UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
NORTHEAST REGION
55 Great Republic Drive
Gloucester, MA 01930-2276

NOV 26 2012

Mark Hasselmann
Manager, ROW & Environment
Federal Highway Administration
40 Western Avenue, Rm. 614
Augusta, ME. 04330

Re: Richmond – Dresden Bridge Replacement

Dear Mr. Hasselman,

Enclosed is our biological opinion issued under Section 7(a) (2) of the Endangered Species Act (ESA), for the Federal Highway Administration's (FHWA) proposal to replace the Richmond – Dresden (Route 197) Bridge over the Kennebec River in Maine. Certain in-water work will also require authorization from the U.S. Army Corps of Engineers, New England District. The work will be carried out by the Maine Department of Transportation and their contractors.

In this Opinion, we conclude that the proposed project may adversely affect, but is not likely to jeopardize, the continued existence of shortnose sturgeon, the Gulf of Maine (GOM) Distinct Population Segment (DPS) of Atlantic salmon, or any DPS of Atlantic sturgeon. We also conclude that the proposed activity will not likely adversely modify or destroy designated critical habitat for the GOM DPS of Atlantic salmon.

The proposed action is likely to result in the incidental take of Atlantic salmon, shortnose sturgeon and Atlantic sturgeon. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2) of the ESA, 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 the Incidental Take Statement (ITS). Incidental take is likely to result from entrapment of individuals within cofferdams when they are closed. The ITS exempts the non-lethal capture of two adult Atlantic salmon and one Atlantic salmon smolt; one shortnose sturgeon and one Atlantic sturgeon from the Gulf of Maine or New York Bight DPS. Sturgeon larvae may also be trapped within the cofferdams and die as they pass through dewatering pumps. The ITS exempts the lethal take of 10% of the shortnose sturgeon and GOM DPS Atlantic sturgeon larvae spawned in the Kennebec River in 2013.
The ITS specifies reasonable and prudent measures and implementing terms and conditions necessary to minimize the impact of these activities on listed species.

The RPMs outlined in the ITS are non-discretionary, binding conditions that must be undertaken in order for the exemption in section 7(o)(2) to apply. Failure to implement the terms and conditions through enforceable measures may result in a lapse of the protective coverage of section 7(o)(2). Monitoring that is required by the ITS will continue to supply information on the level of take resulting from the proposed action.

Re-initiation of this consultation is required if: (1) the amount of taking specified in the ITS is exceeded; (2) new information reveals effects of these actions that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) project activities are subsequently modified in a manner that causes an effect to the listed species that was not considered in this biological opinion; or (4) a new species is listed or critical habitat designated that may be affected by the identified actions.

We look forward to continuing to work cooperatively with your office to minimize the effects of transportation projects on listed species. For further information regarding any consultation requirements, please contact Max Tritt at (207) 866-3756 or by e-mail (Max.Tritt@noaa.gov). Thank you for working cooperatively with my staff throughout this consultation process.

Sincerely,

for John K. Bullard
Regional Administrator

EC: Hasselman, Martin - FWHA
Hamm, MDOT
Crocker, Murphy, Tritt – F/NER3
Doelling, Conant – NMFS/OPR
Clement, ACOE ME
Mahaney, FWS

File Code: Section 7 Richmond - Dresden Bridge Replacement
PCTS: NER-2012-2137

NATIONAL MARINE FISHERIES SERVICE
ENDANGERED SPECIES ACT
BIOLOGICAL OPINION

Agency: Federal Highway Administration

Activity Considered: Replacement of the Richmond-Dresden Bridge on Route 197, Maine
NER-2012-2137

Conducted by: National Marine Fisheries Service
Northeast Region

Date Issued: 11/26/12

Approved by:

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1.0 INTRODUCTION AND BACKGROUND

This constitutes the biological opinion (Opinion) of NOAA's National Marine Fisheries Service (NMFS) on the effects of the Maine Route 197 bridge replacement between Richmond and Dresden, Maine in accordance with Section 7 of the Endangered Species Act (ESA), as amended (16 U.S.C. 1531 et seq.). This action is proposed by the Maine Department of Transportation (MDOT) and will be funded by the Federal Highway Administration (FHWA). MDOT and their contractors will carry out the bridge project. The proposed action involves: the construction of a new bridge over the Kennebec River immediately upstream from the existing bridge; use of the existing bridge as a detour during construction; and, demolishing the old bridge. The action area is within the geographic range of five Distinct Population Segments (DPS) of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus)*, shortnose sturgeon (*Acipenser brevirostrum*), the Gulf of Maine (GOM) DPS of Atlantic salmon (*Salmo salar*), and designated critical habitat for the GOM DPS of Atlantic salmon. A complete administrative record of this consultation will be kept on file at our Maine Field Office in Orono, Maine.

1.1 Consultation History

- January 31, 2012. A MDOT biologist visited our office in Orono, ME to introduce eight future projects that would likely need ESA Section 7 consultation including the Richmond-Dresden (R-D) bridge replacement project.

- March 22, 2012. NMFS and MDOT biologists conducted a site visit to better understand the project, the habitat in the action area, and potential impacts to listed species and critical habitat.

- March 22, 2012. NMFS biologist attended a meeting in Augusta, Maine with MDOT biologist, and planners from the FHWA to address the R-D bridge project. The discussion included the likelihood of formal consultation due to the nature of the project and its associated effects on listed species and designated critical habitat. Preparation of the draft Biological Assessment (BA) was addressed along with requirements and expectations of all parties.

- April 11, 2012. MDOT posted a draft BA to the FHWA's ESA WebTool website for comment. FHWA project manager posted comments/edits to draft BA.

- April 17, 2012. NMFS posted comments/edits to draft BA.

- May 16, 2012. MDOT posted a draft cover letter for the draft BA to the FHWA's ESA WebTool website.

- May 24, 2012. MDOT posted a revised draft BA to the FHWA's ESA WebTool website.

- May 31, 2012. MDOT posted a revised draft BA and cover letter officially requesting formal consultation to the FHWA's ESA WebTool website.

- June 5, 2012. NMFS acknowledged receipt of the formal consultation request and alerted the FHWA project manager and MDOT biologist to deficiencies remaining in the draft BA.

- June 7, 2012. NMFS forwarded recommended changes to the draft BA to the MDOT biologist.
- June 26, 2012. NMFS acknowledged receipt of a draft BA, and submitted comments to MDOT. NMFS also posted the comments on the FHWA's ESA WebTool website.
- June 27, 2012. NMFS participated in a conference call with numerous state and federal agencies regarding the various agency responsibilities, needs, and anticipated consultation timeline.
- June 29, 2012. NMFS informed FWHA and MDOT that formal consultation could not begin until adequate information regarding the action, the species and critical habitat, and the effects of the proposed action was received.
- July 11, 2012. FHWA provided NMFS with a supplemental BA designed to address the original BA's deficiencies.
- July 17, 2012. NMFS sent a letter to FHWA officially requesting more information. Subsequent telephone conversations and emails between MDOT, FHWA, and NMFS resolved outstanding issues and filled remaining data gaps.
- July 11, 2012. Formal consultation was initiated.

1.2 Relevant Documents

The analysis in this Opinion is based on a review of the best available scientific and commercial information. Specific sources are listed in Section 13 and are cited directly throughout the body of the document. Primary sources of information include: 1) FHWA's May 31, 2012 initiation letter and attached BA in support of formal consultation under the ESA; 2) subsequent revisions to the BA (June 26, July 11, 2012); 3) determination of Endangered Status for the GOM DPS of Atlantic salmon; Final Rule (*74 FR 29345*; June 19, 2009); 4) Status Review for Anadromous Atlantic Salmon (*Salmo salar*) in the United States (Fay *et al.* 2006); 5) designation of Critical Habitat for Atlantic salmon GOM DPS (74 FR 29300; June 19, 2009); 6) Final Recovery Plan for Shortnose Sturgeon (December, 1998); 7) Final Listing Determinations for Atlantic Sturgeon (*77 FR 5714 and 77 FR 5880,* February 6, 2012).

1.3 Application of ESA, Section 7(a)(2) Standards – Analytical Approach

This section describes the approach used in this Opinion in order to apply the standards for determining jeopardy and destruction or adverse modification of critical habitat as set forth in Section 7(a)(2) of the ESA and as defined by 50 CFR §402.02 (the consultation regulations). Additional guidance for this analysis is provided by the Endangered Species Consultation Handbook, March 1998, issued jointly by NMFS and the U.S. Fish and Wildlife Service (FWS). In conducting analyses of actions under Section 7 of the ESA, we take the following steps, as directed by the consultation regulations:

- Identifies the action area based on the action agency’s description of the proposed action (Section 2);
- Evaluate the current status of the species with respect to biological requirements indicative of survival and recovery and the essential features of any designated critical habitat (Section 3);
- Evaluate the relevance of the environmental baseline in the action area to biological requirements and the species' current status, as well as the status of any designated critical habitat (Section 4);
- Evaluate the relevance of climate change on environmental baseline and status of the species (Section 5);
- Determine whether the proposed action affects the abundance, reproduction, or distribution of the species, or alters any physical or biological features of designated critical habitat (Section 6);
- Determine and evaluates any cumulative effects within the action area (Section 7); and
- Evaluate whether the effects of the proposed action, taken together with any cumulative effects and the environmental baseline, can be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of the affected species, or is likely to destroy or adversely modify their designated critical habitat (Section 8).

In completing the last step, we determine whether the action under consultation is likely to jeopardize the ESA-listed species or result in the destruction or adverse modification of designated critical habitat. If so, we must identify a reasonable and prudent alternative(s) (RPA) to the action as proposed that avoids jeopardy or adverse modification of critical habitat and meets the other regulatory requirements for an RPA (see 50 CFR §402.02). In making these determinations, we must rely on the best available scientific and commercial data. Conservation recommendations that are discretionary agency activities can also be suggested in order 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.

The critical habitat analysis determines whether the proposed action will destroy or adversely modify designated or proposed critical habitat for ESA-listed species by examining any change in the conservation value of the primary constituent elements of that critical habitat. This analysis focuses on statutory provisions of the ESA, including those in Section 3 of the Act that define “critical habitat” and “conservation,” in Section 4 of the ESA that describe the designation process, and in Section 7 of the ESA that set forth the substantive protections and procedural aspects of consultation. Although some “properly functioning” habitat parameters are generally well known in the fisheries literature (e.g., thermal tolerances), for others, the effects of any adverse impacts are considered in more qualitative terms. This analysis does not rely on the regulatory definition of “adverse modification or destruction” of critical habitat recently at issue in the 9th Circuit Court of Appeals (Gifford Pinchot Task Force et al. v. U.S. Fish and Wildlife Service, No. 03-35279, August 6, 2004).

2.0 PROPOSED ACTION

The proposed action is the replacement of the Route 197 Bridge spanning the Kennebec River between Richmond, Sagadahoc County and Dresden, Lincoln County, Maine (Figure 1). MDOT will construct a new bridge 15-30 meters (50-100 feet) upstream from the existing bridge. The new bridge will be supported by six in-water support piers and will have a total span of approximately 427 meters (1,400 feet). The existing bridge will be utilized as a detour during construction of the new bridge and will be demolished after construction and opening of the new bridge. The project is expected to start in the spring of 2013 and continue for two years.

Figure 1. Map of Project Area and Significant Locations

2.1 Overview of Pre-construction Activities

Preparatory activities for the bridge construction will require the creation of land based staging areas and in-water access roads. Situated on both sides of the river, these staging areas will be necessary for prepositioning heavy machinery, for stockpiling new construction material, and the transfer of demolition rubble.

Construction of in-water temporary access roads will affect about 557 square meters (6,000 square feet) on each side of the river for a total of 1,115 square meters (12,000 feet^2). A temporary geo-textile fabric will be placed over the affected riverbed at low tide, and the temporary road will be built on top of the fabric. The in-water section of the road will be built of clean, washed non-erodible riprap, and will be removed upon completion of demolition activities. These roads could be placed in a location that is just upstream, on alignment, or just downstream of the proposed new bridge. It is intended that construction will be carried out in a way that allows for complete recovery of the rip-rap and restoration of the substrate.

Detailed Work Plan
A staging area will likely be located on each end of the bridge. Staging of equipment and material will facilitate efficiency and reduce traffic congestion on the existing bridge. Pre-positioned equipment may include backhoes, vibratory hammers, compressors/generators, and clamshell excavators. Stockpiled material may include rip-rap, sheet piles and/or H piles. Any fill material placed into the river (rip-rap) will be preceded by the installation of geotextile fabric emplaced at low tide and stabilized prior to contacting the incoming tide. Each access point would be constructed of heavy riprap with a base approximately 10 meters (30 feet) wide and extend approximately 67 meters (200 feet) for access to the closest pier. This size roadbed would accommodate a dry five-meter (16-feet) travel width at all tides with 2:1 side slopes. It is expected the access road would be used to construct the piers closest to shore on opposite sides of the river. The temporary roads may also be used as anchorage for barges and other vessels used to construct the center piers.

It may also be necessary to construct work trestles to access mid-stream pier locations during construction and demolition. The work trestles will likely be supported by H-piles that will be driven into the river bottom with a vibratory hammer.

2.2 Bridge Construction Activities Overview

The initial step for the in-water bridge work on this project is to install six sheet pile cofferdams so that all future in-stream work can be conducted in the dry. This will occur during the first year of construction. This will be done by: 1) setting up cofferdams around the proposed pier sites to prevent water from leaking into the work area, and; 2) dewatering the work area. In-water acoustic monitoring will be conducted to monitor the effects of the sheet pile installation. Should underwater noise exceed acceptable levels (see below), noise minimization techniques and devices will be employed.

After the cofferdams are constructed, a concrete seal must be poured inside of the cofferdam for the bases of the piers. In order to establish a base, some excavation of unconsolidated material from the bottom of the cofferdam may be required. Any excavated materials will not be placed back into the river. The piers will be single shaft cast in place reinforced concrete with a hammerhead pier cap.

It will take approximately one to two weeks to complete the construction of each cofferdam. The cofferdams around each of the six piers will temporarily impact approximately 223 square meters (2,400 square feet) each and 1,337 square meters (14,400 square feet) total. Each cofferdam seal will have a footprint of approximately the same dimensions as the cofferdam itself after completion. Pier footings and piers will be placed on top on cofferdam seal. Because of the location of bedrock, the cement seal placed in the bottom of the cofferdam will remain above riverbed elevation after construction. Once the seal has been established, a mechanical pump will dewater each cofferdam allowing the remaining pier work to be conducted in the dry. All new bridge piers and foundations will be constructed inside of the cofferdams.

