mean daily water temperature reached 18°C before in-water work begins.

4. To implement RPM #2, the FHWA will implement a debris management plan which will implement best management practices to minimize the potential for trash and construction debris to enter the waterway and to ensure the prompt removal of any trash or construction debris from the action area.

5. To implement RPM #3, at least 30 days prior to construction of each cofferdam and installation of piles, the FHWA will conduct a site survey to document water depth, water velocity and substrate type in the area where the cofferdam will be constructed and the piles will be installed (Pre-construction survey). This information must be compiled in a report and submitted to NMFS. This report must also contain a description of the actual size and location of each cofferdam as it is constructed and the date of construction as well as the actual number and location of each pile as installed and the date of installation (as-built report). This report (Pre-construction survey and As-built report) should be submitted to NMFS within 60 days after the completion of each cofferdam or pile-supported trestle causeway.

6. To implement RPM #4, following the removal of each cofferdam surrounding areas where the bridge piers were demolished and prior to March 15 of the following year, the FHWA must replace any cobble or rocks removed from the area and restore habitat conditions to the pre-construction state. A report on habitat restoration must be submitted to NMFS within 90 days of completion (see Term and Condition #8).

7. To implement RPM #4, following the removal of each cofferdam surrounding the new bridge piers and prior to March 15 of the following year, the FHWA must assess habitat conditions in the area where the cofferdam was present and if there is any habitat not

permanently impacted by bridge piers or rip rap, replace any cobble or rocks removed from the area and restore habitat conditions to the pre-construction state.

8. To implement RPM #4, following the removal of each trestle causeway and prior to March 15 of the following year, the FHWA must assess habitat conditions in the area where the piles were present and if there is any habitat disturbance, replace any cobble or rocks removed from the area and restore habitat conditions to the pre-construction state.

9. To implement RPM #4, a survey must be conducted 90 days after habitat restoration activities (outlined in Terms and Conditions 5-7 above) to survey the site and document any differences in the project site following restoration activities. A report must be provided to NMFS documenting the habitat restoration efforts and any changes in habitat (water depth, substrate type) persisting after habitat restoration efforts have been completed.

10. To implement RPM #5, the FHWA will make all reasonable attempts to coordinate with, and obtain data from, current (ERC Inc.) and proposed researchers working on shortnose sturgeon within this segment of the Delaware River, who will be using the acoustic receiver being furnished by the applicants and used by said researchers at the project site to document the use of the action area by tagged shortnose sturgeon. Any available information on the use of the action area by acoustically tagged shortnose sturgeon will be provided to NMFS by November 1 of the year in which it was collected.

11. To implement RPM #6, the FHWA will develop a water quality monitoring plan to be submitted to NMFS for approval. This approved plan must be implemented during the March 15 – June 30 time frame each year that work is ongoing within any cofferdams or along the river bed. The plan must require monitoring of temperature, total suspended solids and turbidity downstream of the project site sufficient to detect any differences in total suspended solids and turbidity between the upstream baseline site and the downstream site influenced by any discharges from the project site. A water quality report detailing the results of this monitoring, including information on any times when TSS or turbidity downstream of the project site exceeded upstream baseline assessments will be submitted to NMFS within 90 days of the close of this time period.

12. To implement RPM #7, the FHWA will develop a plan to monitor cofferdams during the March 15 – June 30 to ensure the detection of any overtopping. This plan will be submitted to NMFS for approval. FHWA has reported that overtopping is likely during any flow conditions greater than 61,725 cfs. Monitoring during these high flow events must include a visual inspection of the cofferdams to confirm that overtopping occurred and an assessment of the depth of water present in the cofferdam as well as a visual inspection to document the presence of any fish. Any overtopping of the cofferdams must be reported to NMFS within 24 hours. This report must include the date that overtopping occurred, flow conditions in the river (cfs), the depth of water in the cofferdams, and any visual observations of fish. Until alerted otherwise, the FHWA should contact Julie Crocker: by email (julie.crocker@noaa.gov) or phone (978) 282-8480 or the Section 7 Coordinator by phone (978)281-9328 or fax (978-281-9394).

