UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 1
5 Post Office Square, Suite 100
BOSTON, MA 02109-3912

AR-378

December 15, 2017

NOAA'S National Marine Fisheries Service
Protected Resources Division
55 Great Republic Drive
Gloucester, MA 01930

Attn: Julie Crocker, Acting Assistant Regional Administrator for Protected Resources

Re: Schiller Station Electric Generating Facility
Portsmouth, New Hampshire
NPDES Permit No. NH0001473

Dear Ms. Crocker,

The U.S. Environmental Protection Agency, Region I, New England (EPA) is preparing to reissue the National Pollutant Discharge Elimination System (NPDES) permit for the Schiller Station Electric Generating Facility (referred to hereinafter as either Schiller Station, Schiller, the Facility, or the Station) located on the southwestern bank of the Piscataqua River in Portsmouth, New Hampshire. This letter is to reinitiate Endangered Species Act (ESA) consultation and request concurrence from your office for the Schiller Station permit action. EPA has made the determination that the proposed activity may affect, but is not likely to adversely affect, any species listed as threatened or endangered. In addition, the proposed action may affect, but is not likely to adversely affect, the designated critical habitat that overlaps with the action area. EPA's supporting analysis is provided below.

Consultation History
Section 7(a) of the Endangered Species Act of 1973, as amended (ESA) grants authority to and imposes requirements upon Federal agencies regarding endangered or threatened species of fish, wildlife, or plants ("listed species") and habitat of such species that has been designated as critical (a "critical habitat"). The ESA requires every Federal agency, in consultation with and with the assistance of the Secretary of Interior, to insure that any action it authorizes, funds, or carries out, in the United States or upon the high seas, is not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. The United States Fish and Wildlife Service (USFWS) administers Section 7 consultations for freshwater species. The National Marine Fisheries Service (NMFS) administers

Section 7 consultations for marine species and anadromous fish.

The Fact Sheet and Draft Permit were placed on public notice on September 30, 2015, and are available for review at: http://www2.epa.gov/aboutepa/public-notice-draft-permit-schiller-station-portsmouth-nh-nh0001473. The comment period was originally scheduled to close on November 28, 2015. However, based on a request by the permittee, the comment period was extended to January 27, 2016. The Draft Permit is intended to replace the existing NPDES permit in governing the withdraw of water for cooling purposes and the discharge of non-contact cooling water, operational plant wastewater, process water, and runoff to the Piscataqua River.

EPA submitted an Endangered Species Act (ESA) section 7 informal consultation letter to NMFS regarding the Schiller Station permit action, dated January 26, 2016. A return letter, dated May 11, 2016, was sent to EPA by NMFS. The NMFS letter concurred with EPA's determination that the proposed action may affect, but is not likely to adversely affect, any species listed by NMFS as threatened or endangered under the ESA of 1973, as amended. As part of the letter, NMFS informed EPA that the ESA section 7 consultation had been completed.

Subsequent to the May 11, 2016, completion of consultation, on August 17, 2017, NMFS published a final rule designating critical habitat for the five Atlantic sturgeon Distinct Population Segments (DPS). The segments are identified as Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic. The rule became effective on September 18, 2017.

A total of 31 Critical Habitat Units were established from Maine to Florida, encompassing all five Atlantic sturgeon DPSs. One of the units, located in New Hampshire, is described as the entirety of the Piscataqua River as well as the Salmon Falls and Cocheco rivers from their confluence with the Piscataqua and upstream to the Route 4 Dam, and Cocheco Falls Dam, respectively. The Schiller Station outfall action area is within this newly designated critical habitat unit. The Shiller Station action has not substantially changed since EPA submitted the Endangered Species Act (ESA) section 7 informal consultation letter to NMFS on January 26, 2016. However, based on EPA's review as well as communication with NMFS, EPA has made the judgment that in this case reinitiation of consultation is warranted because newly designated critical habitat (September 18, 2017) may be affected by the identified action.

The following information is taken primarily from the EPA consultation letter, dated January 26, 2016, the NMFS concurrence letter, dated May 11, 2016, and information included on the NOAA Fisheries Greater Atlantic Regional Fisheries Office website at: https://www.greateratlantic.fisheries.noaa.gov/protected/section7/guidance/consultation/index.html.

Proposed Project

EPA proposes to reissue the NPDES permit for Schiller Station, located on the southwestern bank of the Piscataqua River in Portsmouth, New Hampshire. The Station is a four-unit, 163 megawatt (MW) steam electric generating facility. The three main generators are designated as 4, 5, and 6; all rated at 48 MW each. Units 4 and 6 are equipped with dual fuel boilers capable of firing both pulverized bituminous coal and #6 fuel oil. Unit 5 was converted to a dual fuel fluidized bed boiler that is capable of burning both wood and coal, with wood being its primary fuel. The remaining unit, designated CT-1, is a 19 MW combustion turbine fired with #1 fuel oil that is typically operated during periods of highest seasonal peak demand. Schiller Station is a base load plant and generates upwards of 1 million MW-hrs annually, with a third of the power being provided by a renewable energy resource. Schiller Station produces enough energy to supply 65,000 New Hampshire homes. However, operations over the past few years have been significantly reduced in the 2 coal-burning units (Units 4 and 6).

Schiller Station's current NPDES permit allows the withdrawal of cooling water from and the discharge of pollutants to the Piscataqua River. Figure 1 shows a map of the facility, including outfall locations. The Station is permitted to discharge non-contact cooling water, operational plant wastewater, process water, and runoff. The majority of stormwater runoff on the site is commingled with other non-stormwater waters, so much of the runoff is regulated under the individual permit. For any stormwater that is directly discharged, a Stormwater Prevention Pollution Plan has been drafted and a NOI will be filed to cover these outfalls under a Multi-Sector General Storm Water Permit, and will be consulted upon separately. As such, these discharges will not be analyzed in this consultation.

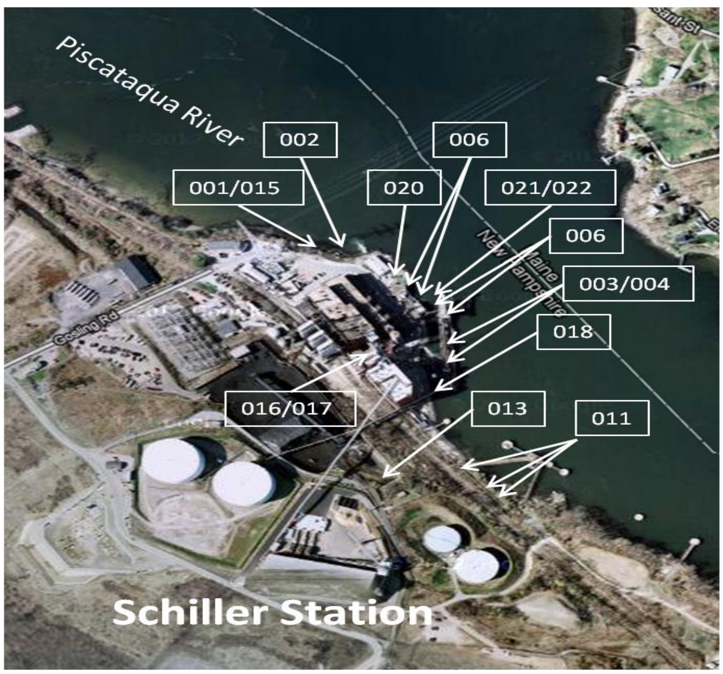

Figure 1. Locations of Schiller Station Outfalls in the Piscataqua River.

Schiller Station operates two intake structures that withdraw water directly from the Piscataqua River. Each intake structure has two openings which provide cooling water to the two circulation pumps. Unit 4 has a submerged offshore intake pipe that is 6.5 feet in diameter. The opening is located 32 feet out into the river and is equipped with a coarse mesh (12-inch by 12-inch grating) stationary bar rack, designed to prevent large debris from entering the intake. In addition, there is another fixed screen at the bottom of the tunnel entrance to divert lobsters from crawling into the intake. PSNH reports that the through-screen velocity is 1.38 fps at mean low water (MLW). However, the intake velocity at the tunnel entrance is 1.97 fps. Enercon, 2013, p.6.

The four screen openings used for Units 5 and 6 are approximately 5.5-feet wide each. The openings are protected by bar racks with 4 3/8-inch by 4 inch gratings. Enercon, 2008, p. 5. Furthermore, the through-screen velocities of these two units is 0.68 feet per second (ft/sec or fps). *Id*., p. 12.

Schiller Station still utilizes the same traveling screen design and technology that was originally installed with each unit: Unit 4 in 1952, Unit 5 in 1955, and Unit 6 in 1957. The mesh size of the traveling screens is 3/8-inch square, which is a size commonly used in the industry for CWIS screens. This mesh size should be small enough to prevent the entrainment of adult fish and most juvenile fish through the plant's cooling water system, but not younger and smaller lifestages (*i.e.*, eggs and larvae). In addition, narrow shelves (2–3 inches wide) are attached to the screens which carry debris and fish up as the screen rotates. These shelves are designed primarily for moving debris, not fish. Since there are no buckets or troughs used to carry fish safely to the fish return trough, fish can fall off the screen shelves as the screens emerge from the water. Consequently, fish can suffer injury or exhaustion from being dropped and re-impinged as the screens rotate.