Detailed Work Plan

Steel sheetpile cofferdams will be constructed in order to isolate the work area for each new pier. This isolation technique has the added benefit of keeping all sediment released by construction in the dry work area where it can be removed before stream flow is restored. Work barges will position the cofferdam/driving frame and deploy spuds (vertical anchors). The steel sheetpiles will be positioned and driven in pairs by a vibratory hammer; two sheets will form the shape of a U when put together. Based on pier geometry, the number of sheetpiles required per cofferdam will be 60 pairs. The vibratory hammer (pile driver) will need to run for 5 to 10 minutes per pair of sheet piles. Sheets occasionally may need to be extracted and reinstalled if obstructions are encountered or if the piles are misaligned. This will result in about 17 hours of noise producing activity over a 10-day period (100 working hours) of work.

Piers 1, 2, 3, and 5 will be installed on bedrock. Cofferdams for these piers will be driven through sediment to bedrock, and the overburden will be excavated prior to start of pier construction. Piers 4 and 6 will be supported by piles that are not driven to bedrock inside of the cofferdam. Cofferdams and excavation will not extend down to bedrock on piers 4 and 6.

The steel sheetpiles will be initially installed using a vibratory hammer and then possibly driven to resistance (bedrock) by an impact hammer. In-water acoustic monitoring will be conducted to monitor the noise associated with the sheet pile installation. Acoustic monitoring will be required at the beginning of each individual cofferdam installation. Should noise intensity levels approach the published threshold for having the potential to injure listed species (187 dB re 1µPa CSEL and/or 206 $_{\text{PEAK}}$ dB re: 1 micro Pascal (1 µ Pa)), noise minimization measures will be used during subsequent pile driving activity. Should recorded underwater noise fall below the threshold for indication of potential behavioral modification by listed species (>150dB re: 1 µPa RMS) during active sheetpile installation at a specific cofferdam location, then, then acoustic monitoring may be suspended for the remainder of the installation of that specific cofferdam. As subsequent cofferdams are installed, monitoring will resume until recorded underwater noise is shown to be consistently below the threshold for potential behavioral modification by listed species.

The cofferdams for the new piers will be constructed with sheet piles and sealed after installation. The installation of each cofferdam will take approximately 1-2 weeks. The cofferdams will be partially constructed and then surveyed for listed species prior to the complete closure and subsequent dewatering, excavation, and placement of the seal and cap. Any fish remaining within the partially closed cofferdam will removed as described in the fish handling and evacuation section in Appendix B.

Once the final sheets are installed and the cofferdam is closed, each of the six cofferdams will be inspected for trapped fish before dewatering begins. Any fish remaining within the cofferdam will be removed as described in the fish handling and evacuation section in Appendix B. For cofferdams around new pier locations, a concrete seal will be placed on the floor of the cofferdam. This seal provides a concrete pad on which to construct the new pier footing and ensures that the cofferdam is sealed tightly. In placing a seal, the substrate within the cofferdam will be excavated down to bedrock with a clam-shell bucket prior to pouring the concrete seal.

Dredge material (sediment) from inside the cofferdam will not be placed in the river.

After the concrete seal has been poured and has cured (generally seven days) dewatering of the cofferdam will commence. Accumulated sediment is allowed to settle on top of the seal during the curing process. As the upper portions of the confined water column will not be in contact with the uncured concrete or settled sediments, the majority of the water inside the cofferdam is discharged overboard (i.e., directly back into the river).

At the first sign of sediment stirring in the cofferdam, the pump is stopped and an outlet hose is attached so that sediment laden water can be captured and, if necessary, treated in a dirty water treatment system. A representative of the MDOT Surface Water Quality Unit will periodically evaluate pH to determine whether the water is within the allowable tolerance to be pumped directly back into the river or whether it needs to be treated prior to discharge back to the river. Once dewatered, the seal will be cleaned of any remaining sediment. After the seal is cleaned, the cofferdam will be maintained in a “dry” condition by pumping to facilitate construction of the new structure.

The cofferdam dewatering system will be installed according to MDOT’s Best Management Practices (BMP) Manual. If there is leakage around the cofferdam, or upwelling in the work area, pockets will be excavated in the work area to collect the water. This water will be pumped into the dirty water system for treatment, prior to its release back into the river.

As the new piers will be constructed inside of the cofferdams, individual wooden forms will be built for each supporting pier and concrete will be poured into the form. Because the forms will be inside of a dry cofferdam, no uncured cement will be introduced into the Kennebec River. The new piers will be allowed to cure prior to any stringers being overlaid.

After all dry in-stream work has been completed the cofferdam will be removed. First, any sandbags will be removed by hand, if they are small, or by an excavator (land based or barge mounted) if they are the large industrial-sized sandbags. Then, the first sheet will be removed with a vibratory extractor (hammer) and the cofferdam will be allowed to fill with water. Each of the remaining sheets will then be removed with the vibratory extractor.

The bridge girder spans, stringers, superstructure, and decking will be built once the piers cure. As construction proceeds over the river, debris containment devices such as nets and trash pans will be installed beneath the new structure.

2.3 Overview of Bridge Demolition Activities

The existing bridge will be removed as part of the project. The old bridge deck will be removed and the bridge piers will be demolished. In-water acoustic monitoring will be conducted to establish the effects of the pier demolition. Should noise intensity approach levels that are likely to result in injury or behavioral disturbance of listed species, mitigation techniques and devices will be employed. MDOT anticipates up to 14 days for the demolition of one pier.

Detailed Work Plan

The bridge demolition will likely take place August 2014 – March of 2015. Using cranes, the old bridge deck will be lowered to a barge or loaded on to trucks moving from the center of the bridge towards shore. As demolition proceeds over the river, debris containment devices such as nets and trash pans will be installed beneath the old structure as practicable. Once the deck is removed, the bridge piers will be demolished using a hoe ram or if that is not successful, by blasting. The bridge piers may be broken into pieces with a hoe ram down to five feet below the existing river substrate elevation. The demolished pieces of the piers will be removed from the river and placed onto a barge with a clamshell bucket. As proposed, the existing piers will be demolished without containment.

As stated earlier, in-water acoustic monitoring will be conducted to establish the noise associated with pier demolition. A hoe ram generates impulsive subsurface sound pressure waves similar to an impact or vibratory hammer by rapidly chiseling or hammering exposed rock. Should noise intensity levels approach the published threshold for having the potential to injure listed fish species (187dB re 1uPa $_{\text{CSEL}}$ and/or 206dB $_{\text{PEAK}}$ re 1 μPa) (FHWG 2008), mitigation techniques such as reducing the settings on the hammer itself, and devices (e.g., micarta blocks and bubble curtains) will be employed. Thresholds for injury discussed above are based on an organism's response to impulsive sound pressure waves. Pile driving and hoe ramming both generate impulsive pressure waves; therefore, both devices affect organisms similarly. Accordingly, both devices can be held to the same performance standard. As a conservative measure, we use 150 dB re 1uPa $_{\text{RMS}}$ as the threshold for potential behavioral effects to ESA-listed fish species (salmon and sturgeon). As such, operators will allow a 12-hour recovery period (i.e., in-water noise <150dB RMS re 1μPa or ambient levels) if noise levels > 150dB $_{\text{RMS}}$ re 1μPa persist for over 12 consecutive hours on any given day. Should recorded noise intensity fall below the acknowledged 12 hour threshold for behavioral modification by listed species (150 dB$_{\text{RMS}}$ re: 1 μPa) or back to ambient levels during pier demolition, then acoustic monitoring may be suspended. However, different pier sections may include materials with different density, e.g. cement, masonry, or granite. As different material, i.e., harder stone, is encountered, higher sound levels will likely be generated, and acoustic monitoring may be required to resume.

Blasting may also be used to aid in the removal of the old bridge piers. If blasting is deemed necessary, a blasting plan including detailed design information on each charge (e.g., type of explosive and detonation velocity (burn rate), type of blasting technique used, borehole dimensions, spacing, charge weights, delay intervals, method of initiation, and noise mitigation plans) will be submitted to NMFS no later than 30 days prior to planned detonation. Based on the proposed blasting as we understand it, MDOT will design the blasting to ensure that there is no potential to harm, harass, injure or kill listed fish. We expect that the blasting plan will contain sufficient information to allow us to assess if that will be the case. At the time the blasting plan is reviewed, we will determine if blasting will introduce effects to listed species that were not considered here. If so, reinitiation of consultation will be necessary.

At this time, it is unknown whether the existing bridge abutments will be removed as part of this project. If the existing abutments are removed, the work will take place in the dry behind a cofferdam that was constructed at low tide to ensure fish are not trapped within the cofferdam limits. The abutment removal site will be stabilized according the MDOT BMPs prior to the removal of the cofferdam.

2.4 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 (project area) involved in the proposed action" (50 CFR 402.02). The action area must encompass all areas where both the direct and indirect effects of the proposed action will be experienced. The action area includes the project footprint where the new bridge will be built and old bridge demolished, as well as wherever increased underwater noise levels, sediment loads, and/or changes in water quality resulting from this action will be experienced.

The action area is a freshwater tidal reach of the lower Kennebec River immediately upstream from Swan Island and Merrymeeting Bay. Short-term, construction related effects are expected to occur largely in the lower Kennebec River- downstream from the project footprint towards Swan Island and the confluence with the Eastern River. The ebb and flow of the tide will influence the direction of the sediment plume. Based on noise attenuation rates and anticipated turbidity, effects of this action will likely extend a few hundred meters up and down stream.

3.0 STATUS OF AFFECTED SPECIES AND CRITICAL HABITAT

Several species listed under NMFS' jurisdiction occur in the action area for this consultation. NMFS has determined that the action being considered in this biological opinion may affect the following endangered or threatened species under NMFS' jurisdiction:

Fish

Gulf of Maine DPS of Atlantic salmon	Endangered
Gulf of Maine DPS of Atlantic sturgeon	Threatened
New York Bight DPS of Atlantic sturgeon	Endangered
Shortnose sturgeon	Endangered

Critical Habitat

Designated for the Gulf of Maine DPS of Atlantic salmon

3.1 Gulf of Maine Distinct Population Segment of Atlantic Salmon

3.1.1 Species Description

The Atlantic salmon is native to the basin of the North Atlantic Ocean, from the Arctic Circle to Portugal in the eastern Atlantic, from Iceland and southern Greenland, and from the Ungava region of northern Quebec south to the Connecticut River (Scott and Crossman 1973). In the United States, Atlantic salmon historically ranged from Maine south to Long Island Sound. However, the Central New England DPS and Long Island Sound DPS have both been extirpated (65 FR 69459; Nov. 17, 2000).

The GOM DPS of anadromous Atlantic salmon was initially listed by the USFWS and NMFS (collectively, the Services) as an endangered species on November 17, 2000 (65 FR 69459). A subsequent listing as an endangered species by the Services (74 FR 29344; June 19, 2009) included an expanded range for the GOM DPS of Atlantic salmon. The decision to expand the geographic range of the GOM DPS was largely based on the results of a Status Review (Fay *et* *al.* 2006) completed by a Biological Review Team (BRT) consisting of federal and state agencies and Tribal interests. Fay *et al.* (2006) concluded that the DPS delineation in the 2000 listing designation was largely appropriate, except in the case of large rivers that were excluded in the 2000 listing determination. Fay *et al.* (2006) concluded that the salmon currently inhabiting Maine's larger rivers (Androscoggin, Kennebec, and Penobscot) are genetically similar to the rivers included in the GOM DPS as listed in 2000, have similar life history characteristics, and/or occur in the same zoogeographic region. Further, the salmon populations inhabiting the large and small rivers from the Androscoggin River northward to the Dennys River differ genetically and in important life history characteristics from Atlantic salmon in adjacent portions of Canada (Spidle *et al.* 2003; Fay *et al.* 2006). Thus, Fay *et al.* (2006) concluded that this group of populations (a "distinct population segment") met both the discreteness and significance criteria of the Services' DPS Policy (61 FR 4722; Feb. 7, 1996), and therefore, recommended the geographic range included in the new expanded GOM DPS. The final rule expanding the GOM DPS agreed with the conclusions of BRT regarding the DPS delineation of Maine Atlantic salmon.

The GOM DPS includes all anadromous Atlantic salmon whose freshwater range occurs in the watersheds from the Androscoggin River northward along the Maine coast to the Dennys River, and wherever these fish occur in the estuarine and marine environment. The following impassable falls delimit the upstream extent of the freshwater range: Rumford Falls in the town of Rumford on the Androscoggin River; Snow Falls in the town of West Paris on the Little Androscoggin River; Grand Falls in Township 3 Range 4 BKP WKR on the Dead River in the Kennebec Basin; the un-named falls (impounded by Indian Pond Dam) immediately above the Kennebec River Gorge in the town of Indian Stream Township on the Kennebec River; Big Niagara Falls on Nesowadnehunk Stream in Township 3 Range 10 WELS in the Penobscot Basin; Grand Pitch on Webster Brook in Trout Brook Township in the Penobscot Basin; and Grand Falls on the Passadumkeag River in Grand Falls Township in the Penobscot Basin. The marine range of the GOM DPS extends from the Gulf of Maine, throughout the Northwest Atlantic Ocean, to the coast of Greenland (Figure 2).

Included in the GOM DPS are all associated conservation hatchery populations used to supplement these natural populations; currently, such conservation hatchery populations are maintained at Green Lake National Fish Hatchery (GLNFH) and Craig Brook National Fish Hatcheries (CBNFH), both operated by the USFWS. Excluded from the GOM DPS are landlocked Atlantic salmon and those salmon raised in commercial hatcheries for the aquaculture industry (74 FR 29344; June 19, 2009).

Atlantic salmon have a complex life history that includes territorial rearing in rivers to extensive feeding migrations on the high seas. During their life cycle, Atlantic salmon go through several distinct phases that are identified by specific changes in behavior, physiology, morphology, and habitat requirements.

Adult Atlantic salmon return to rivers from the ocean and migrate to their natal stream to spawn. Adults ascend their natal rivers beginning in the spring. The ascent of adult salmon continues into the fall. Although spawning does not occur until late fall, the majority of Atlantic salmon in Maine enter freshwater between May and mid-July (Meister 1958; Baum 1997).