13. To implement RPM#7, the FHWA will develop a monitoring plan to ensure that in the event of cofferdam overtopping, visual observations of the cofferdam occur prior to

complete dewatering to allow for the visual identification and removal of any adult shortnose sturgeon entrapped within the cofferdam. The monitoring protocol will identify the triggers for implementation as well as implementation procedures for the safety of personnel. The monitoring plan must be submitted to NMFS at least 60 days prior to the beginning of the first construction season during which cofferdams are constructed in the Delaware River, and FHWA must receive written approval of the monitoring plan by NMFS prior to construction of cofferdams. NMFS will provide written approval of, or comment on, the monitoring plan submitted by FHWA within 15 days of receipt. NMFS and FHWA will work cooperatively to develop a mutually acceptable monitoring plan so as to avoid unreasonable delays to construction. The monitoring plan will also outline reporting requirements. A report must be provided to NMFS within 7 days of any dewatering following overtopping. This report must include the date of dewatering, an estimate of the volume of water removed and any visual observations of fish.

14. To implement RPM #8, the FHWA must contact NMFS within 24 hours of any interactions with shortnose sturgeon at the project site. Until alerted otherwise, the FHWA should contact Julie Crocker: by email (julie.crocker@noaa.gov) or phone (978) 282-8480 or the Section 7 Coordinator by phone (978)281-9328 or fax (978-281-9394).

15. To implement RPM #8, if a shortnose sturgeon is observed at the project site, the observation must be documented on the form included as Appendix B and submitted to NMFS within 48 hours. This form will be submitted to NMFS via email (Julie.Crocker@noaa.gov) or fax (978-281-9394).

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize and monitor the impact of incidental take that might otherwise result from the proposed action. Specifically, these RPMs and Terms and Conditions will keep NMFS informed of when and where construction activities are taking place and will require FHWA to report any take in a reasonable amount of time, as well as implement measures to monitor for capture of shortnose sturgeon in cofferdams following any overtopping event. These RPMs and Terms and Conditions also require FHWA to conduct water quality monitoring and to conduct pre-construction and as-built surveys and to report on habitat restoration. The FHWA and the ACOE, as well as the applicants, have reviewed the RPMs and Terms and Conditions outlined above and all parties have agreed to implement all of these measures as described herein and in the referenced Appendices. The discussion below explains why each of these RPMs and Terms and Conditions are necessary and appropriate to minimize or monitor the level of incidental take associated with the proposed action and how they represent only a minor change to the action as proposed by the FHWA.

RPM #1 and #5 and the implementing Terms and Conditions (#1-3 and #10) are necessary and appropriate because they will serve to verify that the in-water work moratorium designed by the FHWA and the applicant encompasses the time of year when shortnose sturgeon are likely to be present in the action area. The required reporting will allow NMFS to monitor shortnose sturgeon movements to and from the action area, which will facilitate the monitoring of take. This is only a minor change because it is not expected to result in any delay to the project and as the proposed project already includes the in-water work moratorium. Further, the applicants have already proposed to support the cost of installation and maintenance of an acoustic receiver at the project site. Additionally, the cost of monitoring water temperature and producing reports is expected to be small.

RPM #2 and Term and Condition #4 are necessary and appropriate as they will require that the contractors use best management practices to minimize the potential for construction debris to enter the waterway, including the immediate removal of any debris. This will ensure that benthic habitat is not occupied by construction debris and thereby inaccessible to shortnose sturgeon, which will minimize take. This represents only a minor change as following these procedures should not increase the cost of the project or result in any delays of reduction of efficiency of the project. Further, the FHWA has indicated that a debris management plan is considered to be a standard protocol for bridge construction projects.

Several of the RPMs (#3 and #4) as well as the implementing Term and Conditions (#5-9) are necessary and appropriate because they require that the FHWA assess pre-construction conditions where temporary and permanent structures will be placed, document the structures as-built, restore habitat that was temporarily disturbed and report results to NMFS. This is necessary for the monitoring of the level of take associated with the proposed action. The inclusion of these RPMs and Terms and Conditions is only a minor change as the FHWA and the applicant included some level of assessment and habitat restoration in the original project description and the requirement for reporting will not result in any increased cost or delays to the project. These also represent only a minor change as in many instances they serve to clarify the scope of actions already proposed by the FHWA and the applicant.