The Station maintains 16 permitted outfalls into the Piscataqua River (Figure 1) and two separate wastewater treatment plants (WWTP) within the confines of the generation facility that are covered under the scope of this permit. Outfall 001 authorizes discharges from NCCW and drains from the northwest yard. Outfall 001 is subject to a permitted monthly flow of 40 MGD and a maximum daily flow of 40 MGD. Limits are also set for average monthly and total daily total residual oxidant, oil & grease, temperature and temperature rise. Outfalls 002 (Unit 4), 003 (Unit 5) and 004 (Unit 6) are authorized for discharge of NCCW and condenser hotwell drains. Outfall 002 is subject to a permitted monthly flow of 43 .5 MGD with a maximum daily of 52.2 MGD. Outfalls 003 and 004 are subject to a permitted monthly flow and a maximum daily flow of 50.2 MGD. Outfall 006, which consists of six pipes; two for each of Units 4, 5, and 6, is permitted for discharges from emergency boiler blowdowns, deaerator overflows and roof drains. Since this outfall is only used during emergency conditions or when a boiler experiences a severe disruption, the duration and amount of flow shall be estimated when a discharge occurs. Limits are set for average monthly Total Suspended Solids (TSS) and oil & grease for Outfall 006 when discharging.

Outfall 011 is authorized for discharges from the Schiller Station Tank Farm drains and stormwater from the facility. Outfall 011 is permitted to an average monthly limit of 300,000 gallons per day (GPD) and a maximum daily limit 600,000 GPD. Limits for average monthly and total daily Total Suspended Solids (TSS), oil & grease, pH, Group I Polycyclic Aromatic Hydrocarbons (PAHs) and Group II PAHs are also included in the draft permit. Outfall 013, an internal discharge, is authorized for emergency overflow discharge from the coal pile runoff basin into Outfall 018. Discharge from this outfall shall only consist of stormwater from the coal pile area during an emergency condition resulting from an actual storm that exceeds the l 0-year, 24-hour design storm and is included within the scope of this permit.

Outfall 015 is permitted to discharge treated effluent from WWTP # 1. This discharge is only used during times of essential maintenance of WWTP #2. When discharging Outfall 015 is authorized for an average monthly flow of 61,800 GPD and a maximum flow of 85 ,300 GPD. Limits are also set for average monthly and total daily TSS, oil & grease and pH. Outfall 016 is authorized for discharges of treated effluent from WWTP #2 during normal operating conditions, and an average monthly flow of 216,000 GPD and a maximum daily flow of 360,000 GPD are allowed. Limits are also set for average monthly and maximum daily limits for TSS, oil & grease, pH and nitrogen at this outfall. Outfall 017 is authorized for discharges of treated metal cleaning waste from WWTP #2 prior to comingling with any other waste streams, and is permitted for a maximum daily flow of 360,000 GPD as well as for average monthly, and maximum daily limitations for TSS, total copper, total iron, pH and oil & grease.

Outfall 018 is authorized to discharge effluent from Schiller Station's yard drains, the Newington Station Tank Farm yard drains, and heater condensate drips. An average monthly flow of 300,000 GPD and maximum daily limits of 600,000 GPD are authorized at Outfall 018. Limits are also set for average monthly and maximum daily limits for TSS, oil & grease, pH, and Group I and Group II P AHs. Outfall 020, Outfall 021 and Outfall 022 are authorized to discharge effluent from intake screen wash activities at the facility. Outfalls 020 and 021 are limited to maximum daily limits of 108,000 GPD each. Outfall 023 authorizes discharge of stormwater runoff from parking lots containing two chemical loading zones, and is not part of this permit renewal, and thus will not be considered further in this consultation. Limits are set for pH.

Description of the Action Area

The action area is defined as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action" (50 CFR § 402.02). For this project, the action area includes the surface and underwater areas where the effects of the discharge may be experienced in the receiving water body. The action area is a subset of the entire river and includes withdrawal areas and effluent discharge locations to the lower Piscataqua River, at a general discharge point approximately 6 miles upstream from the mouth of the river at the Atlantic Ocean. The total bank-to-bank width of the Piscataqua River in the vicinity of the Schiller Station outfalls, measured at the narrowest point of the river, perpendicular to the flow, is approximately 850 feet. This section of the river is approximately 40 feet deep. Salinity levels in this area of the Lower Piscataqua River range from a high of 33 parts per thousand (ppt) at high tide to a low of approximately 16 ppt during low tide (TRC 2012).

Thermal mapping results (see Figure 6.2 of the Fact Sheet), along with the fixed temperature monitoring station data, confirm that the high energy tidal exchange and volume of the Piscataqua River in the vicinity of Schiller Station results in a thermally influenced action area that is confined to the near-surface of the river and encompasses an area approximately 200 feet in all directions from the discharge. While this limited area is based on an analysis of the thermal component of the Schiller Station's effluent, other pollutants in the Draft Permit are regulated to meet water quality standards at the point of discharge (unlike the CWA § 316(a) thermal variance). Also, other regulated pollutants at Schiller Station, including total suspended solids and heavy metals, in addition to meeting water quality standards at the point of discharge, as mentioned above, are also discharged at much lower flows than the thermal effluent (360,000 gallons per day as opposed to 40 million gallons per day), further reducing the area of these pollutants before mixing with the Piscataqua River. Their presence in the receiving water cannot be detected above ambient levels and these regulated discharges are judged to not cause adverse effects to organisms in the river. Based on this analysis, at peak discharge EPA estimates that the action area is characterized as an area within 200 feet of the discharge locations in all directions into the Piscataqua River, and influences the water column no deeper than a potential maximum of 19.9 feet. In New Hampshire, mixing zones must be as small as feasibly possible, may not interfere with the migration or movement of fish, and must not occupy more than one-half of the water body's area; in this case, the mixing zone extends no more than 200 feet in any direction from any outfall. The total bank-to-bank width of the Piscataqua River, measured at the narrowest point of the river, perpendicular to the flow in the vicinity of the Schiller Station outfalls, is approximately 850 feet. The river depth in the area is approximately 40 feet. As discussed in the Atlantic Sturgeon Critical Habitat section of the letter, at its maximum cross-sectional area in the water column, the Schiller Station thermal plume is approximately 12% of the vertical cross section of the river. When considering the approximate 6-mile length of this section of the Lower Piscataqua River, from Bloody Point to Oriorne State Park, the action area makes up approximately 0.1% of the receiving water.

The entire tidal river is formed by the confluence of the Salmon Falls and Cocheco Rivers. It is approximately 13 miles long and empties into Portsmouth Harbor/ Atlantic Ocean. The tide in this river is semi-diurnal with an average period of 12.4 hours. Tidal flushing requires six to 12 tidal cycles (3 to 6 days) and tidal mixing forces cause the water column to be vertically well mixed. The lower portion of the Piscataqua River has been characterized as a well-mixed estuary.

The Piscataqua River is high value habitat for a variety of marine and estuarine species, and serves as the only conduit between the Gulf of Maine and Great Bay Estuary. While some fish species permanently reside in the river, most use it to either access spawning or nursery habitats in the Great Bay Estuary and associated rivers, or to migrate from these areas to marine habitats in the Gulf of Maine and beyond. Still others are seasonally present, preying on the concentrated but temporal influx of migrating forage species.

This portion of the river to which discharged effluent occurs has been designated a Class B waterbody pursuant to the State of New Hampshire Surface Water Quality Regulations and N.H RSA 485-A:8. Class B waters are "considered as being acceptable for fishing, swimming and other recreational purposes and, after adequate treatment, for use as water supplies." (RSA 485-A:8, II). There are two other federal funded, or carried out actions that NMFS has consulted on located upstream of the Station and one federal action that NMFS has consulted on downstream. None of these actions discharge heated effluent into this portion of the river and each are approximately 1.5 to 2.5 miles away from the Station.

Section 303(d) of the Federal Clean Water Act (CWA) requires states to identify those water-bodies that are not expected to meet surface water quality standards after the implementation of technology-based controls and, as such require the development of total maximum daily loads (TMDL). The section of the Piscataqua River that Schiller Station discharges into is on the 2012 CWA 303(d) list for estuarine bioassessments, polychlorinated biphenyls (PCB’s), mercury and dioxin.

NMFS Listed Species in the Action Area

EPA has reviewed the federal endangered or threatened species of fish, wildlife, or plants to determine if any listed species might potentially be impacted by the re-issuance of the Schiller Station NPDES permit. The two listed species that have the potential to be present in the vicinity of Schiller Station are the shortnose sturgeon (*Acipenser brevirostrum*) and the Atlantic sturgeon (*Acipenser oxyrinchus*).

Shortnose Sturgeon
The range of federally endangered shortnose sturgeon *(Acipenser brevirostrum)* extends from the St. John's River in Canada to the Minas Basin in Nova Scotia, Canada (NMFS 1998; Dadswell et al. 2013). There are approximately 19 spawning populations of shortnose sturgeon within this range. Until recently, shortnose sturgeon were thought to carry out their lifecycle within their natal river. Acoustic telemetry studies indicate, at least within the Gulf of Maine, some percentage of adult shortnose sturgeon participate in coastal migrations, moving between their natal river and other coastal rivers, with the southern and northern limits of detected movements being the Merrimack and Penobscot rivers, respectively.

The Piscataqua River is suspected to have historically supported shortnose sturgeon spawning; there is currently no evidence of spawning by shortnose sturgeon in this river. (SSSRT 2010). Species presence in the river has been confirmed through the detection of three tagged adult shortnose sturgeon by acoustic receivers (Micah Kieffer, USGS, pers. comm. to NMFS, 2015 in NMFS letter 2016). The available information indicates that adult shortnose sturgeon spend only brief periods in the Piscataqua system during longer movements between the Merrimack and Kennebec rivers and that they move between the mouth of the river and the first dam on the Salmon Falls River (at this time there are no receivers deployed in the Cocheco River) (M. Kieffer, pers. comm. to NMFS, 2015 in NMFS letter 2016). Based on the dates of detection of shortnose sturgeon in the river and movement patterns in other river systems, NMFS expect shortnose sturgeon in the action area between early May and early November. Based on the habitat available in the action area, NMFS expect transient adult shortnose sturgeon to be moving through and opportunistically foraging in the action area.