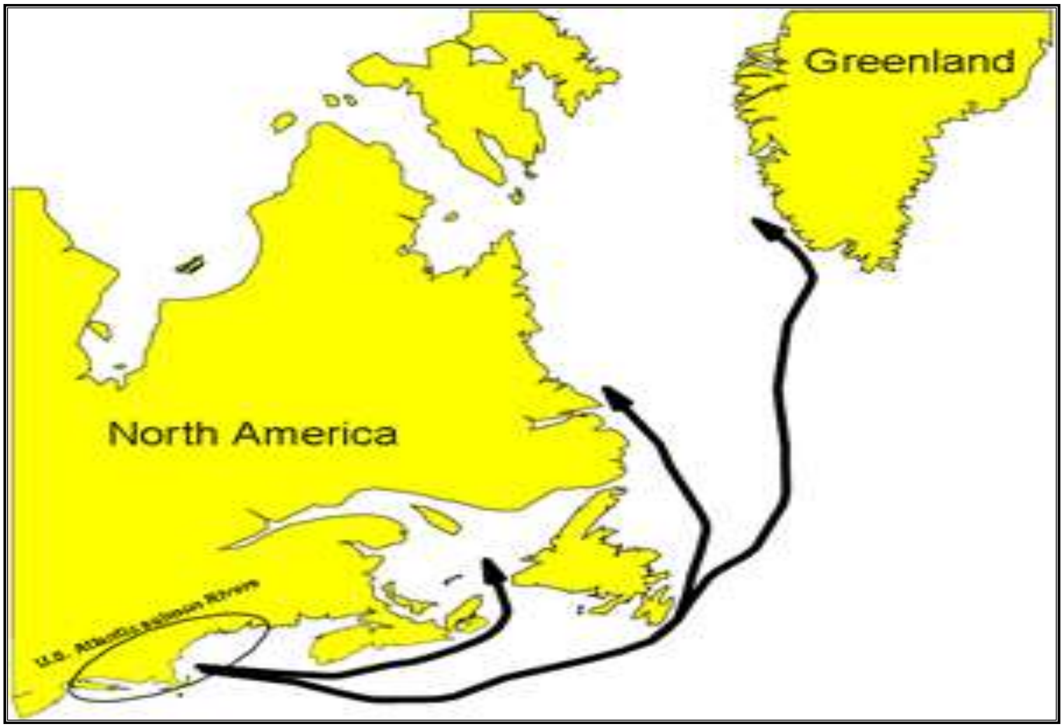


Figure 2. GOM DPS of Atlantic Salmon Migratory Route.

Early migration is an adaptive trait that ensures adults have sufficient time to effectively reach spawning areas despite the occurrence of temporarily unfavorable conditions that naturally occur within rivers (Bjornn and Reiser 1991). Salmon that return in early spring spend nearly five months in the river before spawning, often seeking cool water refuge (e.g., deep pools, springs, and mouths of smaller tributaries) during the summer months.

In the fall, female Atlantic salmon selects sites for spawning. Spawning sites are positioned within flowing water, particularly where upwelling of groundwater occurs, allowing for percolation of water through the gravel (Danie *et al.* 1984). These sites are most often positioned at the head of a riffle (Beland *et al*. 1982); the tail of a pool; or the upstream edge of a gravel bar where water depth is decreasing, water velocity is increasing (McLaughlin and Knight 1987; White 1942), and hydraulic head allows for permeation of water through the redd (a gravel depression where eggs are deposited). Female salmon use their caudal fin to scour or dig redds. The digging behavior also serves to clean the substrate of fine sediments that can embed the cobble/gravel substrate needed for spawning and consequently reduce egg survival (Gibson 1993). As the female deposits eggs in the redd, one or more males fertilize the eggs (Jordan and Beland 1981). The female then continues digging upstream of the last deposition site, burying the fertilized eggs with clean gravel.

A single female may create several redds before depositing all of her eggs. Female anadromous Atlantic salmon produce a total of 1,500 to 1,800 eggs per kilogram of body weight, yielding an average of 7,500 eggs per 2 sea-winter (SW) female (an adult female that has spent two winters at sea before returning to spawn) (Baum and Meister 1971). After spawning, Atlantic salmon may either return to sea immediately or remain in freshwater until the following spring before returning to the sea (Fay *et al.* 2006). From 1967 to 2003, approximately three percent of the wild and naturally reared adults that returned to rivers where adult returns are monitored (mainly the Penobscot River) were repeat spawners (USASAC 2004).

Embryos develop in the redd for a period of 175 to 195 days, hatching in late March or April (Danie *et al.* 1984). Newly hatched salmon referred to as larval fry, alevin, or sac fry, remain in the redd for approximately six weeks after hatching and are nourished by their yolk sac (Gustafson-Greenwood and Moring 1991). Survival from the egg to fry stage in Maine is estimated to range from 15 to 35 percent (Jordan and Beland 1981). Survival rates of eggs and larvae are a function of stream gradient, overwinter temperatures, interstitial flow, predation, disease, and competition (Bley and Moring 1988). Once larval fry emerge from the gravel and begin active feeding they are referred to as fry. The majority of fry (>95 percent) emerge from redds at night (Gustafson-Marjanen and Dowse 1983).

When fry reach approximately 4 cm in length, the young salmon are termed parr (Danie *et al.* 1984). Parr have eight to eleven pigmented vertical bands on their sides that are believed to serve as camouflage (Baum 1997). A territorial behavior, first apparent during the fry stage, grows more pronounced during the parr stage, as the parr actively defend territories (Allen 1940; Kalleberg 1958; Danie *et al.* 1984). Most parr remain in the river for two- three years before undergoing smoltification, the process in which parr go through physiological changes in order to transition from a freshwater environment to a saltwater marine environment. Some male parr may not go through smoltification and will become sexually mature and participate in spawning with sea-run adult females. These males are referred to as “precocious parr.”

First year parr are often characterized as being small parr or 0+ parr (4 to 7 cm long), whereas second and third year parr are characterized as large parr (greater than 7 cm long) (Haines 1992). Parr growth is a function of water temperature (Elliott 1991); parr density (Randall 1982); photoperiod (Lundqvist 1980); interaction with other fish, birds, and mammals (Bjornn and Resier 1991); and food supply (Swansburg *et al.* 2002). Parr movement may be quite limited in the winter (Cunjak 1988; Heggenes 1990); however, movement in the winter does occur (Hiscock *et al.* 2002) and is often necessary, as ice formation reduces total habitat availability (Whalen *et al.* 1999). Parr have been documented using riverine, lake, and estuarine habitats; incorporating opportunistic and active feeding strategies; defending territories from competitors including other parr; and working together in small schools to actively pursue prey (Gibson 1993; Marschall *et al.* 1998; Pepper 1976; Pepper *et al.* 1984; Erkinaro *et al.* 1998; Halvorsen and Svenning 2000; Hutchings 1986; O’Connell and Ash 1993; Erkinaro *et al.*1995; Dempson *et al.* 1996; Klemetsen *et al.* 2003).

In a parr’s second or third spring (age 1 or age 2 respectively), when it has grown to 12.5 to 15 cm in length, a series of physiological, morphological, and behavioral changes occur (Schaffer and Elson 1975). This process, called “smoltification,” prepares the parr for migration to the ocean and life in salt water. In Maine, the vast majority of naturally reared parr remain in freshwater for two years (90 percent or more) with the balance remaining for either one or three years (USASAC 2005). In order for parr to undergo smoltification, they must reach a critical size of 10 centimeter total length at the end of the previous growing season (Hoar 1988). During the smoltification process, parr markings fade and the body becomes streamlined and silvery with a pronounced fork in the tail. Naturally reared smolts in Maine range in size from 13 to 17 cm, and most smolts enter the sea during May to begin their first ocean migration (USASAC 2004). During this migration, smolts must contend with changes in salinity, water temperature, pH, dissolved oxygen, pollution levels, and predator assemblages. The physiological changes that occur during smoltification prepare the fish for the dramatic change in osmoregulatory needs that come with the transition from a fresh to a salt water habitat (Ruggles 1980; Bley 1987; McCormick and Saunders 1987; McCormick *et al.* 1998). The transition of smolts into seawater is usually gradual as they pass through a zone of fresh and saltwater mixing that typically occurs in a river's estuary. Given that smolts undergo smoltification while they are still in the river, they are pre-adapted to make a direct entry into seawater with minimal acclimation (McCormick *et al.* 1998). This pre-adaptation to seawater is necessary under some circumstances where there is very little transition zone between freshwater and the marine environment.

The spring migration of post-smolts out of the coastal environment is generally rapid, within several tidal cycles, and follows a direct route (Hyvarinen *et al.* 2006; Lacroix and McCurdy 1996; Lacroix *et al.* 2004; Lacroix and Knox 2005). Kocik *et al.* (2009) documented smolt migrating with the tides primarily at night. Post-smolts generally travel out of coastal systems on the ebb tide and may be delayed by flood tides (Hyvarinen *et al.* 2006; Lacroix and McCurdy 1996; Lacroix *et al.* 2004; Lacroix and Knox 2005). Lacroix and McCurdy (1996), however, found that post-smolts exhibit active, directed swimming in areas with strong tidal currents. Studies in the Bay of Fundy and Passamaquoddy Bay suggest that post-smolts aggregate together and move near the coast in "common corridors" and that post-smolt movement is closely related to surface currents in the Bay (Hyvarinen *et al.* 2006; Lacroix and McCurdy 1996; Lacroix *et al.* 2004). European post-smolts tend to use the open ocean for a nursery zone, while North American post-smolts appear to have a more near-shore distribution (Friedland *et al.* 2003). Post-smolt distribution may reflect water temperatures (Reddin and Shearer 1987) and/or the major surface-current vectors (Lacroix and Knox 2005). Post-smolts live mainly on the surface of the water column and form shoals, possibly of fish from the same river (Shelton *et al.* 1997).

During the late summer and autumn of the first year, North American post-smolts are concentrated in the Labrador Sea and off of the west coast of Greenland, with the highest concentrations between 56° N. and 58° N. (Reddin 1985; Reddin and Short 1991; Reddin and Friedland 1993). The salmon located off Greenland are composed of both 1SW fish and fish that have spent multiple years at sea (multi-sea winter fish, or MSW) and includes immature salmon from both North American and European stocks (Reddin 1988; Reddin *et al.* 1988). The first winter at sea regulates annual recruitment, and the distribution of winter habitat in the Labrador Sea and Denmark Strait may be critical for North American populations (Friedland *et al.* 1993). In the spring, North American post-smolts are generally located in the Gulf of St. Lawrence, off the coast of Newfoundland, and on the east coast of the Grand Banks (Reddin 1985; Dutil and Coutu 1988; Ritter 1989; Reddin and Friedland 1993; and Friedland *et al.* 1999).

Some salmon may remain at sea for another year or more before maturing. After their second winter at sea, the salmon over-winter in the area of the Grand Banks before returning to their natal rivers to spawn (Reddin and Shearer 1987). Reddin and Friedland (1993) found non-maturing adults located along the coasts of Newfoundland, Labrador, and Greenland, and in the

Labrador and Irminger Sea in the later summer and autumn.

3.1.2 Status and Trends of Atlantic salmon in the GOM DPS

The abundance of Atlantic salmon within the range of the GOM DPS has been generally declining since the 1800s (Fay *et al.* 2006). Data sets tracking adult abundance are not available throughout this entire time period; however, Fay *et al.* (2006) present a comprehensive time series of adult returns to the GOM DPS dating back to 1967 (Figure 3). It is important to note that contemporary abundance levels of Atlantic salmon within the GOM DPS are several orders of magnitude lower than historical abundance estimates. For example, Foster and Atkins (1869) estimated that roughly 100,000 adult salmon returned to the Penobscot River alone before the river was dammed, whereas contemporary estimates of abundance for the entire GOM DPS have never exceeded 5,000 individuals in any given year since 1967 (Fay *et al.* 2006).

Contemporary abundance estimates are informative in considering the conservation status of the GOM DPS today. After a period of population growth in the 1970s, adult returns of salmon in the GOM DPS have been steadily declining since the early 1980s and appear to have stabilized at very low levels since 2000 (Figure 3). The population growth observed in the 1970s is likely attributable to favorable marine survival and increases in hatchery capacity, particularly from GLNFH which was constructed in 1974. Marine survival remained relatively high throughout the 1980s, and salmon populations in the GOM DPS remained relatively stable until the early 1990s. In the early 1990s marine survival rates decreased, leading to the declining trend in adult abundance observed throughout the remainder of the decade. Poor marine survival of Atlantic salmon persists in the GOM DPS to date.

Adult returns to the GOM DPS have been very low for many years and remain extremely low in terms of adult abundance in the wild. Further, the majority of all adults in the GOM DPS return to a single river, the Penobscot, which accounted for 91 percent of all adult returns to the GOM DPS in 2007. Of the 1044 adult returns to the Penobscot in 2006, 996 of these were the result of smolt stocking and only the remaining 48 were naturally-reared. A total of 916 and 2,117 adult salmon returned to the Penobscot River in 2007 and 2008, respectively. Most of these returns were also of hatchery origin (USASAC 2008). The term naturally-reared includes fish originating from natural spawning and from hatchery fry (USASAC 2008). Hatchery fry are included as naturally-reared because hatchery fry are not marked; therefore, they cannot be distinguished from fish produced through natural spawning. Because of the extensive amount of fry stocking that takes place in an effort to recover the GOM DPS, it is possible that a substantial number of fish counted as naturally-reared were actually stocked as fry.

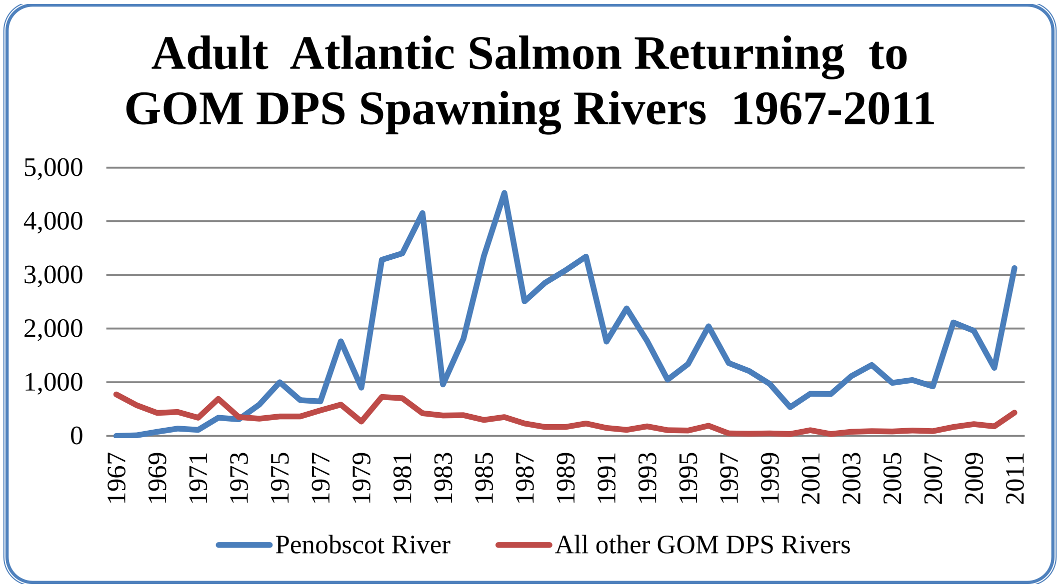


Figure 3. Adult Atlantic Salmon Returns to GOM DPS Rivers 1967-2011.