RPM #6 and Term and Condition #11, is necessary and appropriate as they require the FHWA to conduct water quality monitoring to ensure that water quality in the action area outside of the cofferdams is not affected by work ongoing within the cofferdams, thereby ensuring that there is no unanticipated take associated with increased suspended sediment. This is only a minor change as the FHWA included some level of water quality monitoring in the original project description and the clarification on the type of monitoring and the requirement for reporting will not result in any increased cost or delays to the project. These also represent only a minor change as in many instances they serve to clarify the scope of actions already proposed by the FHWA, the ACOE and the applicant.

RPM #7 and Terms and Conditions #13 and #14 are necessary and appropriate as they require the FHWA to monitor cofferdams for overtopping during high flow events and to report these events to NMFS. This is essential for monitoring the level of incidental take associated with the proposed action. This RPM and the Terms and Conditions represent only a minor change as compliance will not result in any increased cost, delay of the project or decrease in the efficiency of the project.

RPM #8 and #16 and Terms and Conditions #15 and #16 are necessary and appropriate to ensure the proper documentation of any interactions with listed species as well as requiring that these interactions are reported to NMFS in a timely manner with all of the necessary information. This is essential for monitoring the level of incidental take associated with the proposed action. This

RPM and the Terms and Conditions represent only a minor change as compliance will not result in any increased cost, delay of the project or decrease in the efficiency of the project.

CONSERVATION RECOMMENDATIONS

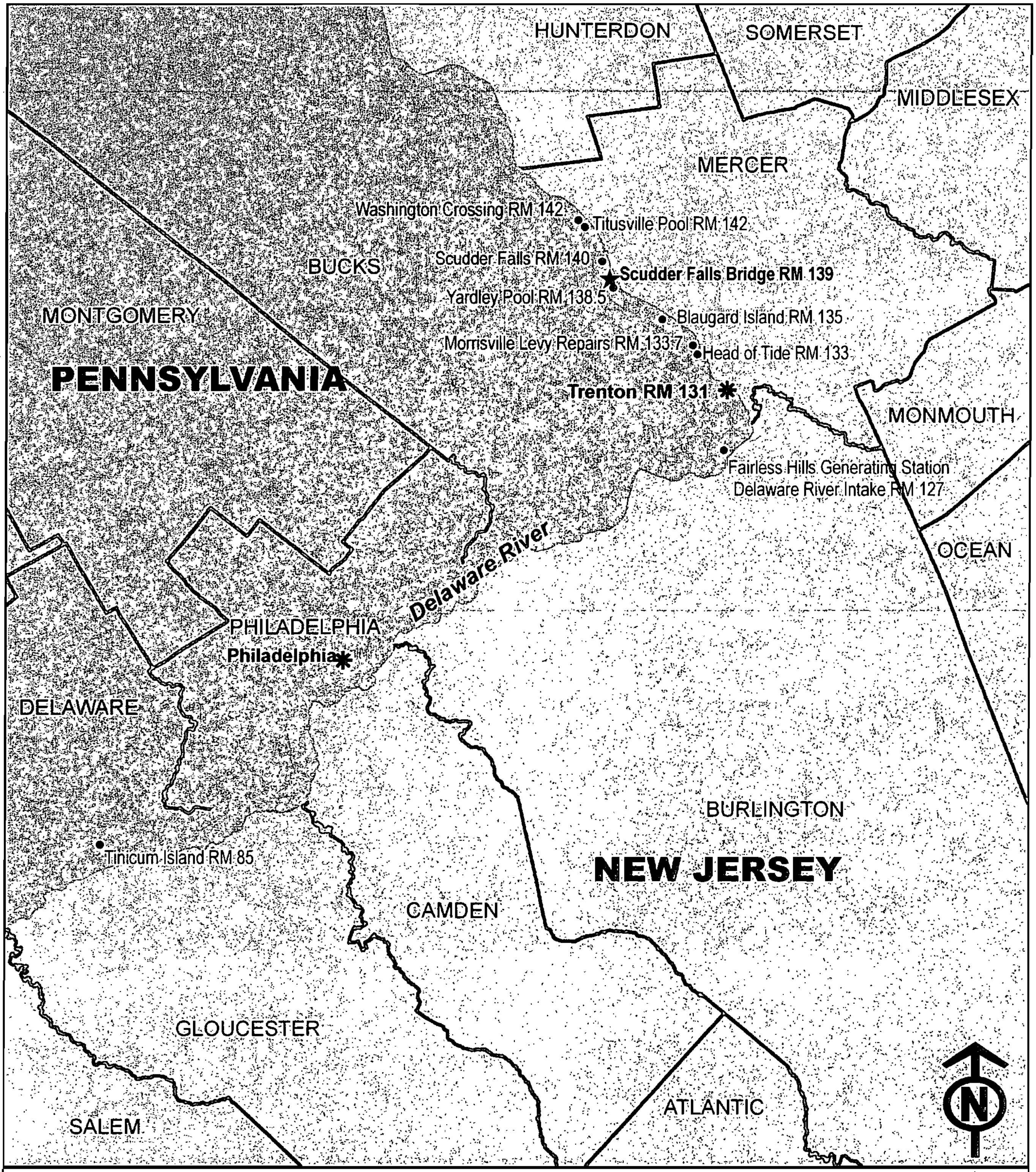
Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. NMFS has determined that the proposed action is not likely to jeopardize the continued existence of shortnose sturgeon. To further reduce the adverse effects of the proposed action on listed species, NMFS recommends that FHWA and ACOE implement the following conservation recommendations.