Atlantic Sturgeon
On February 6, 2012, NOAA's Fisheries Service published in the federal register a final decision to list five distinct population segments of Atlantic sturgeon *(Acipenser oxyrinchus)* under the Endangered Species Act. The decision became effective on April 6, 2012. The Chesapeake Bay, New York Bight (NYB), Carolina, and South Atlantic populations of Atlantic sturgeon were listed as endangered, while the Gulf of Maine (GOM) population was listed as threatened. The marine range of all five DPSs extends along the Atlantic coast from Hamilton Inlet, Labrador, Canada to Cape Canaveral, Florida.

Atlantic sturgeon are long-lived (approximately 60 years), late maturing, estuarine dependent, anadromous fish (Bigelow and Schroeder 1953; Vladykov and Greeley 1963; Mangin 1964; Pikitch *et al.* 2005; Dadswell2006; ASSRT 2007). Diets of adult and migrant subadult Atlantic sturgeon include mollusks, gastropods, amphipods, annelids, decapods, isopods, and fish such as sand lance (Bigelow and Schroeder 1953; ASSRT 2007; Guilbard *et al.* 2007; Savoy 2007). Juvenile Atlantic sturgeon feed on aquatic insects, insect larvae, and other invertebrates (Bigelow and Schroeder 1953; ASSRT 2007; Guilbard *et al.* 2007). Juveniles move downstream and inhabit brackish waters for a few months and when they reach a size of about 30-36 inches (76-92 cm) they move into nearshore coastal waters. Atlantic sturgeon generally use the deepest habitats available to them in rivers.

Young juveniles were observed more often over organic rich mud bottoms and at depths of 3.6-5.4 meters in the Albemarle Sound (Roanoke and Chowan/Nottoway Rivers) of North Carolina.

Information on Atlantic sturgeon presence in the Piscataqua River was provided in the Status Review of Atlantic Sturgeon (ASSRT, 2007) and the NMFS Greater Atlantic Regional Fisheries Office Master ESA Species Table for Atlantic Sturgeon (NMFS Species Table; Listing rules: 77 FR 5880 and 77 FR 5914, 2012) Their distribution and range in the watershed is considered to extend from the mouth of the Piscataqua River up to the confluence with the Salmon Falls and Cocheco Rivers (RKM 19), including Great Bay. The system historically supported spawning (ASSRT, 2007). Hard substrate and low salinity conditions, consistent with conditions that support Atlantic sturgeon spawning habitat, are present in the Cocheco and Salmon Falls Rivers below the first dams (Short 1992; Jones 2000). The Lower Piscataqua River is thought to be used seasonally by adult and subadult Atlantic sturgeon for foraging and resting during spring and fall migrations. Tagging data indicates that use by individual sturgeon is limited to days or weeks (NMFS Species Table).

NMFS has records of two Atlantic sturgeon in the Piscataqua River system since 1990. In June 1990, a gravid female Atlantic sturgeon was captured by a commercial fisherman in a small mesh gill net at the head-of-tide in the Salmon Falls River in South Berwick, ME (D. Grout, NHFG, pers. comm. 2006 in ASSRT 2007). In June 2012, an Atlantic sturgeon (originally tagged in New York Harbor), was detected on acoustic receivers in Great Bay. The detection site is approximately 2.4 miles upstream from the Schiller facility.

Based on the best available information on the distribution of Atlantic sturgeon, NMFS has determined that any spawning adults, young of year or early life stages of Atlantic sturgeon moving up or coming down from Salmon Falls or the Cochecho River are from the GOM DPS. However, it is possible that adults or subadults found in the Lower Piscataqua River can be from any DPS, since they all move within the marine range and can move into any coastal river system. Based on this judgment, for this consultation NMFS considers effects of the proposed action to have the potential to impact all DPSs of Atlantic sturgeon.

The characteristics of habitat used by Atlantic sturgeon life stages, including spawning and foraging habitat, are summarized in Greene *et al.*, 2009. Given the high salinity (approximately 33 ppt at high tide to 16 ppt at low tide) of the action area, NMFS maintains that no eggs, larvae or young of the year Atlantic sturgeon could survive in the action area; therefore, NMFS does not expect any of these life stages to be present in the action area. NMFS has also judged that smaller juvenile Atlantic sturgeon that have not migrated out of the Piscataqua River are likely present in the receiving water. EPA has made the judgment that it is possible for these juveniles to be present in the action area. With suitable forage present in the river, NMFS expects adult and subadult Atlantic sturgeon could be present in the action area during the spring through fall. Tagging detections suggest some Atlantic sturgeon may overwinter in the Kennebec Estuary, and at least one tagged sturgeon was detected during the winter in the Back River, Maine (G. Zydlewski, Univ. of Maine, pers. comm. to NMFS in NMFS letter 2016, Wippelhauser, 2012). However, the best available information suggests Atlantic sturgeon adults and subadults leave coastal estuaries in the fall, traveling along the coast to more southern waters or move into marine waters offshore of coastal estuaries (T. Savoy, CT DEEP, pers. comm. to NMFS in letter 2016, Oliver *et al*,.2013). Based on this information, NMFS does not anticipate Atlantic sturgeon to be present in the action area during the winter.

Consultation Required
In summary, EPA has determined that adult, subadult and juvenile Atlantic sturgeon and adult shortnose sturgeon may be present in the action area and these species and identified critical habitat may be affected by the discharges authorized by the proposed permit. EPA must consult with NMFS under Section 7 of the ESA. EPA has evaluated the potential impacts of the permit action on these two protected species and the critical habitat. On the basis of this evaluation, which is discussed below, EPA's determination is that this action "is not likely to adversely affect listed species or critical habitat." [1] 16 C.F.R. § 402.13(a). As a result, based on the justification contained in this attachment, EPA requests NMFS's written concurrence with EPA's determination in order to complete the consultation with NMFS on an "informal" basis. *See* 16 C.F.R. § 402.13(a). If NMFS does not concur, then a "formal consultation" will be necessary.

Effects of the Action
Schiller Station, like all facilities that utilize a natural waterbody for cooling purposes, can impact aquatic resources in three major ways: (1) by the impingement of larger organisms on the intake screens and the entrainment of small organisms into and through the cooling water system; (2) by creating adverse conditions in the receiving waters from the discharge of heated effluent; and (3) by creating adverse conditions in the receiving waters from the discharge of pollutants. The following information details these three potential impacts.

Impingement

Organisms that have grown to a size too large to pass through intake screens are still vulnerable to being impinged on these screens. Juvenile lifestages are particularly vulnerable to impingement, but adults of certain species are also at risk. As with entrainment, the intake location, design and cooling water flow requirements are major factors in assessing impingement potential.

Fish species that are especially vulnerable to impingement tend to have one or more of the following characteristics:

- pass intake structure in large, dense schools as juveniles or adults;
- are actively pursued as major forage species;
- are attracted to the intake structure as a source of forage or refuge;
- are slow moving or are otherwise unable to escape intake current; and
- are structurally delicate, and likely to die if impinged.

Fish from impingement sampling were collected in the fish and debris return sluice coming off of the traveling screens for each unit. Impingement sampling was conducted from August 31, 2006, through September 27, 2007. Impingement samples were collected over a continuous 24-

[1] A project can be considered "unlikely to adversely affect" a listed species "when direct or indirect effects of the proposed project on listed species are expected to be discountable, insignificant or completely beneficial." August 20, 2009, Letter from Patricia A. Kurkul, Regional Administrator, NOAA, National Marine Fisheries Service, Northeast Region, to Melville P. Cote, EPA Region 1 ("NOAA's August 20, 2009, Rockport Consultation Letter") (addressing ESA issues concerning EPA's proposed NPDES permit for the Rockport, MA, POTW).

hour period, once a week for 57 consecutive weeks. Each individual sample represented a six-hour collection period. Impingement sampling was only conducted when the plant was operational. Operational is defined as having at least 1 circulating pump running at the time of sampling.

Schiller Station conducted an impingement collection efficiency study to determine what percentage of impinged fish on the screens they were able to collect within the fish return sluice as well as an impingement survival study.

Fish impingement losses peaked in April, with secondary peaks in the fall and early winter. White hake, Atlantic herring and cunner were fish exhibiting the highest impingement losses in April (Normandeau 2008). In the fall, rainbow smelt, grubby and white hake were the species with the highest impingement losses (Normandeau 2008).

The table below presents entrainment losses by species (adjusted raw numbers at design flow);

Estimated Annual Fish Impingement Losses from Schiller Station

Common Name	Fish Impinged
Alewife	25
American sand lance	9
Atlantic cod	38
Atlantic herring	297
Atlantic menhaden	328
Atlantic silverside	122
Atlantic tomcod	50
Blueback herring	68
Bluegill	64
Cunner	668
Emerald shiner	33
Grubby	491
Herring family	9
Inland silverside	16
Lumpfish	357
Ninespine stickleback	149
Northern pipefish	621
Pollock	25
Pumpkinseed	9
Rainbow smelt	622
Red hake	9
Rock gunnel	26
Sea raven	16
Shorthorn sculpin	8
Silver hake	9
Skate family	17
Striped bass	25

Common Name	Fish Impinged
Tautog	9
Threespine stickleback	53
Unidentifiable	0
White hake	736
White perch	198
Windowpane	75
Winter flounder	573
Total Impingement	**5,557**

No adult, subadult or juvenile Atlantic sturgeon or adult shortnose sturgeon were collected as part of the impingement study at Schiller Station. Section 8.2.3 of the Fact Sheet contains a complete discussion of impingement mortality impacts from Schiller Station operation.