According to 2011 statistics provided by the Maine Department of Marine Resources (MDMR), Atlantic salmon counts from the Veazie trap on the Penobscot River exceeded 3,100 (Figure 3). The counts are more than double 2010's totals, and represent the eighth highest run since the counting program began in 1978 and the highest since 1986. Low abundances of both hatchery-origin and naturally-reared adult salmon returns to Maine demonstrate continued poor marine survival. Declines in hatchery-origin adult returns are less sharp because of the ongoing effects of hatcheries. In short, hatchery production over this time period has been relatively constant, generally fluctuating around 550,000 smolts per year (USASAC 2008).

In contrast, the number of naturally reared smolts emigrating each year is likely to decline following poor returns of adults (three years prior). Thus, wild smolt production would suffer three years after a year with low adult returns, because the progeny of adult returns typically emigrate three years after their parents return. The relatively constant inputs from smolt stocking, coupled with the declining trend of naturally reared adults, result in the apparent stabilization of hatchery-origin salmon and the continuing decline of naturally reared components of the GOM DPS observed over the last two decades.

Adult returns for the GOM DPS remain well below conservation spawning escapement (CSE) goals that are widely used to describe the status of individual Atlantic salmon populations (ICES 2005). When CSE goals are met, Atlantic salmon populations are generally self-sustaining. When CSE goals are not met (i.e., less than 100 percent), populations are not reaching full potential which can be indicative of a population decline. For all GOM DPS rivers in Maine, current Atlantic salmon populations (including hatchery contributions) are well below CSE levels required to sustain themselves (Fay *et al.* 2006), a further indication of their poor population status.

In conclusion, the abundance of Atlantic salmon in the GOM DPS has been low and either stable or declining over the past several decades. The proportion of fish that are of natural origin is very small (below 10%) and is continuing to decline. The conservation hatchery program has assisted in slowing the decline and helping to stabilize populations at low levels, but has not contributed to an increase in the overall abundance of salmon and has not been able to halt the decline of the naturally reared component of the GOM DPS.

3.1.3 Critical Habitat for Atlantic Salmon in the GOM DPS

Coincident with the June 19, 2009 endangered listing, NMFS designated critical habitat for the GOM DPS of Atlantic salmon (74 FR 29300; June 19, 2009) (Figure 4). The final rule was revised on August 10, 2009. In this revision, designated critical habitat for the expanded GOM DPS of Atlantic salmon was reduced to exclude trust and fee holdings of the Penobscot Indian Nation and a table was corrected (74 FR 39003; August 10, 2009).

The status of Atlantic salmon critical habitat in the GOM DPS is important for two reasons: a) because it affects the viability of the listed species within the action area at the time of the consultation; and b) because those habitat areas designated "critical" provide PCEs essential for the conservation (i.e., recovery) of the species. The complex life cycles exhibited by Atlantic salmon give rise to complex habitat needs, particularly during the freshwater phase (Fay *et al.* 2006). Spawning gravels must be a certain size and free of sediment to allow successful incubation of the eggs. Eggs also require cool, clean, and well-oxygenated waters for proper development. Juveniles need abundant food sources, including insects, crustaceans, and other small fish. They need places to hide from predators (mostly birds and bigger fish), such as under logs, root wads, and boulders in the stream, as well as beneath overhanging vegetation. They also need places to seek refuge from periodic high flows (side channels and off-channel areas) and from warm summer water temperatures (coldwater springs and deep pools). Returning adults generally do not feed in fresh water but instead rely on limited energy stores to migrate, mature, and spawn. Like juveniles, they also require cool water and places to rest and hide from predators. During all life stages, Atlantic salmon require cool water that is free of contaminants. They also need migratory corridors with adequate passage conditions (timing, water quality, and water quantity) to allow access to the various habitats required to complete their life cycle.

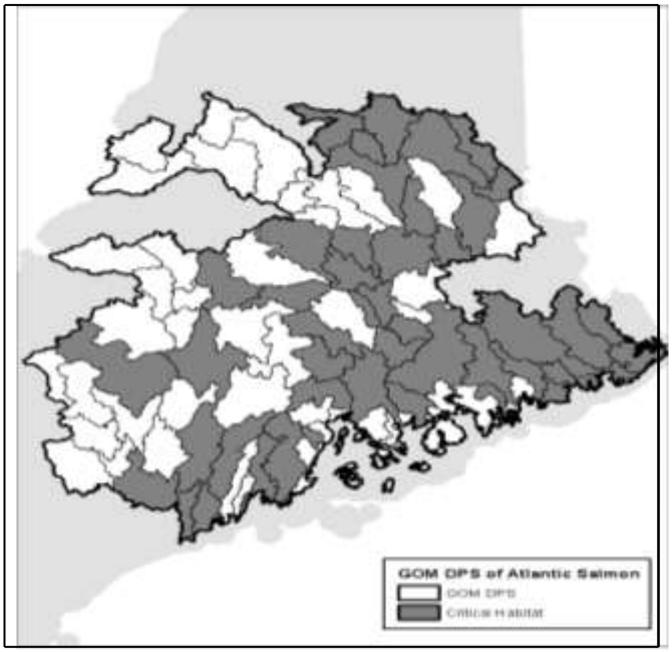


Figure 4. HUC-10 Watersheds Designated as Atlantic Salmon Critical Habitat within the GOM DPS.

The physical and biological features of the two PCEs for Atlantic salmon critical habitat are as follows:

<u>Physical and Biological Features of the Spawning and Rearing PCE</u>

1. Deep, oxygenated pools and cover (*e.g.*, boulders, woody debris, vegetation, etc.), near freshwater spawning sites, necessary to support adult migrants during the summer while they await spawning in the fall.
2. Freshwater spawning sites that contain clean, permeable gravel and cobble substrate with oxygenated water and cool water temperatures to support spawning activity, egg incubation, and larval development.
3. Freshwater spawning and rearing sites with clean, permeable gravel and cobble substrate with oxygenated water and cool water temperatures to support emergence, territorial development and feeding activities of Atlantic salmon fry.
4. Freshwater rearing sites with space to accommodate growth and survival of Atlantic salmon parr.
5. Freshwater rearing sites with a combination of river, stream, and lake habitats that accommodate parr's ability to occupy many niches and maximize parr production.
6. Freshwater rearing sites with cool, oxygenated water to support growth and survival of Atlantic salmon parr.
7. Freshwater rearing sites with diverse food resources to support growth and survival of Atlantic salmon parr.

Physical and Biological Features of the Migration PCE

1. Freshwater and estuary migratory sites free from physical and biological barriers that delay or prevent access of adult salmon seeking spawning grounds needed to support recovered populations.
2. Freshwater and estuary migration sites with pool, lake, and in-stream habitat that provide cool, oxygenated water and cover items (e.g., boulders, woody debris, and vegetation) to serve as temporary holding and resting areas during upstream migration of adult salmon.
3. Freshwater and estuary migration sites with abundant, diverse native fish communities to serve as a protective buffer against predation.
4. Freshwater and estuary migration sites free from physical and biological barriers that delay or prevent emigration of smolts to the marine environment.
5. Freshwater and estuary migration sites with sufficiently cool water temperatures and water flows that coincide with diurnal cues to stimulate smolt migration
6. Freshwater migration sites with water chemistry needed to support sea water adaptation of smolts.

Habitat areas designated as critical habitat must contain one or more PCEs within the acceptable range of values required to support the biological processes for which the species uses that habitat. Critical habitat has only been designated in areas considered currently occupied by the species. Critical habitat includes the stream channels within the designated stream reach and includes a lateral extent as defined by the ordinary high-water line or the bankfull elevation in the absence of a defined high-water line. In estuaries, critical habitat is defined by the perimeter of the water body as displayed on standard 1:24,000 scale topographic maps or the elevation of extreme high water, whichever is greater.

For an area containing PCEs to meet the definition of critical habitat, the ESA also requires that the physical and biological features essential to the conservation of Atlantic salmon in that area "may require special management considerations or protections." Activities within the GOM DPS that were identified as potentially affecting the physical and biological features and therefore requiring special management considerations or protections include agriculture, forestry, changing land-use and development, hatcheries and stocking, roads and road crossings, mining, dams, dredging, and aquaculture.

Salmon Habitat Recovery Units within Critical Habitat for the GOM DPS

In describing critical habitat for the Gulf of Maine DPS, NMFS divided the GOM DPS into three Salmon Habitat Recovery Units or SHRUs. The three SHRUs include the Downeast Coastal, Penobscot Bay, and Merrymeeting Bay. The SHRU delineations were designed by NMFS to ensure that a recovered Atlantic salmon population has widespread geographic distribution to help maintain genetic variability and, therefore, a greater probability of population sustainability in the future. Areas designated as critical habitat within each SHRU are described in terms of habitat units. One habitat unit represents 100 m^2 of suitable salmon habitat (which could be spawning and rearing habitat or migration habitat). Habitat units within the GOM DPS were estimated through the use of a GIS-based salmon habitat model (Wright *et al.* 2008). Additionally, NMFS discounted the functional capacity of modeled habitat units in areas where habitat degradation has affected the PCEs. For each SHRU, NMFS determined that 30,000 fully functional units of habitat are needed in order to achieve recovery objectives for Atlantic salmon. Brief historical descriptions for each SHRU, as well as contemporary critical habitat designations and special management considerations, are provided below.

Downeast Coastal SHRU
The Downeast Coastal SHRU encompasses fourteen HUC-10 watersheds covering approximately 747,737 hectares (1,847,698 acres) within Washington and Hancock counties. In this SHRU there are approximately 59,066 units of spawning and rearing habitat for Atlantic salmon among approximately 6,039 km of rivers, lakes and streams. Of the 59,066 units of spawning and rearing habitat, approximately 53,400 units of habitat in eleven HUC-10 watersheds are considered to be currently occupied. The Downeast SHRU has enough habitat units available within the occupied range that, in a restored state (e.g. improved fish passage or improved habitat quality), the Downeast SHRU could satisfy recovery objectives as described in the final rule for critical habitat (74 FR 29300; June 19, 2009). Certain tribal and military lands within the Downeast Coastal SHRU are excluded from critical habitat designation.

Penobscot Bay SHRU
The Penobscot Bay SHRU, which drains approximately 22,234,522 hectares (54,942,705 acres), contains approximately 315,574 units of spawning and rearing habitat for Atlantic salmon among approximately 17,440 km of rivers, lakes and streams. Of the 315,574 units of spawning and rearing habitat (within 46 HUC-10 watersheds), approximately 211,000 units of habitat are considered to be currently occupied (within 28 HUC-10 watersheds). Three HUC-10 watersheds (Molunkus Stream, Passadumkeag River, and Belfast Bay) are excluded from critical habitat designation due to economic impact. Certain tribal lands within the Penobscot Bay SHRU are also excluded from critical habitat designation.

Merrymeeting Bay SHRU
The Merrymeeting Bay SHRU drains approximately 2,691,814 hectares of land (6,651,620 acres) and contains approximately 372,600 units of historically accessible spawning and rearing habitat for Atlantic salmon located among approximately 5,950 km of historically accessible rivers, lakes and streams. Of the 372,600 units of spawning and rearing habitat, approximately 136,000 units of habitat are considered to be currently occupied. There are forty-five HUC 10 watersheds in this SHRU, but only nine are considered currently occupied. Of the 136,000 occupied units within the Merrymeeting Bay SHRU, NMFS calculated these units to be the equivalent of nearly 40,000 functional units or approximately 11 percent of the historical functional potential. This estimate is based on the configuration of dams within the Merrymeeting Bay SHRU that limit migration and other land use activities that cause degradation of physical and biological features and which reduce the productivity of habitat within each HUC 10. The combined qualities and quantities of habitat available to Atlantic salmon within the currently occupied areas within the Merrymeeting Bay SHRU meet the objective of 30,000 fully functional units of habitat available to Atlantic salmon. Lands controlled by the Department of Defense within the Little Androscoggin HUC 10 and the Sandy River HUC 10 are excluded as critical habitat.

The June 19, 2009 final critical habitat designation for the GOM DPS includes 45 specific areas occupied by Atlantic salmon that comprise approximately 19,571 km of perennial river, stream, and estuary habitat and 799 square km of lake habitat within the range of the GOM DPS and on which are found those physical and biological features essential to the conservation of the species. Within the occupied range of the GOM DPS, approximately 1,256 km of river, stream, and estuary habitat and 100 square km of lake habitat have been excluded from critical habitat pursuant to section 4(b)(2) of the ESA.

3.1.4 Status of Atlantic Salmon and Critical Habitat in the Action Area

A summary of the status of the species rangewide and designated critical habitat in its entirety was provided above. This section will focus on the status of Atlantic salmon and designated critical habitat in the action area.

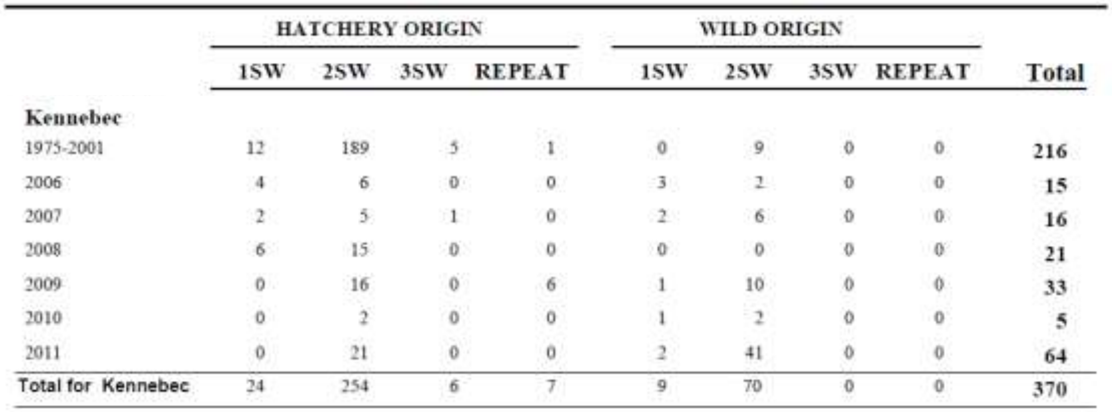
The Kennebec River watershed supports a small run of Atlantic salmon. Restoration efforts in the upper watershed have utilized egg, fry, and parr stocking to promote returning adult salmon. As such, all lifestages of Atlantic salmon could be present in the action area of this consultation. From 2003 to 2007, an average of 30,000 fry were released annually to the Sandy River (Paul Christman, MDMR, personal communication). In addition, some amount of natural reproduction is likely occurring in the Sandy River. Since the fishway at the Lockwood Dam has been operational in 2006, adults have been captured and transported to the Sandy River. The number of eggs contributed to the Sandy River from these adults has ranged from 11,250 in 2006 to 247,500 in 2011. Estimated smolt production for this range would be between 169 and 3,735 annually.