(1) Population information on certain life stages of shortnose sturgeon is still sparse for this river system. The FHWA and ACOE should continue to support studies to evaluate habitat and the use of the river, in general, by juveniles as well as determining the fate of early life stages spawned in the action area.

REINITIATION OF CONSULTATION

This concludes formal consultation on the effects of the proposed I-95 Scudders Falls Bridge Improvement Project to be carried out by the Delaware River Joint Toll Bridge Commission in association with the Pennsylvania and New Jersey Department of Transportation and to be authorized by the US Federal Highway Administration's and the US Army Corps of Engineers, Philadelphia District. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of taking specified in the incidental take statement is exceeded; (2) new information reveals effects of the action that may not have been previously considered; (3) the identified action is subsequently modified in a manner that causes an effect to listed species; or (4) a new species is listed or critical habitat designated that may be affected by the identified action. In instances where the amount or extent of incidental take is exceeded, Section 7 consultation must be reinitiated immediately.

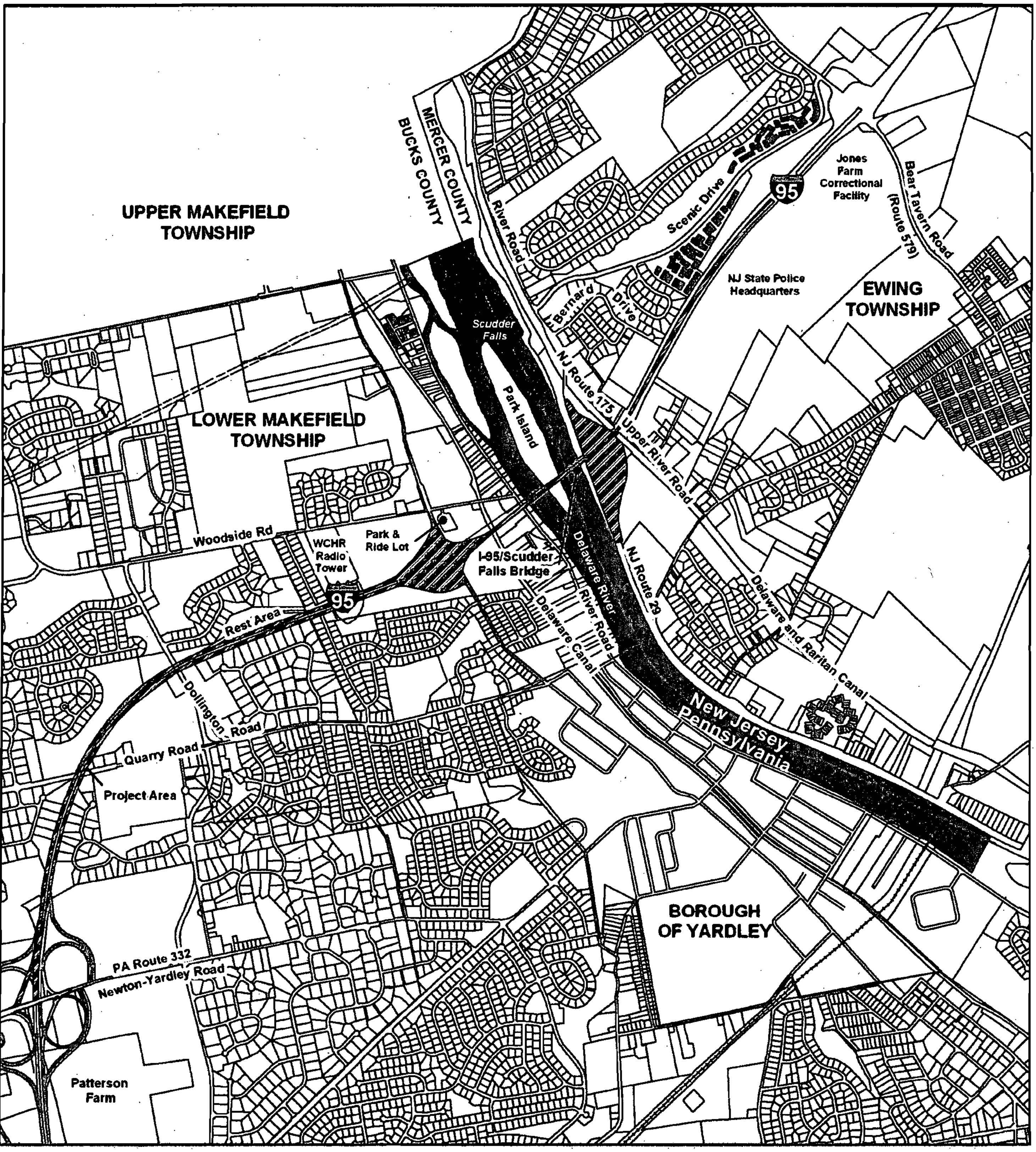
Appendix A



Delaware River
River Mile Location Map

FIGURE 1

RM = River Mile



Project Area

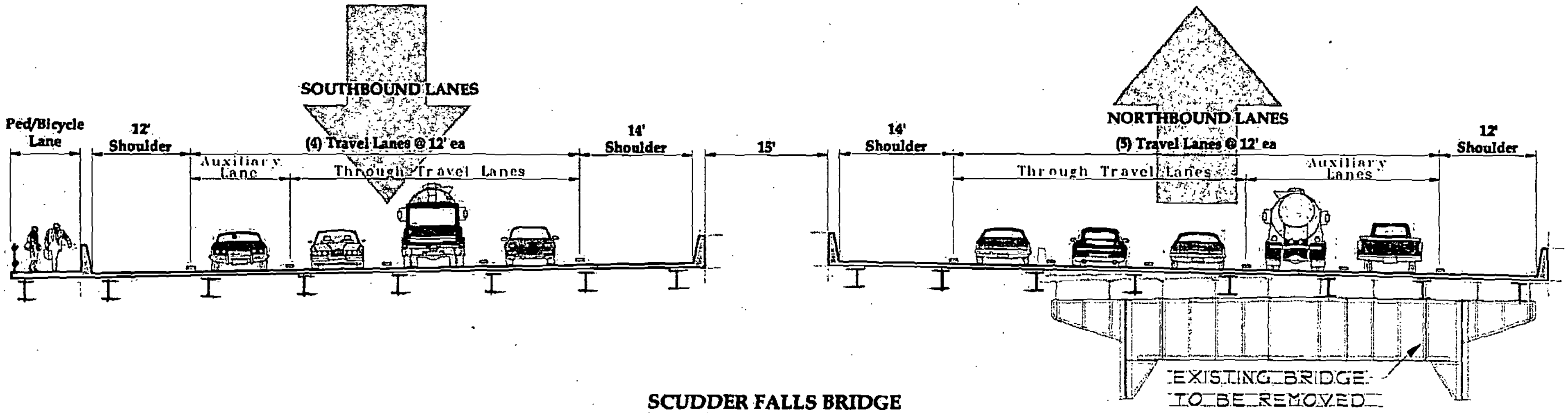
Not to Scale

I-95/Scudder Falls Bridge Improvement Project

Project Location Map

Figure 2

M:\38476\EA\FIGURES\Final EA Figures\Figure 1-2 Vicinity Map.mxd



SCUDDER FALLS BRIDGE

UPSTREAM ALTERNATIVE

Figure 3

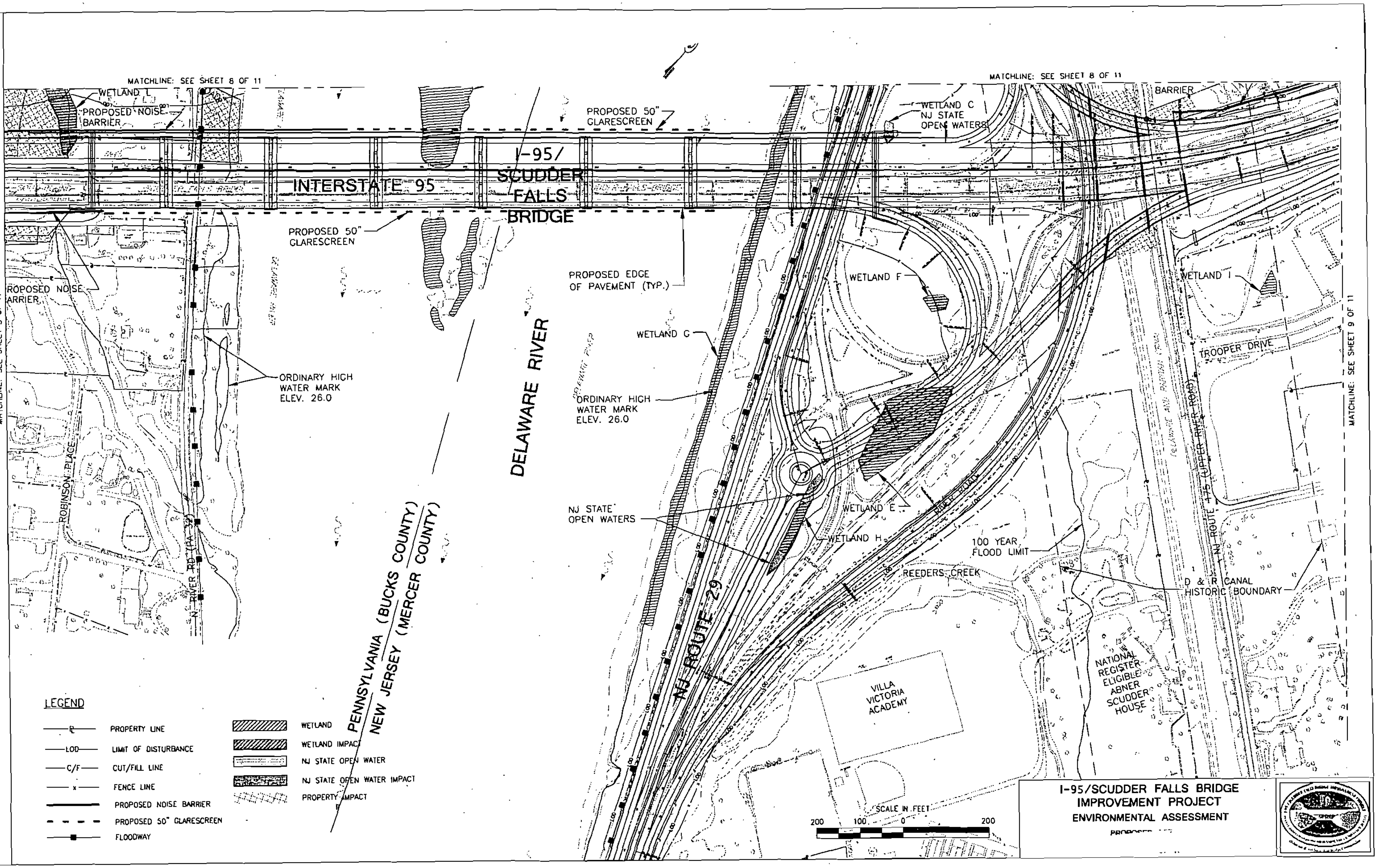


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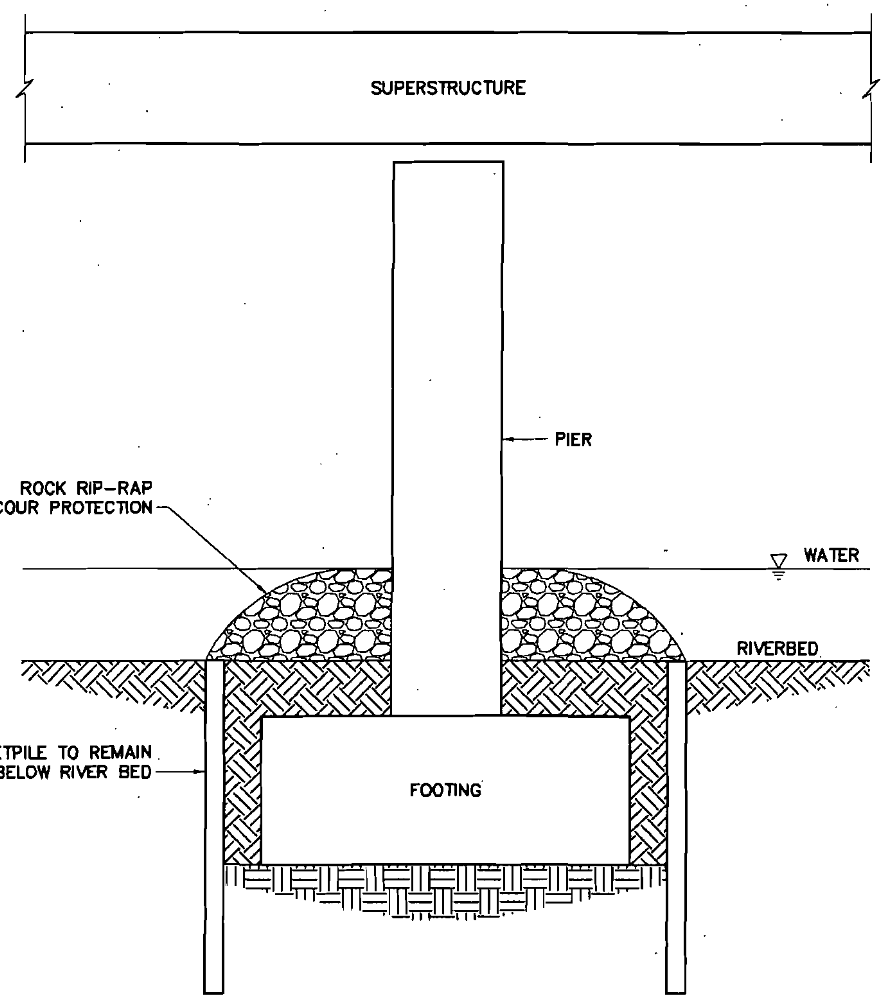
Figure 4



ELEVATION
TYPICAL RIVER PIER
SCOUR PROTECTION

FIGURE 3

APPENDIX B

ENDANGERED SPECIES OBSERVATION FORM
I-95/Scudders Falls Bridge

Daily Report

Date: ______________________________

Geographic Site: ____

Weather conditions: ____

____

Water temperature: ___________

Description of Observation: ____

____

____

FISH ALIVE: YES NO

Fish Decomposed: NO SLIGHTLY MODERATELY SEVERELY

Photographs Attached: YES NO

Comments (description of animal including approximate length, approximate water depth, unusual circumstances, etc:)

____

____

____

____

____

____

____

Observer's Name: ____

Observer's Signature: ____