<u>Finfish Impingement Mitigation</u>

As part of the proposed permit Best Technology Available (BTA) requirements, EPA has identified the following technology to further mitigate adult and juvenile finfish losses, including the potential for Atlantic sturgeon impacts, from current expected impingement mortality levels at the cooling water intake structure (CWIS).

EPA proposes the installation of wedgewire screen intake structures with a mesh or slot size of 0.80 mm, 0.69 mm, or 0.60 mm to maintain an intake through-screen velocity of 0.5 feet per second (fps) or less. These slot sizes are estimated to reduce adult and juvenile finfish impingement by approximately 87% from current levels. The torpedo shaped intake structures will be installed parallel with the tidal currents of the river, approximately three feet off the bottom. EPA assumes that the expected swim speed of adult, subadult and juvenile Atlantic sturgeon and adult shortnose sturgeon can overcome a through-screen velocity of 0.5 fps (the average critical swim speed velocity of white sturgeon is estimated to be approximately 1.9 fps; see EPRI, 2000, Table A). Based on this information, EPA has made the preliminary determination that impingement of Atlantic sturgeon and shortnose sturgeon by the wedgewire screen CWIS will be unlikely. The operation of the wedgewire screen intake structure is expected to result in the intake having a discountable effect on the sturgeon species.

EPA estimates that Schiller Station will withdraw water using the present CWIS system for up to 52 months after the permit renewal action is finalized. This time is needed to conduct a pilot project to confirm the most effective design, obtain permits necessary for construction and complete the full scale installation of the new CWIS. EPA has judged that the present CWIS design and operation will have a discountable effect on Atlantic and shortnose sturgeon during this interim period because 1) the operation of the CWIS will continue for a relatively short period of time; 2) the near surface location of the CWIS is not in proximity to the near-bottom habitat where Atlantic and shortnose sturgeon are generally expected to be found; 3) the through-screen intake velocity now observed at the CWIS ranges from approximately 0.7 feet per second (fps) at two units to 1.4 fps at the third unit. These intake velocities are much lower than the maximum tidal currents in the river of approximately 4.9 fps during ebb tide and 4.4 fps during flood tide, so do not pose a major obstacle to sturgeon movement; 4) the average critical swim speed velocity of white sturgeon, for example, is estimated to be approximately 1.9 fps

(EPRI, 2000, Table A). Strong swimming Atlantic and shortnose sturgeon are expected to possess similar swim speeds. In the unlikely event that a sturgeon comes in close contact with the CWIS, the sturgeon swim speed will overcome the through-screen velocity at the CWIS and allow the sturgeon to swim past the CWIS without being impinged; and 4) there is no historical record of Atlantic sturgeon or shortnose sturgeon impingement at this facility.

<u>Entrainment</u>

The potential to impact aquatic organisms by entrainment largely depends on the presence and abundance of organisms that are vulnerable to entrainment, and the flow required for cooling. Organisms (including forage species) most vulnerable to entrainment in the vicinity of this proposed facility are species that have positively buoyant eggs, and/or pelagic larvae. Other important considerations include the location and design of the intake structure. According to section 316(b) of the Clean Water Act, any point source that uses a cooling water intake structure (CWIS) must ensure that its location, design, construction, and capacity reflects the best technology available (BTA) for minimizing adverse environmental impact.

Entrainment monitoring was conducted at Schiller Station for 41 weeks over a 13-month period with the following frequency. Samples were collected 1 day a week from January 2007 to March 2007 and June 2007 to September 2007. From September 2006 to December 2006 and from April to May 2007, samples were collected every other week.

Sorting, species and life stage identification and enumeration were all completed to generate entrainment rates (# of eggs or larvae per volume of water). Entrainment losses were calculated by multiplying the entrainment rate by the weekly plant cooling water flow.

At Schiller Station, entrainment losses of ichthyoplankton peaked in July, with a much smaller peak in the winter (January-March). Cunner eggs accounted for a large percentage of the losses in the July period (Normandeau, 2008). The peak in entrainment losses in the winter was comprised of winter spawners, such as American sand lance and rock gunnel (Normandeau, 2008). Macrocrustacean entrainment losses also peaked in July and were essentially almost non-existent during spring, fall and winter.

The table below presents entrainment losses by species (adjusted raw numbers at design flow);

Estimated Annual Entrainment Losses for Fish from Schiller Station

Common Name	Eggs & Larvae
Alligator fish	134,305
American eel	8,420
American plaice	1,061,867
American sand lance	13,677,174
Atlantic cod	329,888
Atlantic cod/haddock	161,177
Atlantic cod/haddock/witch flounder	344,498
Atlantic herring	1,921,628
Atlantic mackerel	5,846,389
Atlantic menhaden	633,228
Atlantic seasnail	389,677
Atlantic tomcod	53,043
Cunner	32,539,552
Cunner/yellowtail flounder	72,955,812
Fourbeard rockling	1,723,189
Fourbeard rockling/hake	6,394,256
Goosefish	135,665
Grubby	3,393,233
Gulf snailfish	21,770
Haddock	7,072
Hake family	1,397,166
Longhorn sculpin	424,745
Northern pipefish	716,836
Pollock	661,273
Radiated shanny	201,269
Rainbow smelt	1,752,755
Rock gunnel	7,634,337
Sculpin family	59,139
Sea raven	13,329
Sea robin family	71,494
Shorthorn sculpin	93,113
Silver hake	275,997
Striped killifish	8,420
Summer flounder	11,904
Tautog	56,294
Unidentified	246,244
Windowpane	547,224
Winter flounder	372,846
Witch flounder	17,617
Wrymouth	5,790
Total Entrainment	**156,179,633**

According to entrainment monitoring at Schiller Station, no early life stages (ELS) of Atlantic sturgeon or shortnose sturgeon were identified in entrainment samples at the facility. Based on a review of species lifestage presence, ELS of these two species are not expected to be in the action area because of high salinity levels salinity (approximately 33 ppt at high tide to 16 ppt at low tide).

Section 8.2.3 of the Fact Sheet contains a complete discussion of entrainment mortality impacts from Schiller Station operation.

Finfish Entrainment Mitigation

As part of the proposed permit Best Technology Available (BTA) requirements, EPA has identified the following technology to further mitigate ELS finfish losses, including EFH species, from current expected entrainment mortality levels at the cooling water intake structure (CWIS).

EPA proposes the installation of wedgewire screen intake structures with a mesh or slot size of 0.80 mm, 0.69 mm, or 0.60 mm to maintain an intake through-screen velocity of 0.5 fps or less. These slot sizes are estimated to reduce finfish ELS entrainment by approximately 37%, 44% and 49% from current levels, respectively. The actual screen slot size selected will be subject to EPA approval and based upon the results of the Facility's pilot testing and demonstration report submitted to the agencies.

In addition, EPA proposes that the annual maintenance outage at Unit 5, when no water is withdrawn, take place in June. This is estimated to reduce finfish ELS entrainment mortality by another 4% from current levels.

The proposed BTA will also reduce the entrainment levels of macrocrustacean ELS, which are a food source for Atlantic sturgeon. Section 10 of the Fact Sheet includes a full discussion of a number of potential mitigation measures and their expected reduction of finfish as well as macrocrustacean ELS entrainment mortality.

In summary, EPA proposes permit requirements that are estimated to reduce finfish ELS entrainment by approximately 41% to 53%, depending on the wedgewire slot size selected.

Based on the expected absence of spawning of Atlantic sturgeon and shortnose sturgeon in the Piscataqua River and resulting absence of early life stages vulnerable to entrainment, the habitat where they may reside, and the expected performance of the proposed BTA for entrainment reduction, EPA has made the preliminary determination that there is minimal potential for Atlantic sturgeon and shortnose sturgeon ELS entrainment, if at all. The effects of the operation of the CWIS are extremely unlikely to occur, therefore all effects of entrainment on these two protected species are discountable.

Discharge of Heated Effluent

The discharge of heated effluent may kill or impair organisms outright, or create intolerable conditions in otherwise high value habitats, and interfere with spawning. Thermal impacts associated with the discharge are related primarily to the dilution capacity of the receiving water, the rate of discharge, and the change in temperature (delta-T or ΔT) of the effluent compared to ambient water temperatures. Another important consideration is the presence of temperature-sensitive organisms and vegetated habitats.

As discussed in detail in Section 6.4 of the Fact Sheet, Schiller Station's existing permit's thermal discharge requirements are based on a CWA § 316(a) variance. The Facility initially requested that its new permit retain the same thermal discharge limits based on a renewal of its CWA § 316(a) variance. Schiller's request maintains, in essence, that the Facility's existing thermal discharge has not caused appreciable harm to the BIP and, indeed, could not have caused such harm given how small it is relative to the large volume and cold temperatures of the waters of the Piscataqua River estuary.

Based on the analysis of thermal plume monitoring and mapping data collected in the summer and fall of 2010, along with other supporting information (see Section 6.4.4. of the Fact Sheet), EPA concludes that Schiller Station's existing thermal discharge has not caused appreciable harm to the BIP. Moreover, EPA concludes that the record provides reasonable assurance that with the same thermal discharge limits in place, the Facility's thermal discharge will not cause such harm to the BIP in the future – in other words, will allow for the protection and propagation of the BIP. Indeed, the Facility's declining capacity factors indicate that, if anything, Schiller Station's thermal discharges will decrease overall in the future, though EPA cannot be sure of whether or when such reductions may occur.