The main stem of the lower Kennebec River is designated as critical habitat. It serves primarily as a migratory pathway to more suitable spawning and rearing habitat higher in the watershed. The action area is tidal riverine and does not provide suitable spawning or rearing habitat. Geotechnical investigations completed by MDOT in December, 2011 indicate the substrate in the area of the bridge consists of alluvium, submarine outwash sands, Presumpscot formation (medium stiff silty clay), marine near shore deposits (sand & gravel), and till.
While some salmon spawning and rearing habitat is now available in the restored tributaries between the former Edwards and current Lockwood Dams, the vast majority of salmon spawning and rearing habitat (nearly 95%) in the Kennebec River watershed is located above the Lockwood Dam (T. Trinko-Lake, pers comm. 2012).

Atlantic Salmon Adults
Counts for Atlantic salmon in the Kennebec River are available since 2006 when a fishlift was installed at the first dam on the river (Lockwood Dam) (NMFS and USFWS 2009). Adult Atlantic salmon are trapped, and biological data (e.g., fork lengths) are collected before the salmon are trucked and released in the Sandy River, which is an upstream tributary of the Kennebec River containing plentiful spawning and rearing habitat (MDMR 2011). Returning adult salmon at the first dam on the Kennebec River averaged eight fish per year from 1975 to 2000 and 18 per year fish from 2006 to 2010 (Table 2). In 2011, 64 adult Atlantic salmon returned to the Kennebec River (P. Christman, pers. comm. 2012). Monthly return data for 2009, 2010, and 2011 indicate peak adult returns to the Kennebec River occur in the months of June and July (Table 3). Additionally, five adult Atlantic salmon had returned to the Kennebec River by September 2012 (MDMR 2012).

Between 2007 and 2009, manual tracking radio telemetry studies were conducted in the Kennebec River watershed to test if this technology can be used to observe the behavior of adult Atlantic salmon during known spawning periods (MDMR 2010). Study fish were translocated to the Sandy River in 2007 and 2008, and were monitored into the fall of 2009. Sixteen of the 18 adult salmon tracked in the study were detected in the Sandy River throughout the spawning season, and displayed known migratory patterns throughout their residency in the Sandy River, including longer-range migration after release in the spring, minimal movement in the summer, and short-range migration in the fall during spawning (MDMR 2010). Only one of the tagged adult salmon migrated downstream before spawning would have occurred. Five of the radio tags were detected in identical locations in 2009 as observed in 2008, and it was determined that these fish regurgitated their tags, or were mortalities. In addition, redd counts and juvenile surveys confirmed that adult salmon translocated to the Sandy River successfully spawned (MDMR 2010). The total trap catch for 2011 was 64 adult sea-run Atlantic salmon; 21 were of hatchery origin two-sea winter (2SW), and 43 were naturally reared (41-2SW, 2-1SW). All 64 adult Atlantic salmon were trucked and released to the Sandy River.

Table 2. Adult Atlantic salmon returns by origin to the Kennebec River recorded from 1975 to 2011.



	HATCHERY ORIGIN				WILD ORIGIN				
	1SW	2SW	3SW	REPEAT	1SW	2SW	3SW	REPEAT	Total
Kennebec									
1975-2001	12	189	5	1	0	9	0	0	**216**
2006	4	6	0	0	3	2	0	0	**15**
2007	2	5	1	0	2	6	0	0	**16**
2008	6	15	0	0	0	0	0	0	**21**
2009	0	16	0	6	1	10	0	0	**33**
2010	0	2	0	0	1	2	0	0	**5**
2011	0	21	0	0	2	41	0	0	**64**
Total for Kennebec	24	254	6	7	9	70	0	0	**370**

Source: USASAC 2011.

Following spawning in the fall, Atlantic salmon kelts may immediately return to the sea, or over-winter in freshwater habitat and migrate in the spring, typically April or May (Baum 1997). Spring flows resulting in spillage at the dams facilitate out-migration of adult salmon (Shepard 1988). The number of kelts in the Kennebec River is proportional to the number of adults entering the river each year to spawn. As such, the number of kelts in the Kennebec River is likely to be a few dozen annually.

Atlantic salmon smolts out migrate through the site in April, May and June. Atlantic salmon could be expected in the action area at anytime between April and September with the highest likelihood being in late April to mid-June.

The Kennebec River in the vicinity of the Richmond-Dresden Bridge serves as migration habitat for adults returning to freshwater to spawn and for smolts and kelts bound for the ocean. No spawning or rearing habitat has been identified in, or adjacent to the action area. Two small tributaries of the Kennebec River, Togus Stream and Bond Brook, located approximately 25 river kilometers upstream of the action area near Augusta have had documented adult and juvenile salmon returns. Subsequent monitoring data collected from 2004 to 2009 by Maine Atlantic Salmon Commission (MASC) biologists suggests that both populations are very small.

Year	**Maturity**	**Month of Capture**						**Total**
		May	**June**	**July**	**Aug**	**Sept**	**Oct**	
2009	MSW Wild ♂	0	2	0	0	0	1	3
	MSW Wild ♀	0	2	3	0	0	2	7
	MSW Hatchery ♂	0	0	5	0	1	0	6
	MSW Hatchery ♀	1	0	6	1	0	0	8
	Domestic ♂	1	0	0	0	0	0	1
	Domestic ♀	3	0	0	0	0	0	3
	Domestic Unk[1]	0	1	0	0	0	0	1
	Total	**5**	**5**	**14**	**1**	**1**	**3**	**29**
2010	MSW Wild ♂	0	0	0	0	0	0	0
	MSW Wild ♀	0	2	0	0	0	0	2
	MSW Hatchery ♂	0	0	0	0	0	0	0
	MSW Hatchery ♀	0	2	0	0	0	0	2
	1SW Wild ♂	0	0	0	0	0	1	1
	1SW Wild ♀	0	0	0	0	0	0	0
	1SW Hatchery ♂	0	0	0	0	0	0	0
	1SW Hatchery♀	0	0	0	0	0	0	0
	Total	**0**	**4**	**0**	**0**	**0**	**1**	**5**
2011	MSW Wild ♂	0	9	5	0	1	0	15
	MSW Wild ♀	0	12	12	0	0	1	25
	MSW Hatchery ♂	0	4	8	0	0	0	12
	MSW Hatchery ♀	0	5	3	0	0	0	8
	1SW Wild ♂	0	2	0	0	0	0	2
	1SW Wild ♀	0	0	0	0	0	0	0
	1SW Hatchery ♂	0	0	0	0	0	0	0
	1SW Hatchery♀	0	0	0	0	0	0	0
	MSW Hatchery Unknown	0	1	1	0	0	0	2
	Total	**0**	**33**	**29**	**0**	**1**	**1**	**64**

Table 3. Adult Atlantic Salmon captured at the Lockwood Project fishlift and translocated to the

Sandy River. Source: MDMR 2010, 2011, 2012.

Juvenile Atlantic Salmon

Atlantic salmon stocking practices are common in the region for the GOM DPS stock enhancement program. The total number of juvenile salmon stocked in the Kennebec River was 2,200 individuals (2,000 fry and 200 smolts) in 2009 and 147,000 fry in 2010 (USASAC 2010, 2011). In contrast, approximately 1.8 million juvenile salmon (fry, parr, and smolts) were stocked in the Penobscot River in 2010. Overall, 314,300 juvenile salmon, of which all were fry (except for 200 smolts) have been stocked in the Kennebec River since stocking commenced in 2001 (USASAC 2011). Given shortages of Atlantic salmon hatchery resources, MDMR has been supplementing Atlantic salmon populations by producing fry from streamside incubators and by planting Atlantic salmon eggs directly into gravel. Streamside incubation of eggs occurred from 2004 to 2007, and egg planting has continued since 2004. In 2010, MDMR planted approximately 530,000 Penobscot River origin eggs from the Green Lake National Fish Hatchery, and 51,000 eggs were planted from the USDA ARS National Cold Water Marine Aquaculture Center. All eggs were planted in the Sandy River drainage within the Kennebec River watershed (MDMR 2011).

Generally, salmon smolts begin moving out of Maine rivers in mid-April to June. Atlantic salmon smolts originating in the Sandy River will occur in the action area as they migrate to the ocean. Most data concerning the emigration of smolts in Maine have been collected in the Penobscot River. Based on unpublished data from smolt-trapping studies in 2000 – 2005 by NMFS, smolts migrate from the Penobscot between late April and early June. The majority of the smolt migration appears to take place over a three to five week period after water temperatures rise to 10°C.

In the spring of 2012, a smolt-trapping study was conducted on the Sandy River, a tributary to the Kennebec River, by NextEra Energy. NextEra Energy installed a rotary screw trap in the lower reaches to sample outmigrating Atlantic salmon smolts. The Sandy River RST was operational from April 18, 2012 to May 30, 2012. A total of 52 smolts were captured during 29 days of sampling. The first smolt was captured on April 18 and the last smolt was captured on May 21. Peak capture of smolts occurred in the first week of May. Ambient water temperatures in the Sandy River during sampling ranged from 8° C to 19° C.

While the annual abundance of smolts in the Kennebec River is presently unknown, MDMR estimates the current egg stocking and natural reproduction in the Sandy River may be producing over 10,000 smolts annually. Smolt abundance in the river is likely to remain stable or grow as restoration efforts in the river continue.

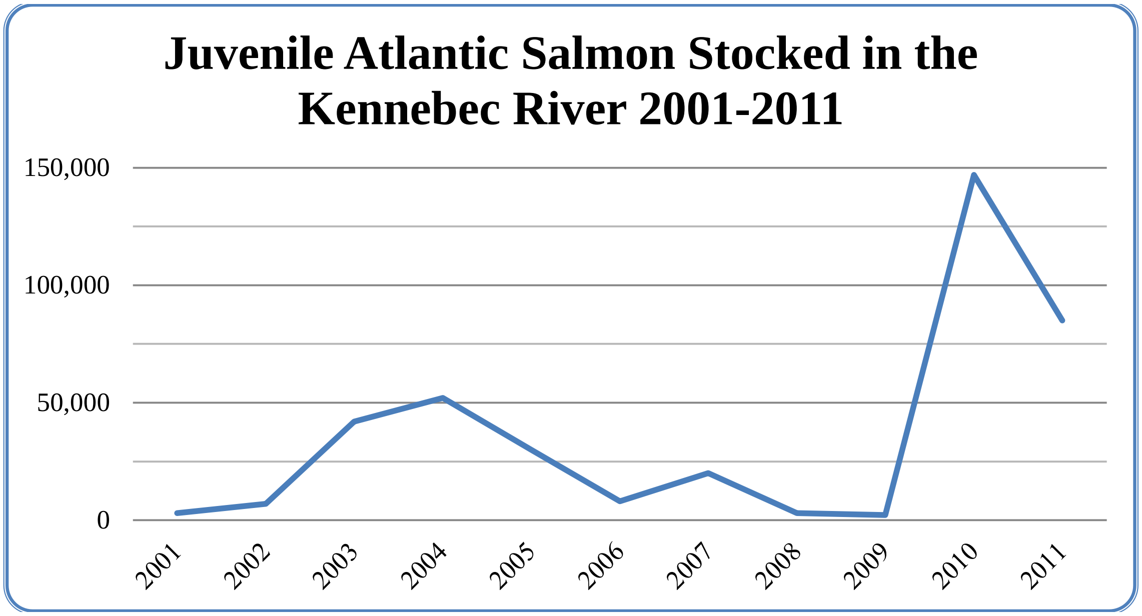


Figure 5. Atlantic Salmon Stocked in the Kennebec River 2001-2011.

Critical Habitat

As discussed in section 3.1.3, critical habitat for Atlantic salmon has been designated in the Kennebec River. One PCE for Atlantic salmon (sites for migration) is present in the action area as it was described in Section 3 of this Opinion.

To facilitate and standardize determinations of effect for section 7 consultations involving Atlantic salmon critical habitat, NMFS developed the "Matrix of Primary Constituent Elements (PCEs) And Essential Features For Assessing The Environmental Baseline Of The Action Area" (Appendix A). The matrix lists the PCEs, physical and biological features (essential features) of each PCE, and the potential conservation status of critical habitat within an action area. The two PCEs in the matrix (spawning and rearing, and migration) are described in regards to five distinct Atlantic salmon life stages: (1) adult spawning; (2) embryo and fry development; (3) parr development; (4) adult migration; and, (5) smolt migration. The conservation status of the essential features may exist in varying degrees of functional capacity within the action area. The three degrees of functional capacity used in the matrix are described in ascending order: (1) fully functioning; (2) limited function; and (3) not properly functioning. Using this matrix along with information presented in FHWA's BA and site-specific knowledge of the action area, NMFS determined that several essential features to Atlantic salmon in the action area have limited function.

3.1.5 Factors Affecting Atlantic Salmon in the Action Area

The Town of Richmond, population of less than 4,000, is situated along the west bank of the river. Their publically owned waste water treatment works (POTW) is located approximately two kilometers downstream of the bridge site. The Town of Dresden, population 1,600, is located on the east bank of the river.

The area is characterized by muddy substrate with a fringing freshwater intertidal emergent wetland along the river in both Richmond and Dresden. The emergent wetlands are dominated by plants tolerant of intertidal exposure such as rice (*Zinzania aquatica*) and bulrush (*Scirpus* or *Schoenoplectus* spp). Some uncommon freshwater plant species such as estuarine monkey flower (*Mimulus ripens*) and Parker's pipewort (*Eriocaulon Parkerii*) also occur in the area. The river depth is approximately 7.5 meters (25 feet) deep in the main channel and the mean tidal range is 1.6 meters (5.3 feet). Larson and Dogett (1976) measured salinities at Carney point, about 6.4 kilometers (4 miles) downstream of the bridge and found that summer salinities were 0.5 ppt or less. There are two types of wetlands found at the Richmond-Dresden bridge replacement site.

Geotechnical investigations completed by MDOT in December, 2011 indicate the substrate in the area of the bridge consists of alluvium, submarine outwash sands, Presumpscot formation (medium stiff silty clay), marine near shore deposits (sand, some gravel), and till. These substrates are considered highly suitable habitat for Shortnose sturgeon and Atlantic sturgeon foraging.

The wetted area in the vicinity of the bridge experiences tidally induced fluctuations in water level, flow direction, and salinity. Table 1 provides calculated water velocities around the bridge piers during peak tidal exchange and during severe weather events. Water velocity under the bridge is less than 1.5 feet per second (ft/s) during "slack" tides, and as high as 8.11 ft/s during flood tide.

Calculated Velocity At The <u>Existing</u> Bridge	Average Flow Rate For Time Period Or Episodic Event	Calculated Velocity At The <u>Proposed</u> Bridge
3.95 ft/s	Velocity Q1.1	3.70 ft/s
6.31 ft/s	Velocity Q10	5.93 ft/s
7.78 ft/s	Velocity Q25	6.38 ft/s
7.12 ft/s	Velocity Q50	6.71 ft/s
7.46 ft/s	Velocity Q100	7.04 ft/s
8.11 ft/s	Velocity Q500	7.69 ft/s

Table 1. Calculated Water Velocity Around Existing and Proposed Bridge Piers.

The existing bridge has a negligible effect on the hydrology of action area. The water velocity in the action area is naturally low because of the gradient and width of the river. The water accelerates slightly around the bridge piers, but the 300 meter width of the river provides multiple corridors of lower velocity whereby allowing unrestricted fish migration (Table 1).

Water quality in the Kennebec River has drastically improved since log drives in the river were halted in the mid-1970s. This, along with the implementation of water quality regulations and the removal of Edwards Dam in 1999 has added to those improvements. However, the water quality in the action area is considered degraded and does not meet state standards for all designated uses (S. Meidel, MDEP, pers. com. 2012).

While the Kennebec River Basin has been extensively developed for hydroelectric power production, there are no dams or impoundments in the action area that could impede salmon or sturgeon migration. Further, the lack of dams in the action area precludes habitat fragmentation and loss of connectivity.

Many species of birds prey upon Atlantic salmon throughout their life cycle (Fay *et al.* 2006). Blackwell *et al.* (1997) reported that salmon smolts were the most frequently occurring food items in cormorant sampled at main stem dam foraging sites. The abundance of alternative prey resources such as upstream migrating alewife, likely minimizes the impacts of cormorant predation on the GOM DPS of Atlantic salmon (Fay *et al.* 2006). Common mergansers and belted kingfishers are likely the most important predators of Atlantic salmon fry and parr in freshwater environments. Avian predators may find the elevated bridge structure an advantageous perch from which to observe potential prey.

Native and introduced fish species, such as smallmouth bass, chain pickerel, and northern pike are important predators of Atlantic salmon within the range of the GOM DPS (Fay *et al.* 2006). Smallmouth bass are important predators of smolts in main stem habitats, although bioenergetics modeling indicates that bass predation is insignificant at 5°C and increases with increasing water temperature during the smolt migration (Van den Ende 1993). Chain pickerel are known to feed upon smolts within the range of the GOM DPS and certainly feed upon fry and parr, as well as smolts, given their piscivorous feeding habits (Van den Ende 1993). Northern pike were illegally stocked in Maine, and their range has expanded. Northern pike are ambush predators that rely on vision and thus, predation upon smolts occurs primarily in daylight with the highest predation rates in low light conditions at dawn and dusk (Bakshtansky *et al.* 1982). Hatchery smolts experience higher rates of predation by fish than wild smolts, particularly from northern pike (Ruggles 1980; Bakshtansky *et al.* 1982).

3.1.6 Summary of Factors Affecting Recovery of Atlantic salmon

There are a wide variety of factors that affect the current status of the GOM DPS of Atlantic salmon and its designated critical habitat. The potential interactions among these factors are not well understood, nor are the reasons for the seemingly poor response of salmon populations to the many ongoing conservation efforts for this species.

Threats to the Species
The recovery plan for the previously designated GOM DPS (NMFS and USFWS 2005), the latest status review (Fay *et al.* 2006), and the 2009 listing rule all provide a comprehensive assessment of the many factors, including both threats and conservation actions that are currently affecting the status and recovery of listed Atlantic salmon. The Services are writing a new recovery plan that will include the current, expanded GOM DPS and its designated critical habitat. The new recovery plan provides the most up to date list of significant threats affecting the GOM DPS. These are the following:

Dams
1. Inadequacy of existing regulatory mechanisms for dams
2. Continued high mortality rates from turbine passage by kelts and smolts

3. Lack of access to spawning and rearing habitat due to inadequate upstream passage

In addition to these significant threats there are a number of lesser stressors. These are the following:

- Degraded water quality
- Aquaculture practices, which pose ecological and genetic risks
- Climate change
- Depleted diadromous fish communities
- Incidental capture of adults and parr by recreational anglers
- Introduced fish species that compete or prey on Atlantic salmon
- Poaching of adults in DPS rivers
- Recovery hatchery program (potential for artificial selection/domestication)
- Sedimentation of spawning and rearing habitat
- Water extraction

Fay *et al.* (2006) examined each of the five statutory ESA listing factors and determined that each of the five listing factors is at least partly responsible for the present low abundance of the GOM DPS of Atlantic salmon. The information presented in Fay *et al.* (2006) is reflected in and supplemented by the final listing rule for the new GOM DPS (74 FR 29344; June 19, 2009). The following gives a brief overview of the five listing factors as related to the GOM DPS.

Present or Threatened Destruction, Modification, or Curtailment of its Habitat or Range – Historically, dams have adversely impacted Atlantic salmon by obstructing fish passage and degrading riverine habitat. Dams are considered to be one of the primary causes of both historic declines and the contemporary low abundance of the GOM DPS. Land use practices, including forestry and agriculture, have reduced habitat complexity (e.g., removal of large woody debris from rivers) and habitat connectivity (e.g., poorly designed road crossings) for Atlantic salmon. Water withdrawals, elevated sediment levels, and acid rain also degrade Atlantic salmon habitat.

Overutilization for Commercial, Recreational, Scientific, or Educational Purposes – While most directed commercial fisheries for Atlantic salmon have ceased, the impacts from past fisheries are still important in explaining the present low abundance of the GOM DPS. Both poaching and by-catch in recreational and commercial fisheries for other species remain of concern, given critically low numbers of salmon.

Predation and Disease – Natural predator-prey relationships in aquatic ecosystems in the GOM DPS have been substantially altered by introduction of non-native fishes (e.g., chain pickerel, smallmouth bass, and northern pike), declines of other native diadromous fishes, and alteration of habitat by impounding free-flowing rivers and removing instream structure (such as removal of boulders and woody debris during the log-driving era). The threat of predation on the GOM DPS is noteworthy because of the imbalance between the very low numbers of returning adults and the recent increase in populations of some native predators (e.g., double-crested cormorant), as well as non-native predators. Atlantic salmon are susceptible to a number of diseases and parasites, but mortality is primarily documented at conservation hatcheries and aquaculture facilities.

Inadequacy of Existing Regulatory Mechanisms – The ineffectiveness of current federal and state regulations at requiring fish passage and minimizing or mitigating the aquatic habitat impacts of dams is a significant threat to the GOM DPS today. Furthermore, most dams in the GOM DPS do not require state or federal permits. Although the State of Maine has made substantial progress in regulating water withdrawals for agricultural use, threats still remain within the GOM DPS, including those from the effects of irrigation wells on salmon streams.

Other Natural or Manmade Factors – Poor marine survival rates of Atlantic salmon are a significant threat, although the causes of these decreases are unknown. The role of ecosystem function among the freshwater, estuarine, and marine components of the Atlantic salmon's life history, including the relationship of other diadromous fish species in Maine (e.g., American shad, alewife, sea lamprey), is receiving increased scrutiny in its contribution to the current status of the GOM DPS and its role in recovery of the Atlantic salmon. While current state and federal regulations pertaining to finfish aquaculture have reduced the risks to the GOM DPS (including eliminating the use of non-North American Atlantic salmon and improving containment protocols), risks from the spread of diseases or parasites and from farmed salmon escapees interbreeding with wild salmon still exist.

Threats to Critical Habitat within the GOM DPS

The final rule designating critical habitat for the GOM DPS identifies a number of activities that have and will likely continue to impact the biological and physical features of spawning, rearing, and migration habitat for Atlantic salmon. These include agriculture, forestry, changing land-use and development, hatcheries and stocking, roads and road-crossings and other instream activities (such as alternative energy development), mining, dams, dredging, and aquaculture. Most of these activities have or still do occur, at least to some extent, in each of the three SHRUs.

Today, dams are the greatest impediment, outside of marine survival, to the recovery of salmon in the Penobscot, Kennebec and Androscoggin river basins (Fay *et al.* 2006). Hydropower dams in the Merrymeeting Bay SHRU significantly impede the migration of Atlantic salmon and other diadromous fish and either reduce or eliminate access to roughly 330,000 units of historically accessible spawning and rearing habitat. In addition to hydropower dams, agriculture and urban development largely affect the lower third of the Merrymeeting Bay SHRU by reducing substrate and cover, reducing water quality, and elevating water temperatures. Additionally, smallmouth bass and brown trout introductions, along with other non-indigenous species, significantly degrade habitat quality throughout the Merrymeeting Bay SHRU by altering natural predator/prey relationships.

Impacts to substrate and cover, water quality, water temperature, biological communities, and migratory corridors, among a host of other factors, have impacted the quality and quantity of habitat available to Atlantic salmon populations within the Downeast Coastal SHRU. Two hydropower dams on the Union river, and to a lesser extent the small ice dam on the lower Narraguagus River, limit access to roughly 18,500 units of spawning and rearing habitat within these two watersheds. In the Union River, which contains over 12,000 units of spawning and rearing habitat, physical and biological features have been most notably limited by high water temperatures and abundant smallmouth bass populations associated with impoundments. In the Pleasant River and Tunk Stream, which collectively contain over 4,300 units of spawning and rearing habitat, pH has been identified as possibly being the predominate limiting factor. The Machias, Narraguagus, and East Machias rivers contain the highest quality habitat relative to other HUC 10's in the Downeast Coastal SHRU and collectively account for approximately 40 percent of the spawning and rearing habitat in the Downeast Coastal SHRU.

Efforts to Protect the GOM DPS and its Critical Habitat

Efforts aimed at protecting Atlantic salmon and their habitats in Maine have been underway for well over one hundred years. These efforts are supported by a number of federal, state, and local government agencies, as well as many private conservation organizations. The 2005 recovery plan for the originally-listed GOM DPS (NMFS and USFWS 2005) presented a strategy for recovering Atlantic salmon that focused on reducing the most severe threats to the species and immediately halting the decline of the species to prevent extinction. The 2005 recovery program included the following elements:

1. Protect and restore freshwater and estuarine habitats;
2. Minimize potential for take in freshwater, estuarine, and marine fisheries;
3. Reduce predation and competition for all life-stages of Atlantic salmon;
4. Reduce risks from commercial aquaculture operations;
5. Supplement wild populations with hatchery-reared DPS salmon;
6. Conserve the genetic integrity of the DPS;
7. Assess stock status of key life stages;
8. Promote salmon recovery through increased public and government awareness; and
9. Assess effectiveness of recovery actions and revise as appropriate.

A wide variety of activities have focused on protecting Atlantic salmon and restoring the GOM DPS, including (but not limited to) hatchery supplementation; removing dams or providing fish passage; improving road crossings that block passage or degrade stream habitat; protecting riparian corridors along rivers; reducing the impact of irrigation water withdrawals; limiting effects of recreational and commercial fishing; reducing the effects of finfish aquaculture; outreach and education activities; and research focused on better understanding the threats to Atlantic salmon and developing effective restoration strategies. In light of the 2009 GOM DPS listing and designation of critical habitat, the Services will produce a new recovery plan for the expanded GOM DPS of Atlantic salmon.

3.1.7 Summary of Information on Atlantic Salmon in the Action Area

Adult returns for the GOM DPS remain well below conservation spawning escapement (CSE). For all GOM DPS rivers in Maine, current Atlantic salmon populations (including hatchery contributions) are well below CSE levels required to sustain themselves (Fay *et al.* 2006), which is further indication of their poor population status. The abundance of Atlantic salmon in the GOM DPS has been low and either stable or declining over the past several decades. The proportion of fish that are of natural origin is very small (approximately 6% over the last ten years) and is continuing to decline. The conservation hatchery program has assisted in slowing the decline and helping to stabilize populations at low levels, but has not contributed to an increase in the overall abundance of salmon and has not been able to halt the decline of the naturally reared component of the GOM DPS.

A number of activities within the Merrymeeting Bay SHRU will likely continue to impact the biological and physical features of spawning, rearing, and migration habitat for Atlantic salmon. These include agriculture, forestry, changing land-use and development, hatcheries and stocking, roads and road-crossings and other instream activities (such as alternative energy development), mining, dams, dredging, and aquaculture. Dams, along with degraded substrate and cover, water quality, water temperature, and biological communities, have reduced the quality and quantity of habitat available to Atlantic salmon populations within the Merrymeeting Bay SHRU.

3.2 Shortnose Sturgeon

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, isopods), insects, 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) 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). 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 and a mean of 11,568 eggs/kg body weight (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. Dispersal rates differ at least regionally, laboratory studies on Connecticut River larvae indicated dispersal peaked 7-12 days after hatching in comparison to Savannah River larvae that had longer dispersal rates with multiple, prolonged peaks, and a low level of downstream movement that continued throughout the entire larval and early juvenile period (Parker 2007). Synder (1988) and Parker (2007) considered individuals to be juvenile when they reached 57mm TL. Laboratory studies demonstrated that larvae from the Connecticut River made this transformation on day 40 while Savannah River fish made this transition on day 41 and 42 (Parker 2007).

The juvenile phase can be subdivided in to young of the year (YOY) and immature/ sub-adults. YOY and sub-adult habitat use differs and is believed to be a function of differences in salinity tolerances. Little is known about YOY behavior and habitat use, though it is believed that they are typically found in channel areas within freshwater habitats upstream of the salt wedge for about one year (Dadswell *et al.* 1984; Kynard 1997). One study on the stomach contents of YOY revealed that the prey items found corresponded to organisms that would be found in the channel environment (amphipods) (Carlson and Simpson 1987). Sub-adults are typically described as age one or older and occupy similar spatio-temporal patterns and habitat-use as adults (Kynard 1997). Though there is evidence from the Delaware River that sub-adults may overwinter in different areas than adults and do not form dense aggregations like adults (ERC Inc. 2007). Sub-adults feed indiscriminately; typical prey items found in stomach contents include aquatic insects, isopods, and amphipods along with large amounts of mud, stones, and plant material (Dadswell 1979; Carlson and Simpson 1987; Bain 1997).

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 reach between 7-9.7ºC (44.6-49.5°F), 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 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 - 15ºC (46.4-59°F), and bottom water velocities of 0.4 to 0.8 m/sec (Dadswell *et al.* 1984; Hall *et al.* 1991, Kieffer and Kynard 1996; 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°C (46.4°F) and 12°C (53.6°F), 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 or sub-adults tend to move downstream in fall and winter as water temperatures decline and the salt wedge recedes and 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 *et al.* 1994; Rogers and Weber 1995; Weber 1996).