Thus, EPA's new Draft Permit for Schiller Station proposes to retain the thermal discharge limits from the existing permit.

- A daily maximum discharge temperature limit (Max-T) of 95ºF;

- A daily maximum temperature differential between the intake and discharge temperatures (Delta-T) of 25ºF (this limit is increased to 30ºF for a two-hour period during condenser maintenance); and

- A prohibition of discharges that cause the receiving water to exceed a maximum temperature of 84°F at any point beyond a distance of 200 feet in any direction from the point of discharge.

Consistent with the Facility's request, EPA is proposing to issue these permit limits pursuant to a variance under CWA § 316(a).

Since the thermal plume has been documented as a near-surface feature which is relatively small in surface area (approximately 200 feet in any direction from the thermal outfalls; see action area of Schiller Station effluent discussion, above) and the maximum temperatures observed have not exceeded 82.4°F, the potential for acute or chronic impacts to finfish in the vicinity of the facility is discountable.

The total bank-to-bank width of the Piscataqua River, measured at the narrowest point of the river, perpendicular to the flow in the vicinity of the Schiller Station outfalls, is approximately

850 feet. Water temperature data shows, however, that the highest temperature "hot spot" recorded within the 200-foot mixing zone designated by the existing permit is only 82.4ºF, and this peak temperature occurs at a small point within the mixing zone. The area outside this mixing zone, while required to meet a temperature limit below 84ºF, is only minimally affected by the thermal discharge and maintains ambient river temperatures for the majority of the remaining width of the river. An examination of Figure 6-2 of the Fact Sheet indicates that a rise in surface temperature of up to a degree Celsius, from 23.1ºC to 24ºC (approximately a 1.7ºF rise; 73.6ºF to 75.2ºF) over ambient river temperature is evident in a localized area upstream from the discharge. This is a minimal, localized surface temperature increase, likely of short duration. The high energy tidal flow of the Piscataqua River moves water past the discharge, fostering vigorous mixing. A transitory temperature increase of this magnitude is expected to have an insignificant impact on fish passage in the river and the aquatic community in the vicinity of the discharge.

Based on relatively small size and minimal temperature rise within the thermal plume and the brief exposure time of juvenile, subadult or adult lifestages of Atlantic sturgeon or adult shortnose sturgeon that may encounter the plume, any effects on Atlantic or shortnose sturgeon from the thermal plume would be too small to be meaningfully detected and therefore the effects are insignificant. Section 6.4 of the Fact Sheet discusses the thermal discharge from Schiller Station in detail.

Discharge of Pollutants

The Draft Permit also proposes limits on the following pollutants:

Effluent Characteristic	**Average Monthly**	**Maximum Daily**
Total Residual Chlorine	---	0.2 mg/L
Oil and Grease	15 mg/L	20 mg/L
Total Suspended Solids (TSS)	30 mg/L	100 mg/L
Total Copper	1.0 mg/L	1.0 mg/L
Total Iron	1.0 mg/L	1.0 mg/L
pH	6.5 – 8.0 S.U. (range)	

These limits are calculated to meet water quality standards and protect all aquatic organisms in the receiving water, including protected sturgeon species. Water quality criteria are developed by EPA for protection of aquatic life. Both acute (short term exposure) and chronic (long term exposure) water quality criteria are developed by EPA based on toxicity data for plants and animals. Often, both saltwater and freshwater criteria are developed, based on the suite of species likely to occur in the freshwater or saltwater environment. For aquatic life, the national recommended toxics criteria are derived using a methodology published in *Guidelines for Deriving Numeric National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses.* Under these guidelines, criteria are developed from data quantifying the sensitivity of species to toxic compounds in controlled chronic and acute toxicity studies. The final recommended criteria are based on multiple species and toxicity tests. The groups of organisms are selected so that the diversity and sensitivities of a broad range of aquatic life are represented in the criteria values. To develop a valid criterion, toxicity data must be available for at least one species in each of eight families of aquatic organisms. The eight taxa required are as follows: (1)

salmonid (e.g., trout, salmon); (2) a fish other than a salmonid (e.g., bass, fathead minnow); (3) chordata (e.g., salamander, frog); (4) planktonic crustacean (e.g., daphnia); (5) benthic crustacean (e.g., crayfish); (6) insect (e.g., stonefly, mayfly); (7) rotifer, annelid (worm), or mollusk (e.g., mussel, snail); and, (8) a second insect or mollusk not already represented. Where toxicity data are available for multiple life stages of the same species (e.g., eggs, juveniles, and adults), the procedure requires that the data from the most sensitive life stage be used for that species.

The result of the above analysis is the calculation of acute (CMC) and chronic (CCC) criteria. CMC is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed briefly (i.e., for no more than one hour) without resulting in an unacceptable effect. The CCC is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed indefinitely without resulting in an unacceptable effect. EPA defines "unacceptable acute effects" as effects that are lethal or immobilize an organism during short term exposure to a pollutant and defines "unacceptable chronic effects" as effects that will impair growth, survival, and reproduction of an organism following long term exposure to a pollutant. The CCC and CMC levels are designed to ensure that aquatic species exposed to pollutants in compliance with these levels will not experience any impairment of growth, survival or reproduction.

Very few toxicity tests have been conducted with sturgeon. In the absence of species specific chronic and acute toxicity data, the EPA aquatic life criteria represent the best available scientific information. Absent species specific data, NMFS has judged that it is reasonable to consider that the CMC and CCC criteria for pollutants are applicable to ESA listed species under NMFS jurisdiction as these criteria are derived from data using the most sensitive species and life stages for which information is available. As explained above, a suite of species is utilized to develop criteria and these species are intended to be representative of the entire ecosystem, including Atlantic and shortnose sturgeon as well as their benthic prey. These criteria are designed to not only prevent mortality but to prevent all "unacceptable effects," which, as noted above, are defined by EPA to include not only lethal effects but also effects that impair growth, survival and reproduction. Therefore, discharges in compliance with water quality standards will result in effects to listed species that will be so small they would not be meaningfully detected. As such, EPA maintains that effects are insignificant.

Chlorine

The Draft Permit limit for total residual chlorine is based on the existing permit in accordance with the antibacksliding requirements found in 40 CFR §122.44. This limit was originally established based on New Source Performance Standards (NSPS) established in the Federal Guidelines for the Steam Electric Power Generating Point Source Category (40 CFR Part 423.15(j)(1)).

Section 423.15(j)(1) limits the maximum and average concentration of free available chlorine discharged in cooling tower blowdown as shown below. The quantity of pollutant (mass limit) is determined by multiplying the flow of cooling tower blowdown by the concentration listed in the table. However, the existing and Draft Permit limits are expressed as concentration limits pursuant to Section 423.15(m).

40 C.F.R. Part 423.15(j)(2) prohibits the discharge of free available chlorine or total residual chlorine (TRC) from any unit for more than two hours in any one day, and; not more than one unit in any plant may discharge free available or total residual chlorine at any one time unless the utility can demonstrate that the units in a particular location cannot operate at or below this level of chlorination.

At these extremely low chlorine concentrations, coupled with the limited duration of such an event, the discharge of this pollutant will not be able to be meaningfully measured or detected, and will have insignificant effects on Atlantic and shortnose sturgeon.

Total Suspended Solids
The Draft Permit limits for Total Suspended Solids (TSS) and Oil and Grease (O&G) are based on the existing permit in accordance with the antibacksliding requirements found in 40 CFR §122.44. These limits were originally established based on NSPS established in the Federal Guidelines for the Steam Electric Power Generating Point Source Category (40 CFR Part 423.15(c) for low volume waste source(s)).

Section 423.15(c) limits the maximum and average concentration of TSS and O&G discharged in low volume waste source(s) as shown below. The quantity of pollutant (mass limit) is determined by multiplying the flow of low volume waste source by the concentration listed in the table. However, the existing permit, as well as the Draft Permit limits, are expressed as concentration limits pursuant to Section 423.15(m). The permit reflects these limits prior to mixing with cooling water in the tower.

Studies of the effects of turbid waters on fish suggest that concentrations of suspended solids can reach thousands of milligrams per liter before an acute toxic reaction is expected (Burton 1993). The studies reviewed by Burton demonstrated lethal effects to fish at concentrations of 580 mg/L to 700,000 mg/L depending on species. Sublethal effects have been observed at substantially lower turbidity levels. For example, prey consumption was significantly lower for striped bass larvae tested at concentrations of 200 and 500 mg/L compared to larvae exposed to 0 and 75 mg/L (Breitburg 1988 in Burton 1993). Studies with striped bass adults showed that pre-spawners did not avoid concentrations of 954 to 1,920 mg/L to reach spawning sites (Summerfelt and Moiser 1976 and Combs 1979 in Burton 14 F993). While there have been no directed studies on the effects of TSS on Atlantic sturgeon, shortnose sturgeon juveniles and adults are often documented in turbid water. Dadswell (1984) reports that shortnose sturgeon are more active under lowered light conditions, such as those in turbid waters. Based on the general similarity of the two sturgeon species, Atlantic and shortnose sturgeon are assumed to be as least as tolerant to suspended sediment as other estuarine fish such as striped bass. Therefore, effects of increased TSS on Atlantic sturgeon and shortnose sturgeon in the action area will not be able to be meaningfully measured or detected, and are insignificant.