While shortnose sturgeon do not undertake the significant marine migrations seen in Atlantic sturgeon, telemetry data indicates that shortnose sturgeon do make localized coastal migrations. This is particularly true within certain areas such as the Gulf of Maine (GOM) and among rivers in the Southeast. Intra-basin movements have been documented among rivers within the GOM. Inter-basin basin movements have been documented between the GOM rivers and the Merrimack, between the Connecticut and Hudson rivers, the Delaware River and Chesapeake Bay, and among the rivers in the Southeast.

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 (35.6-37.4°F) (Dadswell *et al.* 1984) and as high as 34ºC (93.2°F) (Heidt and Gilbert 1978). However, water temperatures above 28ºC (82.4°F) are thought to adversely affect shortnose sturgeon. In the Altamaha River, water temperatures of 28-30ºC (82.4-86°F) during summer months create unsuitable conditions and shortnose sturgeon are found in deep cool water refuges. Dissolved oxygen (DO) also seems to play a role in temperature tolerance, with increased stress levels at higher temperatures with low DO versus the ability to withstand higher temperatures with elevated DO (Niklitchek 2001).

Shortnose sturgeon are known to occur at a wide range of depths. A minimum depth of 0.6m (approximately 2 feet) is necessary for the unimpeded swimming by adults. Shortnose sturgeon are known to occur at depths of up to 30m (98.4 ft) but are generally found in waters less than 20m (65.5 ft) (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; Squires and Smith 1979). McCleave *et al.* (1977) reported adults moving freely through a wide range of salinities, crossing waters with differences of up to 10 ppt 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); however, shortnose sturgeon forage on vegetated mudflats and over shellfish beds in shallower waters when suitable forage is also present.

3.2.1 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 century’s, shortnose sturgeon commonly were taken in a commercial fishery for the closely related and commercially valuable Atlantic sturgeon (*Acipenser oxyrinchus 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 (NMFS 1998). Shortnose sturgeon are listed as “vulnerable” on the International Union for the Conservation of Nature (IUCN) Red List.

Although shortnose sturgeon are listed as endangered range-wide, in the final recovery plan 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) of shortnose sturgeon under the ESA. Although 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).

Studies conducted since the issuance of the 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, inter-orbital 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 inter-orbital 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 eleven 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 five 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. These differences likely account 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 re-colonized. 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. Population sizes vary across the species' range. From available estimates, the smallest populations occur in the Cape Fear (~8 adults; Moser and Ross 1995) in the south and Merrimack and Penobscot rivers in the north (~ several hundred to several thousand adults depending on population estimates used; M. Kieffer, United States Geological Survey, personal communication; Dionne 2010), while the largest populations are found in the Saint John (~18, 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 population range wide, 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.

3.2.2 Status of Shortnose Sturgeon in the Action Area

Since the removal of the Edwards Dam in 1999, numerous studies have been conducted by state and federal agencies on habitat re-colonization. Recently, academic studies on shortnose sturgeon have been focusing on the species use of small coastal rivers and inter-basin movements, such as the utilization of the St. George and/or Damariscotta Rivers while migrating between the Kennebec and Penobscot Rivers.

ASchnabel estimate using tagging and recapture data from 1998, 1999 and 2000 indicates a population estimate of 9,488 (95% CI, 6,942 to 13,358) for the estuarine complex (Squires 2003). The average density of adult shortnose sturgeon per hectare of habitat in the estuarine complex of the Kennebec River was the second highest of any population studied through 1983 (Dadswell *et al.* 1984).

Shortnose sturgeon occupy the Kennebec River year-round and migrate up and downstream seasonally between overwintering habitat, spawning grounds, and foraging areas.

Movement to the spawning grounds occurs in early spring (April - May) in the Kennebec River. 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 8-9°C. Shortnose sturgeon typically spawn at the most upstream accessible site with suitable conditions. Spawning sites have been identified in the Kennebec River near Gardiner. Since the removal of the Edwards Dam in 1999, shortnose sturgeon have been able to travel as far upstream as the Lockwood Dam. Based on this pattern, it is likely that shortnose sturgeon may now be spawning in additional upriver sites.

During a 1999 tracking study by Normandeau Associates, several fish presumed to be non-spawning sturgeon, were documented in at Chops Point and Swan Island. Studies indicate that at least a portion of the shortnose sturgeon population in the Kennebec River overwinters in Merrymeeting Bay (Squires 2003). For several years, shortnose sturgeon were documented overwintering in an area three- five kilometers downstream of the Richmond-Dresden Bridge at the confluence of the Eastern and Kennebec Rivers near Swan Island. However, during the overwintering period 2011-2012 shortnose sturgeon overwintered in the deep water channels between Hallowell and Farmingdale, Maine, approximately one kilometer upstream of Brown's Island and nearly 20 rkm upstream of the action area (G. Wipplehauser, MDMR, personal communication 2012).

Overwintering areas may change year to year. Because of this it is difficult to predict where the species may overwinter during the bridge replacement activities. If sturgeon overwintered upstream of Gardiner, then they would only spend a short period of time in the action area as they migrate through. However, if shortnose sturgeon were to overwinter near Swan Island, then they could be exposed to construction effects for an extended period.

Based on the best available information on the seasonal distribution of shortnose sturgeon in the Kennebec River, adult shortnose sturgeon are likely to be present in the action area during the spring while migrating to and from any spawning sites that likely exist upstream of the action area.

3.3 Atlantic Sturgeon

The section below describes the Atlantic sturgeon listing, provides life history information that is relevant to all DPSs of Atlantic sturgeon and then provides information specific to the status of each DPS of Atlantic sturgeon. Below, we also provide a description of which Atlantic sturgeon DPSs likely occur in the action area and provide information on the use of the action area by Atlantic sturgeon.

The Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) is a subspecies of sturgeon distributed along the eastern coast of North America from Hamilton Inlet, Labrador, Canada to Cape Canaveral, Florida, USA (Scott and Scott, 1988; ASSRT, 2007; T. Savoy, CT DEP, pers. comm.). NMFS has delineated U.S. populations of Atlantic sturgeon into five DPSs[1] (77 FR

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[1] To be considered for listing under the ESA, a group of organisms must constitute a "species." A "species" is defined in section 3 of the ESA to include "any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature."

5880 and 77 FR 5914). These are: the Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs (see Figure 3). The results of genetic studies suggest that natal origin influences the distribution of Atlantic sturgeon in the marine environment (Wirgin and King, 2011). However, genetic data as well as tracking and tagging data demonstrate sturgeon from each DPS and Canada occur throughout the full range of the subspecies. Therefore, sturgeon originating from any of the five DPSs can be affected by threats in the marine, estuarine and riverine environment that occur far from natal spawning rivers.

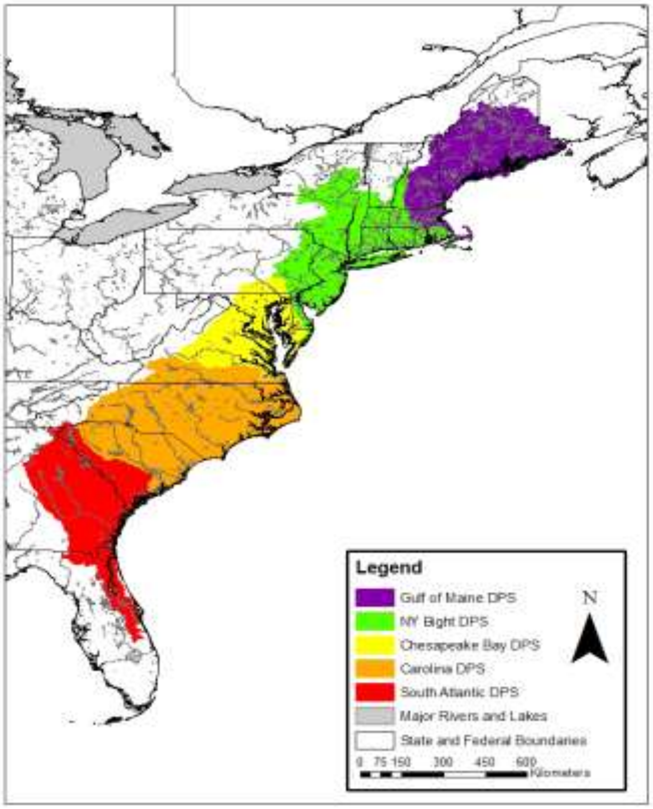
On February 6, 2012, we published notice in the *Federal Register* that we were listing the New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs as "endangered," and the Gulf of Maine DPS as "threatened" (77 FR 5880 and 77 FR 5914). The effective date of the listings was April 6, 2012. The DPSs do not include Atlantic sturgeon that are spawned in Canadian rivers. Therefore, Canadian spawned fish are not included in the listings.

As explained above, the range of all five DPSs overlaps and extends from Canada through Cape Canaveral, Florida. The distribution of Atlantic sturgeon is influenced by geography, with Atlantic sturgeon from a particular DPS becoming less common the further from the river of origin one moves. Areas that are geographically close are expected to have a similar composition of individuals. We have considered the best available information to determine from which DPSs individuals in the action area are likely to have originated.

There is currently no mixed stock analysis for the Kennebec River. Mixed stock analysis is available for the Bay of Fundy. Given the geographic proximity of the Bay of Fundy to the action area, it is reasonable to anticipate similar distribution in these two areas (93% Gulf of Maine DPS (60% St. John, 40% Kennebec) and 7% New York Bight DPS). However, in the action area we would expect a higher frequency of Kennebec River origin individuals than St. John River individuals. As such, in the action area we expect Atlantic sturgeon to occur at the following frequencies: Gulf of Maine 93% (60-100% Kennebec and ~0-40% St. John (Canada)) and 7% New York Bight . These occurrences are supported by preliminary genetic analyses of fish caught in the Gulf of Maine. The genetic assignments have a plus/minus 5% confidence interval; however, for purposes of section 7 consultation we have selected the reported values above, which approximate the mid-point of the range, as a reasonable indication of the likely genetic makeup of Atlantic sturgeon in the action area. These assignments and the data from which they are derived are described in detail by Damon-Randall *et al.* (2012).

Information general to all Atlantic sturgeon as well as information specific to each of the relevant DPSs, is provided below.

Figure 3. Map Depicting the Boundaries of the five Atlantic sturgeon DPSs



Atlantic sturgeon life history

Atlantic sturgeon are long lived (approximately 60 years), late maturing, estuarine dependent, anadromous[2] fish (Bigelow and Schroeder, 1953; Vladykov and Greeley 1963; Mangin, 1964; Pikitch *et al*., 2005; Dadswell, 2006; ASSRT, 2007).

The life history of Atlantic sturgeon can be divided up into five general categories as described in the table below (adapted from ASSRT 2007).

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[2] Anadromous refers to a fish that is born in freshwater, spends most of its life in the sea, and returns to freshwater to spawn (NEFSC FAQs, available at http://www.nefsc.noaa.gov/faq/fishfaq1a.html, modified June 16, 2011).

Age Class	Size	Description
Egg		Fertilized or unfertilized
Larvae		Negative photo-taxic, nourished by yolk sac
Young of Year (YOY)	**0.3 grams <41 cm TL**	Fish that are > 3 months and < one year; capable of capturing and consuming live food
Sub-adults	**>41 cm and <150 cm TL**	Fish that are at least age 1 and are not sexually mature
Adults	**>150 cm TL**	Sexually mature fish

Table 4. Descriptions of Atlantic sturgeon life history stages.

They are a relatively large fish, even amongst sturgeon species (Pikitch *et al.*, 2005). Atlantic sturgeon are bottom feeders that suck food into a ventrally-located protruding mouth (Bigelow and Schroeder, 1953). Four barbels in front of the mouth assist the sturgeon in locating prey (Bigelow and Schroeder, 1953). 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). While in the river, Atlantic sturgeon feed on aquatic insects, insect larvae, and other invertebrates (Bigelow and Schroeder, 1953; ASSRT, 2007; Guilbard *et al.*, 2007).

Rate of maturation is affected by water temperature and gender. In general: (1) Atlantic sturgeon that originate from southern systems grow faster and mature sooner than Atlantic sturgeon that originate from more northern systems; (2) males grow faster than females; (3) fully mature females attain a larger size (i.e. length) than fully mature males; and (4) the length of Atlantic sturgeon caught since the mid-late 20th century have typically been less than 3 meters (m) (Smith *et al.*, 1982; Smith *et al.*, 1984; Smith, 1985; Scott and Scott, 1988; Young *et al.*, 1998; Collins *et al.*, 2000; Caron *et al.*, 2002; Dadswell, 2006; ASSRT, 2007; Kahnle *et al.*, 2007; DFO, 2011). The largest recorded Atlantic sturgeon was a female captured in 1924 that measured approximately 4.26 m (Vladykov and Greeley, 1963). Dadswell (2006) reported seeing seven fish of comparable size in the St. John River estuary from 1973 to 1995. Observations of large-sized sturgeon are particularly important given that egg production is correlated with age and body size (Smith *et al.*, 1982; Van Eenennaam *et al.*, 1996; Van Eenennaam and Doroshov, 1998; Dadswell, 2006). However, while females are prolific with egg production ranging from 400,000 to 4 million eggs per spawning year, females spawn at intervals of 2-5 years (Vladykov and Greeley, 1963; Smith *et al.*, 1982; Van Eenennaam *et al.*, 1996; Van Eenennaam and Doroshov, 1998; Stevenson and Secor, 1999; Dadswell, 2006). Given spawning periodicity and a female's relatively late age to maturity, the age at which 50 percent of the maximum lifetime egg production is achieved is estimated to be 29 years (Boreman, 1997). Males exhibit spawning periodicity of 1-5 years (Smith, 1985; Collins *et al.*, 2000; Caron *et al.*, 2002). While long-lived, Atlantic sturgeon are exposed to a multitude of threats prior to achieving maturation and have a limited number of spawning opportunities once mature.

Water temperature plays a primary role in triggering the timing of spawning migrations (ASMFC, 2009). Spawning migrations generally occur during February-March in southern systems, April-May in Mid-Atlantic systems, and May-July in Canadian systems (Murawski and Pacheco, 1977; Smith, 1985; Bain, 1997; Smith and Clugston, 1997; Caron *et al.*, 2002). Male sturgeon begin upstream spawning migrations when waters reach approximately 6° C (43° F) (Smith *et al.*, 1982; Dovel and Berggren, 1983; Smith, 1985; ASMFC, 2009), and remain on the spawning grounds throughout the spawning season (Bain, 1997). Females begin spawning migrations when temperatures are closer to 12° C to 13° C (54° to 55° F) (Dovel and Berggren, 1983; Smith, 1985; Collins *et al.*, 2000), make rapid spawning migrations upstream, and quickly depart following spawning (Bain, 1997).