Oil and Grease
The Draft Permit proposes an average monthly limit of 15 mg/L and a maximum daily limit of 20 mg/L for oil and grease. These limits are based on water quality considerations. It is likely that any discharge of oil and grease from Outfalls 001, 006, 011, 015, 016, 017, and 018 in the concentration allowed under the proposed permit will remain localized and on the surface of the river, and not come in contact with deeper waters or benthic habitat where sturgeon may be

foraging or migrating. Because of the high dilution, low discharge concentration in compliance with standards, and the likelihood that oil and grease will remain in surface waters until full dilution, any effects to Atlantic and shortnose sturgeon or their prey are extremely unlikely to occur, and are, therefore, discountable.

pH

EPA, in consultation with NHDES has determined that the current permit as well as this Draft Permit retains the pH limited range of 6.5 - 8.0 S.U. A pH of 6.0 to 9.0 is harmless to most aquatic life; therefore, discharges in compliance with the permit limits will have insignificant effects (not able to be meaningfully detected) to aquatic life, including both sturgeons and their prey.

Metals

The persistence of a regulated effluent containing metals can vary, but typically, near field regions (i.e. the point of discharge/regulatory mixing zone) may experience some persistence in the environment, whereas far field locations tend to experience effluent decay (EPA Water Quality Based Toxics Control, 1991). In this site-specific case, with the high energy tidal exchange and volume of the Piscataqua River in the vicinity of Schiller Station, the zone of initial dilution (ZID) is expected to be relatively small and complete mixing will occur through dispersion and advection, thus limiting any potential exposure routes for shortnose and Atlantic sturgeon. Additionally, with the expected large dilution in the near-field, persistence will be reduced and far-field areas will likely contain levels that would be indistinguishable from ambient levels. Because of this, any effects on sturgeon species would be too small to be meaningfully detected and therefore EPA judges the far-field effects to be insignificant.

Heavy and trace metals may accumulate in the metabolically-active tissues of aquatic organisms, particularly in benthic feeders such as Atlantic sturgeon, and may lead to lethal and sublethal effects including reduced fecundity, body malformation, inability to avoid predation, and susceptibility to infectious organisms (Post, 1987, Alam *et al.*, 2000). Alam *et al.* (2000) indicate that Gulf sturgeon from the Suwannee River (a threatened species) tend to accumulate iron and lead in their blood, although the direct toxicity of iron is unknown (Vuorinen, 1999).

EPA's Draft Permit proposes to require (a) that the non-chemical metal cleaning waste be discharged from Outfall 016A subject to the 1.0 mg/L limits for total copper and total iron, and (b) that compliance monitoring for this type of metal cleaning waste occur after treatment but before discharge being comingled with any other waste streams. Furthermore, the Draft Permit allows low volume, runoff and drainage waste streams to be combined and discharged through Outfall 016 subject to the relevant effluent limits other than the technology-based copper and iron limits. Copper and iron limits will no longer be in Outfall 016 but will instead be in Outfall 016A.

In addition, any metals discharged from Schiller Station Outfall 016A will be mixed in the upper layers of the water column of the Piscataqua River by the high energy of the tidal currents in the near field of the discharge. The effluent is not expected to reach the deeper waters or benthic habitat where Atlantic and shortnose sturgeon are found the majority of the time.

These limits are calculated to meet New Hampshire Water Quality Standards and protect all aquatic organisms in the receiving water, including protected species. In the absence of species-specific acute and chronic data, EPA has identified the EPA aquatic criteria as the best available scientific information. As discussed above, discharges will be in compliance with water quality standards, which have been shown to have negligible effects on aquatic life, including sturgeon species and their prey. As such, any effects will be too small to be detected, and are, therefore, insignificant.

Polynuclear Aromatic Hydrocarbons (PAHs)
PAHs are a group of organic compounds that form through the incomplete combustion of hydrocarbons. PAHs are also present in crude oil and some heavier petroleum derivatives and residuals such as No. 6 fuel oil. Discharge of these products can introduce PAHs into the environment where they strongly adsorb to suspended particulates and biota. PAHs can also bio-accumulate in fish and shellfish. The ultimate fate of those PAHs which accumulate in the environment is believed to be biodegradation and biotransformation by benthic organisms. Several PAHs are well known animal carcinogens, while others are not carcinogenic alone but can enhance the response of the carcinogenic PAHs.

There are 16 PAH compounds identified as priority pollutants under the CWA (*see* Appendix A to 40 C.F.R. Part 423).   In view of evidence of PAH-induced animal carcinogenicity and the type of petroleum products stored at the facility, the Draft Permit establishes monitoring requirements, without limits, for these Group I and II PAHs, as listed below.

Group 1 PAHs comprise seven known animal carcinogens:

- Benzo(a)anthracene
- Benzo(a)pyrene
- Benzo(b)fluoranthene
- Benzo(k)fluoranthene
- Chrysene
- Dibenzo(a,h)anthracene
- Indeno(1,2,3-cd)pyrene.

Quarterly monitoring of the above Group I PAHs, without limits, is required.

Group II PAHs comprise nine priority pollutants which are not considered carcinogenic alone, but which can enhance or inhibit the response of the carcinogenic PAHs:

- Acenaphthene
- Acenaphthylene
- Anthracene
- Benzo(g,h,i) perylene
- Fluoranthene
- Fluorene
- Napthalene
- Phenanthrene

- Pyrene

Quarterly monitoring of the above Group II PAHs, without limits, is required. Of these, naphthalene is considered an important limiting pollutant parameter based upon its prevalence in petroleum products and its toxicity (i.e., naphthalene has been identified as a possible human carcinogen).

For the maximum protection of human health from the potential carcinogenic effects of exposure to PAHs through ingestion of contaminated water and contaminated aquatic organisms, EPA established human health "organism only" *National Recommended Water Quality Criteria* for individual PAH compounds based on the increase of cancer risk over the lifetime and consumption of contaminated fish. The human health criteria for Group I PAHs were established in ng/L, which is many orders of magnitude below the current Practical Quantitation Limits (PQLs) for determining PAH concentrations in aqueous solutions.

The Draft Permit also requires that the quantitative methodology used for PAH analysis must achieve a minimum level for analysis ("ML") using approved analytical methods in 40 C.F.R. Part 136. The ML is not the minimum level of detection, but rather the lowest level at which the test equipment produces a recognizable signal and acceptable calibration point for an analyte, representative of the lowest concentration at which an analyte can be measured with a known level of confidence. The ML for each Group I PAH compound must be <0.1 µg/L. The ML for each Group II PAH compound must be <1 µg/L. These MLs are based on those listed in Appendix VI of EPA's Remediation General Permit. Sample results for an individual compound that is at or below the ML should be reported according to the latest EPA Region 1 *NPDES Permit Program Instructions for the Discharge Monitoring Report Forms (DMRs)*. These values may be reduced by modification pursuant to 40 CFR §122.62 as more sensitive tests become available or are approved by EPA and the State.

Due to the infrequent nature of storm water flows at Outfalls 011 and 018, and the trace amounts of these pollutants detected in past monitoring events, toxics in the waste stream are not expected to cause an excursion above the standards in the receiving water due to 1) limited levels of pollutants in the storm water and 2) high dilution at the site. In the absence of species-specific acute and chronic data, EPA has identified requirements that are necessary for the protection of human health, that maintain the water quality standards established under Section 303 of the CWA, and that meet New Hampshire's water quality criteria as the best available scientific information. As discussed above, discharges during wet weather events will be in compliance with water quality standards, which have been shown to have insignificant effects on aquatic life, including sturgeon species and their prey. As such, any effects will be too small to be detected, and are, therefore, insignificant.

Atlantic Sturgeon Critical Habitat
A total of 31 Critical Habitat Units have been established for Atlantic sturgeon (effective September 18, 2017) from Maine to Florida, encompassing all five Atlantic sturgeon DPSs. As discussed in the *Consultation History* section of this letter, one of the 31 newly established critical habitat rivers is identified as the Piscataqua River. This critical habitat unit includes the Piscataqua River as well as the Salmon Falls and Cocheco rivers from their confluence with the Piscataqua and upstream to the Route 4 Dam, and Cocheco Falls Dam, respectively. As

discussed in the *Description of the Action Area* section of this letter, the action area includes the surface and underwater areas where the effects of the discharge may be experienced in the receiving water body. The Schiller Station outfall action area overlaps with this newly designated critical habitat unit. The action area is a subset of the entire river and includes withdrawal areas and effluent discharge locations to the lower Piscataqua River, approximately 6 miles upstream from the mouth of the river at the Atlantic Ocean. The action area is described as being confined to the near-surface of the river and encompasses a surface area approximately 200 feet in all directions from the discharge. The total bank-to-bank width of the Piscataqua River, measured at the narrowest point of the river, perpendicular to the flow in the vicinity of the Schiller Station outfalls, is approximately 850 feet. The river depth in the area is approximately 40 feet. At its maximum cross-sectional area in the water column, the Schiller Station thermal plume is approximately 12% of the vertical cross section of the river. When considering the approximate 6-mile length of this section of the Lower Piscataqua River, from Bloody Point to Oriorne State Park, the action area makes up approximately 0.1% of the receiving water."

The four physical or biological features (PBF) for reproduction and recruitment requiring special management considerations or protection for Atlantic sturgeon critical habitat are included below. An analysis of potential impacts from the regulated action follows each PBF.

(1) *Hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (i.e., 0.0–0.5 ppt range) for settlement of fertilized eggs, refuge, growth, and development of early life stages;*

The EP Newington Energy Facility (Newington) is located on the New Hampshire side of the Lower Piscataqua River, approximately one mile upstream from Schiller Station. Based on salinity studies performed by Newington in the mainstem of the Piscataqua River, conducted in 2008 and 2009, salinity levels in the Lower Piscataqua River reached maximum ambient salinity levels of 30 to 33 ppt (TRC 2012). The lower salinity range in this reach of the tidal river was documented to be well above 15 ppt for the majority of the low tide readings (TRC 2012). This salinity range is well above the range specified in PBF #1, above, and supports EPA's judgment that PBF #1 is not applicable to the Schiller Station action area.

In addition, the May 11, 2016, concurrence letter reported that given the high salinity of the action area, NMFS maintains that no eggs, larvae or young of the year Atlantic sturgeon could survive in the action area. In addition, the regulated discharges from Schiller do not contribute effluent with salinity levels above ambient conditions. These discharges do not have a measurable effect on salinity in the action area. Because of the high ambient salinity levels NMFS does not expect any of these early life stages to be present in the action area. This information also supports EPA's judgment that PBF #1 is not applicable to the Schiller Station action area.

Based on this analysis, using the best available science, EPA has determined that PBF #1 is not applicable to the Schiller Station action area.

(2) Aquatic habitat with a gradual downstream salinity gradient of 0.5 up to as high as 30 ppt and soft substrate (e.g., sand, mud) between the river mouth and spawning sites for juvenile foraging and physiological development;

As mentioned previously, Newington Station is located approximately one mile upstream from Schiller. Information obtained from the Newington salinity study, conducted in 2008 and 2009, documents that salinity levels in the reach of the Lower Piscataqua River associated with the Schiller Station action area are not gradual. Rather, salinity values continually fluctuate from as high as 33 ppt at high tides to as low as approximately 15 ppt at low tides, depending on the tidal cycle (TRC 2012). This section of the river experiences two high tides and two low tides in a twenty-four-hour period. This characterization supports EPA's judgment that PBF #2 is not applicable to the Schiller Station action area.

Also, information obtained from inspection and maintenance of the Newington Station deep water discharge diffuser describes a hard bottom, rocky substrate, continually scoured by the high energy tidal flows of the river (Newington Fact Sheet 2012). EPA maintains it is reasonable to judge that this hard bottom, rocky substrate is also present one mile downstream, in the vicinity of the Schiller Station action area. This description of the bottom substrate supports EPA's judgment that PBF #2 is not applicable to the Schiller Station action area.

Lastly, the regulated discharges from Schiller do not contribute effluent with salinity levels above ambient conditions. Therefore, they do not have a measurable effect on salinity in the action area or critical habitat and any effects are insignificant.

(3) Water of appropriate depth and absent physical barriers to passage (e.g., locks, dams, thermal plumes, turbidity, sound, reservoirs, gear, etc.) between the river mouth and spawning sites necessary to support: Unimpeded movements of adults to and from spawning sites; seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary, and; staging, resting, or holding of subadults or spawning condition adults. Water depths in main river channels must also be deep enough (e.g., at least 1.2 m) to ensure continuous flow in the main channel at all times when any sturgeon life stage would be in the river,

The thermal plume discharged from Schiller Station has the potential to be a physical barrier to juvenile, subadult and adult Atlantic sturgeon passage and movement into or out of the Piscataqua River. An analysis of the thermal plume was performed to evaluate this potential impact to Atlantic sturgeon critical habitat.

Based on mapping of the Schiller Station thermal plume under worst case conditions (August 31, 2010; Section 6.4.4 of the Fact Sheet) the highest temperature "hot spot" recorded within the 200-foot plume was 28.0°C (82.4°F). This peak temperature occurred at a small point within the surface of the mixing zone. This value was 5.0°C (9.0°F) higher than the ambient temperature of the Piscataqua River recorded that day, and EPA judged this spot to represent the confined near-surface area where the thermal discharge first enters the receiving water, just as it mixes with the Piscataqua River. The majority of the 200-foot plume surface area recorded a surface temperature of 24.0°C (75.2°F) to 25.0°C (77.0°F) or below. That represented a 1.0°C (1.8°F) to 2.0°C (3.6°F) elevation in temperature above ambient temperature conditions. Sturgeon temperature preferences are not well known. However, temperatures above 28°C (82.4°F) are thought to adversely affect shortnose sturgeon (Dadswell et al. 1984). Avoidance temperatures for juvenile, subadult and adult Atlantic sturgeon may likely be below this temperature.

As mentioned previously in the *Description of the Action Area* section of this letter, the portion of the river that is overlapped by the Schiller Station action area has a total bank-to-bank width of 850 feet. This section of the river is approximately 40 feet deep. The thermal plume from Schiller, under worst case conditions, measures approximately 200 feet in all surface directions from the surface discharge point along the bank. The buoyant plume could not be detected in a biologically meaningful way at a depth of approximately 20 feet (Section 6.4.4 of the Schiller Fact Sheet). Therefore, under worse case, conservative conditions, the thermal plume occupies an area that extends out from the New Hampshire bank 200 feet toward the middle of the river and reaches an estimated depth of no more than 19.9 feet. At its maximum cross-sectional area in the water column, the plume is approximately 12% of the vertical cross section of the river. When considering the approximate 6-mile length of the Lower Piscataqua River, from Bloody Point to Oriorne State Park, the action area makes up approximately 0.1% of the receiving water. Also, the plume does not reach the near bottom and substrate habitat of the river, where juvenile, subadult and adult Atlantic sturgeon are often found.

Although elevated water temperatures may exist in the plume that would cause juvenile, subadult and adult Atlantic sturgeon to avoid the area, most temperature zones within the plume are only 1.0°C (1.8°F) to 2.0°C (3.6°F) above ambient temperature conditions. In addition, the overall cross-sectional area of the plume is relatively small (maximum of 12% of river cross section), and the most likely utilized Atlantic sturgeon habitat in this section of the river is near bottom, where the thermal plume is not present.

In addition, water depths in the main river channel not impacted by the thermal plume are expected to be deep enough (a depth of 20 feet from the surface to the bottom substrate at approximately 40 feet deep) to ensure continuous flow of ambient temperature water in the main channel at all times.

Based on the best scientific information available, the thermal plume is not expected to impede movement of adults to and from spawning sites, is expected to be sufficiently small to allow unimpeded seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary, and is not expected to prevent or impede staging, resting, or holding of subadults or spawning condition adults. While the action of the discharge of the thermal plume may slightly alter PBF #3, the effect of the alteration on the ability of the PBF to provide its conservation function in the action area is so small that it cannot be meaningfully measured, detected or evaluated. EPA concludes that the effect on PBF #3 is insignificant. Therefore, the thermal effluent from Schiller Station discharge may affect, but is not likely to adversely affect the critical habitat in the action area as described in PBF #3.

All other pollutants discharged from the Schiller outfalls must meet New Hampshire Water Quality Standards at the end of pipe. The discharge flows containing these pollutants are much less than the thermal discharge flow allowed by the Draft Permit. Therefore, no other pollutant regulated from the Schiller outfalls is expected to be discharges in sufficient concentrations or extend to a sufficient distance in the river to be a physical barrier to Atlantic sturgeon passage. While the action of the discharge of other pollutants may slightly alter PBF #3, the effect of the alteration on the ability of the PBF to provide its conservation function in the action area is expected to be so small that it cannot be meaningfully measured, detected or evaluated. EPA concludes that the effect on PBF #3 is insignificant. All other regulated discharges from Schiller Station may affect, but are not likely to adversely affect the critical habitat as described in PBF #3.

(4) Water, between the river mouth and spawning sites, especially in the bottom meter of the water column, with the temperature, salinity, and oxygen values that, combined, support: Spawning; annual and interannual adult, subadult, larval, and juvenile survival; and larval, juvenile, and subadult growth, development, and recruitment (e.g., 13 °C to 26 °C for spawning habitat and no more than 30 °C for juvenile rearing habitat, and 6 mg/L or greater DO for juvenile rearing habitat).

As discussed in the analysis in PBF #3 above, temperature values within the thermal plume were recorded as high as 28.0°C (82.4°F). This peak temperature occurred at a small point within the mixing zone. This value was 5.0°C (9.0°F) higher than the ambient temperature of the Piscataqua River recorded that day. However, the majority of the 200-foot plume surface area maintained a surface temperature of 24.0°C (75.2°F) to 25.0°C (77.0°F) or below. That represented a 1.0°C (1.8°F) to 2.0°C (3.6°F) elevation in temperature above ambient temperature conditions. The thermal plume from Schiller will not elevate temperatures above 30 °C, so will have no impact on potential juvenile Atlantic sturgeon rearing habitat.

The regulated discharges from Schiller Station do not measurably influence ambient salinity values in the critical habitat. As noted in the PBF #2 discussion above, ambient salinity values in the action area continually fluctuate from as high as 33 ppt at high tides to as low as approximately 16 ppt at low tides, depending on the tidal cycle (TRC 2012). This section of the river experiences two high tides and two low tides in a twenty-four-hour period.

Continuous dissolved oxygen (DO) data was recorded by EPA from September 1 through October 1, 2016, at a station just upstream from the Schiller Station action area. The depth of the monitor fluctuated with the tidal cycle, but generally recorded DO levels between 6 and 12 feet from the surface. Over the course of the month, the DO ranged from 7.1 to 9.1 milligrams per liter (mg/l), with an average for the month of 7.8 mg/l. Although these readings were not taken near the deeper, near bottom waters (40 feet deep), this section of the river has been described as a well-mixed estuary. It is reasonable to assume the DO readings in the deeper, near-bottom waters of the Atlantic sturgeon juvenile, subadult and adult critical habitat would have been similar.

EPA has judged that the regulated discharges from Schiller Station do not measurably influence these dissolved oxygen values in the river. Elevated temperatures in the thermal plume are not of a magnitude that results in the discharge containing substantially less oxygen that the surrounding ambient waters. For example, the recorded Piscataqua River ambient temperature of 23.0°C (73.4.0°F) on August 31, 2010, with an assumed salinity value of 33 ppt (salinity and DO readings were not taken), would have a calculated maximum DO level of 7.1 milligrams per liter (mg/l), assuming 100% saturation. In the majority of the surface thermal plume, the elevated temperature value was measured at 1.0°C (1.8°F) to 2.0°C (3.6°F) higher than ambient (Section 6.4.4 of the Fact Sheet). A measured temperature of 25.0°C (77.0°F), with an assumed salinity value of 33 ppt, would have a calculated maximum DO value only 0.3 mg/l lower, at 6.8 mg/l, assuming 100% saturation (USGS DOTABLES).   Taking into consideration the well mixed, high energy tidal flows characteristic of the Lower Piscataqua River, EPA does not consider a potential transient DO reduction within the thermal plume of 0.3 mg/l to be biologically meaningful. As discussed previously, the buoyant plume could not be detected in a biologically meaningful way at a depth of approximately 20 feet (Section 6.4.4 of the Schiller Fact Sheet). The well mixed water column in the action area is approximately forty feet deep.

Based on the best scientific information available, the thermal plume is not expected to measurably degrade critical habitat to the point where annual and interannual adult and subadult and juvenile survival is negatively impacted and subadult growth, development, and recruitment is impeded. The thermal plume from Schiller will not elevate temperatures above 30 °C, so will have no impact on potential juvenile Atlantic sturgeon rearing habitat. While the action of the discharge of the thermal plume may slightly alter temperature and oxygen values as described in PBF #4, the effect of the alteration on the ability of the PBF to provide its conservation function in the action area is so small that it cannot be meaningfully measured, detected or evaluated. EPA concludes that the effect on PBF #4, especially in the bottom meter (three feet) of the forty-foot water column, is insignificant.

Finding

As detailed in this letter and the Draft Permit's Fact Sheet, the proposed CWIS BTA is designed to reduce current levels of impingement by 87% and entrainment by from 41% to 53%. The thermal discharge has been granted a CWA §316(a) variance. During discharge, any regulated pollutants rapidly mix in all tidal occurrences, with the exception of the brief slack tide period. Based on these factors and the analysis of potential impacts to Atlantic and shortnose sturgeon presented in this letter, EPA has determined that impacts to Atlantic and shortnose sturgeon from Schiller Station's CWIS and regulated effluent, if any, will be insignificant and the reissuance of this permit is not likely to adversely affect Atlantic or shortnose sturgeon.

In addition, EPA has judged that all effects to the applicable aspects of the four PBFs will be insignificant and the reissuance of this permit is not likely to adversely affect the critical habitat.

Therefore, EPA has judged that a formal consultation pursuant to Section 7 of the ESA is not required. EPA is seeking concurrence from NMFS regarding this determination through the information in this letter, as well as supporting information contained in the Fact Sheet, the Draft Permit, the EPA consultation letter, dated January 26, 2016, the NMFS concurrence letter, dated May 11, 2016, and information included on the NOAA Fisheries Greater Atlantic Regional Fisheries Office website at:
https://www.greateratlantic.fisheries.noaa.gov/protected/section7/guidance/consultation/index.html

Reinitiation of consultation will take place: (a) if new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered in the consultation; (b) if the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the consultation; or (c) if a new species is listed or critical habitat is designated that may be affected by the identified action.

Sincerely,

John H. Nagle

John H. Nagle
Environmental Scientist/Biologist
Office of Ecosystem Protection

cc: Michael Cobb, EPA
Christine Vaccaro, NMFS

Selected Literature

Anderson, E.K, Chen Z.Q.R., Bandeh H., Hannum M., Carr K., Cayar M., Haltas 1., Kavvas M.L., Cocherell D., Kawabata A., Kratville D., Hamilton S., MacColl T., Kanemoto L., Webber J., Cech Jr. J.J., Wilkinson C., McGee Rotondo M., Padilla R., Miranda J., Churchwell R. (2007) "Through-Delta Facility White Sturgeon Passage Ladder Study." (http ://baydeltaoffice.water.ca.gov/ndeltal/fishery/documents/TDF%20Sturgeon %20Passage%20Ladder.pdf).

Atlantic Sturgeon Status Review Team (ASSRT). 2007. <http://www.nero.noaa.gov/protres/CandidateSpeciesProgram/ AtlSturgeonStatusReviewReport.pdf>

Bigelow H. B., and W. C. Schroeder. 1953. Fishes of the Gulf of Maine. Fisheries Bulletin, U.S. Fish and Wildlife Service 53, Washington, D.C.

Burton, W.H. 1993. Effects of bucket dredging on water quality in the Delaware River and the potential for effects on fisheries resources. Versar, Inc., 9200 Rumsey Road, Columbia, Maryland 21045.

Dadswell, M. 2006. A review of the status of Atlantic sturgeon in Canada, with comparisons to populations in the United States and Europe. Fisheries 31: 218-229.

Damon-Randall, K., M. Colligan, and J. Crocker. 2013. Composition of Atlantic Sturgeon in Rivers, Estuaries, and Marine Waters. National Marine Fisheries Service, NERO, Unpublished Report. February 2013. 33 pp.

Environmental Protection Agency Region 1 (EPA Region 1). ESA Section 7 Request for Concurrence Letter for Schiller Station National Pollutant Discharge Elimination System Permit Renewal. January 26, 2016.

Environmental Protection Agency Region 1 (EPA Region 1). 2015-2016. Lower Piscataqua River Monitoring Program, Preliminary Data Report In Review. 2017

Environmental Protection Agency (EPA). 1986. Quality Criteria for Water. EPA 440/5-86-001.

Erickson, D. L., Kahnle, A., Millard, M. J., Mora, E. A., Bryja, M., Higgs, A., and E. K. Pikitch. 2011. Use of pop-up satellite archival tags to identify oceanic-migratory patterns for adult Atlantic Sturgeon, *Acipenser oxyrinchus oxyrinchus* Mitchell, 1815. Journal of Applied Ichthyology, 27(2), 356-365.

Guilbard, F., Munro, J., Dumont, P., Hatin, D., and R. Fortin. 2007. Feeding ecology of Atlantic sturgeon and lake sturgeon co-occurring in the St. Lawrence estuarine transition zone. In American Fisheries Society Symposium (Vol. 56, p. 85). American Fisheries Society.

Jones, S. H. (2000. (ed.)). A Technical Characterization of Estuarine and Coastal New Hampshire. Published by the New Hampshire Estuaries Project, Jackson Estuarine Laboratory, University of New Hampshire, 279.

Little, C. E., Kieffer, M., Wippelhauser, G., Zydlewski, G., Kinnison, M., Whitefleet-Smith, L. A. and J. A. Sulikowski. 2013. First documented occurrences of the shortnose sturgeon *(Acipenser brevirostrum,* Lesueur, 1818) in the Saco River, Maine, USA. Journal of Applied Ichthyology, 29: 709- 712. doi: 10.1111/jai.12159

Linares-Casenave, J., I. Werner, J.P. Eenennaam, S.I. Doroshov. 2013. Temperature stress induces notochord abnormalities and heat shock proteins expression in larval green sturgeon (Acipenser mesirostris. Ayres 1854). Journal of Applied Ichthyology, 29 (5). 958-967.

National Oceanic and Atmospheric Administration (NOAA). Tidal Current Predictions - NOAA Tides & Currents. Published June, 2012. Retrieved April 7, 2016, from http:/ /tidesandcurrents.noaa.gov/currents 12/tab2ac 1.html

National Marine Fisheries Service (NMFS) 2016. ESA Section 7 Concurrence Letter for Schiller Station National Pollutant Discharge Elimination System Permit Renewal. May 16, 2016.

National Marine Fisheries Service (NMFS) & U.S Fish and Wildlife Service (USFWS). 2014. Endangered Species Act Section 7 Consultation Programmatic Biological Opinion on the U.S Environmental Protection Agency's Issuance and Implementation of the Final Regulations Section 316(b) of the Clean Water Act. Biological Opinion. May 19, 2014.

National Marine Fisheries Service (NMFS) & U.S Fish and Wildlife Service (USFWS). 1998. Atlantic Sturgeon Status Review. (http://www .nmfs.noaa.gov/pr/species/statusreviews.htm).

Pikitch, EK., P. Doukakis, L. Lauck, P. Chakrabarty, and DL. Erickson. 2005. Status, Trends and Management of Sturgeon and Paddlefish Fisheries. Fish and Fisheries 6:233-65.

Savoy, T. 2007. Prey eaten by Atlantic sturgeon in Connecticut waters. *In* American Fisheries Society Symposium (Vol. 56, p. 157). American Fisheries Society.

Stein, A. B., Friedland, K. D., and M. Sutherland. 2004. Atlantic sturgeon marine distribution and habitat use along the northeastern coast of the United States. Transactions of the American Fisheries Society, 133(3), 527-537.

TRC. 2012. Salinity and Temperature Monitoring Study. Newington Power Facility. Newington, New Hampshire. 20 pages w/graphs.

United States Geological Survey. Temperature and Dissolved Oxygen Tables. Last Updated December 5, 2016. (https://water.usgs.gov/software/DOTABLES/).

Vladykov, V.D. and J.R. Greeley. 1963. Order Acipenseroidea. Pages 24-60 in Fishes of the Western North Atlantic. Memoir Sears Foundation for Marine Research 1(Part Ill). xxi + 630 pp.

Zydlewski, G. B., Kinnison, M. T., Dionne, P. E., Zydlewski, J. and Wippelhauser, G. S. 2011. Shortnose sturgeon use small coastal rivers: the importance of habitat connectivity. Journal of Applied Ichthyology, 27: 41--44.