The spawning areas in most U.S. rivers have not been well defined. However, the habitat characteristics of spawning areas have been identified based on historical accounts of where fisheries occurred, tracking and tagging studies of spawning sturgeon, and physiological needs of early life stages. Spawning is believed to occur in flowing water between the salt front of estuaries and the fall line of large rivers, when and where optimal flows are 46-76 cm/s and depths are 3-27 m (Borodin, 1925; Dees, 1961; Leland, 1968; Scott and Crossman, 1973; Crance, 1987; Shirey *et al.* 1999; Bain *et al.*, 2000; Collins *et al.*, 2000; Caron *et al.* 2002; Hatin *et al.* 2002; ASMFC, 2009). Sturgeon eggs are deposited on hard bottom substrate such as cobble, coarse sand, and bedrock (Dees, 1961; Scott and Crossman, 1973; Gilbert, 1989; Smith and Clugston, 1997; Bain *et al.* 2000; Collins *et al.*, 2000; Caron *et al.*, 2002; Hatin *et al.*, 2002; Mohler, 2003; ASMFC, 2009), and become adhesive shortly after fertilization (Murawski and Pacheco, 1977; Van den Avyle, 1983; Mohler, 2003). Incubation time for the eggs increases as water temperature decreases (Mohler, 2003). At temperatures of 20° and 18° C, hatching occurs approximately 94 and 140 hours, respectively, after egg deposition (ASSRT, 2007).

Larval Atlantic sturgeon (i.e. less than 4 weeks old, with total lengths (TL) less than 30 mm; Van Eenennaam *et al.* 1996) are assumed to undertake a demersal existence and inhabit the same riverine or estuarine areas where they were spawned (Smith *et al.*, 1980; Bain *et al.*, 2000; Kynard and Horgan, 2002; ASMFC, 2009). Studies suggest that age-0 (i.e., young-of-year), age-1, and age-2 Atlantic sturgeon occur in low salinity waters of the natal estuary (Haley, 1999; Hatin *et al.*, 2007; McCord *et al.*, 2007; Munro *et al.*, 2007) while older fish are more salt tolerant and occur in higher salinity waters as well as low salinity waters (Collins *et al.*, 2000). Atlantic sturgeon remain in the natal estuary for months to years before emigrating to open ocean as subadults (Holland and Yelverton, 1973; Dovel and Berggen, 1983; Waldman *et al.*, 1996; Dadswell, 2006; ASSRT, 2007).

After emigration from the natal estuary, subadults and adults travel within the marine environment, typically in waters less than 50 m in depth, using coastal bays, sounds, and ocean waters (Vladykov and Greeley, 1963; Murawski and Pacheco, 1977; Dovel and Berggren, 1983; Smith, 1985; Collins and Smith, 1997; Welsh *et al.*, 2002; Savoy and Pacileo, 2003; Stein *et al.*, 2004; USFWS, 2004; Laney *et al.*, 2007; Dunton *et al.*, 2010; Erickson *et al.*, 2011; Wirgin and King, 2011). Tracking and tagging studies reveal seasonal movements of Atlantic sturgeon along the coast. Satellite-tagged adult sturgeon from the Hudson River concentrated in the southern part of the Mid-Atlantic Bight at depths greater than 20 m during winter and spring, and in the northern portion of the Mid-Atlantic Bight at depths less than 20 m in summer and fall (Erickson *et al.*, 2011). Shirey (Delaware Department of Fish and Wildlife, unpublished data reviewed in ASMFC, 2009) found a similar movement pattern for juvenile Atlantic sturgeon based on recaptures of fish originally tagged in the Delaware River. After leaving the Delaware River estuary during the fall, juvenile Atlantic sturgeon were recaptured by commercial fishermen in nearshore waters along the Atlantic coast as far south as Cape Hatteras, North Carolina from November through early March. In the spring, a portion of the tagged fish re-entered the Delaware River estuary. However, many fish continued a northerly coastal migration through the Mid-Atlantic as well as into southern New England waters where they were recovered throughout the summer months. Movements as far north as Maine were documented. A southerly coastal migration was apparent from tag returns reported in the fall. The majority of these tag returns were reported from relatively shallow near shore fisheries with few fish reported from waters in excess of 25 m (C. Shirey, Delaware Department of Fish and Wildlife, unpublished data reviewed in ASMFC, 2009). Areas where migratory Atlantic sturgeon commonly aggregate include the Bay of Fundy (e.g., Minas and Cumberland Basins), Massachusetts Bay, Connecticut River estuary, Long Island Sound, New York Bight, Delaware Bay, Chesapeake Bay, and waters off of North Carolina from the Virginia/North Carolina border to Cape Hatteras at depths up to 24 m (Dovel and Berggren, 1983; Dadswell *et al.*, 1984; Johnson *et al.*, 1997; Rochard *et al.*, 1997; Kynard *et al.*, 2000; Eyler *et al.*, 2004; Stein *et al.*, 2004; Wehrell, 2005; Dadswell, 2006; ASSRT, 2007; Laney *et al.*, 2007). These sites may be used as foraging sites and/or thermal refuge.

Distribution and Abundance

Atlantic sturgeon underwent significant range-wide declines from historical abundance levels due to overfishing in the mid to late 19th century when a caviar market was established (Scott and Crossman, 1973; Taub, 1990; Kennebec River Resource Management Plan, 1993; Smith and Clugston, 1997; Dadswell, 2006; ASSRT, 2007). Abundance of spawning-aged females prior to this period of exploitation was predicted to be greater than 100,000 for the Delaware, and at least 10,000 females for other spawning stocks (Secor and Waldman, 1999; Secor, 2002). Historical records suggest that Atlantic sturgeon spawned in at least 35 rivers prior to this period. Currently, only 16 U.S. rivers are known to support spawning based on available evidence (i.e., presence of young-of-year or gravid Atlantic sturgeon documented within the past 15 years) (ASSRT, 2007). While there may be other rivers supporting spawning for which definitive evidence has not been obtained (e.g., in the Penobscot and York Rivers), the number of rivers supporting spawning of Atlantic sturgeon are approximately half of what they were historically. In addition, only four rivers (Kennebec, Hudson, Delaware, James) are known to currently support spawning from Maine through Virginia where historical records support there used to be fifteen spawning rivers (ASSRT, 2007). While spawning may also be occurring in other rivers (e.g., the Androscoggin River in Maine), we do not yet have confirmation of spawning in other

Northeast rivers. Thus, there are substantial gaps in the range between Atlantic sturgeon spawning rivers amongst northern and mid-Atlantic states which could make recolonization of extirpated populations more difficult.

There are no current, published population abundance estimates for any of the currently known spawning stocks. Therefore, there are no published abundance estimates for any of the five DPSs of Atlantic sturgeon. An annual mean estimate of 863 mature adults (596 males and 267 females) was calculated for the Hudson River based on fishery-dependent data collected from 1985-1995 (Kahnle *et al.*, 2007). An estimate of 343 spawning adults per year is available for the Altamaha River, GA, based on fishery-independent data collected in 2004 and 2005 (Schueller and Peterson, 2006). Using the data collected from the Hudson River and Altamaha River to estimate the total number of Atlantic sturgeon in either subpopulation is not possible, since mature Atlantic sturgeon may not spawn every year (Vladykov and Greeley, 1963; Smith, 1985; Van Eenennaam *et al.*, 1996; Stevenson and Secor, 1999; Collins *et al.* 2000; Caron *et al.*, 2002), the age structure of these populations is not well understood, and stage to stage survival is unknown. In other words, the information that would allow us to take an estimate of annual spawning adults and expand that estimate to an estimate of the total number of individuals (e.g., yearlings, subadults, and adults) in a population is lacking. The ASSRT presumed that the Hudson and Altamaha rivers had the most robust of the remaining U.S. Atlantic sturgeon spawning populations and concluded that the other U.S. spawning populations were likely less than 300 spawning adults per year (ASSRT, 2007).

Threats faced by Atlantic sturgeon throughout their range

Atlantic sturgeon are susceptible to over exploitation given their life history characteristics (e.g., late maturity, dependence on a wide-variety of habitats). Similar to other sturgeon species (Vladykov and Greeley, 1963; Pikitch *et al.*, 2005), Atlantic sturgeon experienced range-wide declines from historical abundance levels due to overfishing (for caviar and meat) and impacts to habitat in the 19th and 20th centuries (Taub, 1990; Smith and Clugston, 1997; Secor and Waldman, 1999).

Based on the best available information, NMFS has concluded that unintended catch of Atlantic sturgeon in fisheries, vessel strikes, poor water quality, water availability, dams, lack of regulatory mechanisms for protecting the fish, and dredging are the most significant threats to Atlantic sturgeon (77 FR 5880 and 77 FR 5914; February 6, 2012). While all of the threats are not necessarily present in the same area at the same time, given that Atlantic sturgeon subadults and adults use ocean waters from the Labrador, Canada to Cape Canaveral, FL, as well as estuaries of large rivers along the U.S. East Coast, activities affecting these water bodies are likely to impact more than one Atlantic sturgeon DPS. In addition, given that Atlantic sturgeon depend on a variety of habitats, every life stage is likely affected by one or more of the identified threats.

An ASMFC interstate fishery management plan for sturgeon (Sturgeon FMP) was developed and implemented in 1990 (Taub, 1990). In 1998, the remaining Atlantic sturgeon fisheries in U.S. state waters were closed per Amendment 1 to the Sturgeon FMP. Complementary regulations were implemented by NMFS in 1999 that prohibit fishing for, harvesting, possessing or retaining Atlantic sturgeon or its parts in or from the Exclusive Economic Zone in the course of a commercial fishing activity.

Commercial fisheries for Atlantic sturgeon still exist in Canadian waters (DFO, 2011). Sturgeon belonging to one or more of the DPSs may be harvested in the Canadian fisheries. In particular, the Bay of Fundy fishery in the Saint John estuary may capture sturgeon of U.S. origin given that sturgeon from the Gulf of Maine and the New York Bight DPSs have been incidentally captured in other Bay of Fundy fisheries (DFO, 2010; Wirgin and King, 2011). Because Atlantic sturgeon are listed under Appendix II of the Convention on International Trade in Endangered Species (CITES), the U.S. and Canada are currently working on a conservation strategy to address the potential for captures of U.S. fish in Canadian directed Atlantic sturgeon fisheries and of Canadian fish incidentally in U.S. commercial fisheries. At this time, there are no estimates of the number of individuals from any of the DPSs that are captured or killed in Canadian fisheries each year.

Based on geographic distribution, most U.S. Atlantic sturgeon that are intercepted in Canadian fisheries are likely to originate from the Gulf of Maine DPS, with a smaller percentage from the New York Bight DPS.

Fisheries bycatch in U.S. waters is the primary threat faced by all 5 DPSs. At this time, we have an estimate of the number of Atlantic sturgeon captured and killed in sink gillnet and otter trawl fisheries authorized by Federal FMPs (NMFS NEFSC 2011) in the Northeast Region but do not have a similar estimate for Southeast fisheries. We also do not have an estimate of the number of Atlantic sturgeon captured or killed in state fisheries. At this time, we are not able to quantify the effects of other significant threats (e.g., vessel strikes, poor water quality, water availability, dams, and dredging) in terms of habitat impacts or loss of individuals. While we have some information on the number of mortalities that have occurred in the past in association with certain activities (e.g., mortalities in the Delaware and James rivers that are thought to be due to vessel strikes), we are not able to use those numbers to extrapolate effects throughout one or more DPS. This is because of (1) the small number of data points and, (2) lack of information on the percent of incidences that the observed mortalities represent.

As noted above, the NEFSC prepared an estimate of the number of encounters of Atlantic sturgeon in fisheries authorized by Northeast FMPs (NEFSC 2011). The analysis prepared by the NEFSC estimates that from 2006 through 2010 there were 2,250 to 3,862 encounters per year in observed gillnet and trawl fisheries, with an average of 3,118 encounters. Mortality rates in gillnet gear are approximately 20%. Mortality rates in otter trawl gear are believed to be lower at approximately 5%.

3.3.1 Gulf of Maine DPS of Atlantic sturgeon

The Gulf of Maine DPS includes the following: all anadromous Atlantic sturgeons that are spawned in the watersheds from the Maine/Canadian border and, extending southward, all watersheds draining into the Gulf of Maine as far south as Chatham, MA. Within this range, Atlantic sturgeon historically spawned in the Androscoggin, Kennebec, Merrimack, Penobscot, and Sheepscot Rivers (ASSRT, 2007). Spawning still occurs in the Kennebec River, and it is possible that it still occurs in the Penobscot River as well. Spawning in the Androscoggin River was just recently confirmed by the Maine Department of Marine Resources when they captured a larval Atlantic sturgeon during the 2011 spawning season below the Brunswick Dam; however, the extent of spawning in this river is unknown. There is no evidence of recent spawning in the remaining rivers. In the 1800s, construction of the Essex Dam on the Merrimack River at river kilometer (rkm) 49 blocked access to 58 percent of Atlantic sturgeon habitat in the river (Oakley, 2003; ASSRT, 2007). However, the accessible portions of the Merrimack seem to be suitable habitat for Atlantic sturgeon spawning and rearing (i.e., nursery habitat) (Keiffer and Kynard, 1993). Therefore, the availability of spawning habitat does not appear to be the reason for the lack of observed spawning in the Merrimack River. Studies are on-going to determine whether Atlantic sturgeon are spawning in these rivers. Atlantic sturgeons that are spawned elsewhere continue to use habitats within all of these rivers as part of their overall marine range (ASSRT, 2007). The movement of subadult and adult sturgeon between rivers, including to and from the Kennebec River and the Penobscot River, demonstrates that coastal and marine migrations are key elements of Atlantic sturgeon life history for the Gulf of Maine DPS as well as likely throughout the entire range (ASSRT, 2007; Fernandes, *et al.*, 2010).

Bigelow and Schroeder (1953) surmised that Atlantic sturgeon likely spawned in Gulf of Maine Rivers in May-July. More recent captures of Atlantic sturgeon in spawning condition within the Kennebec River suggest that spawning more likely occurs in June-July (Squiers *et al.*, 1981; ASMFC, 1998; NMFS and USFWS, 1998). Evidence for the timing and location of Atlantic sturgeon spawning in the Kennebec River includes: (1) the capture of five adult male Atlantic sturgeon in spawning condition (i.e., expressing milt) in July 1994 below the (former) Edwards Dam; (2) capture of 31 adult Atlantic sturgeon from June 15,1980, through July 26,1980, in a small commercial fishery directed at Atlantic sturgeon from the South Gardiner area (above Merrymeeting Bay) that included at least 4 ripe males and 1 ripe female captured on July 26,1980; and, (3) capture of nine adults during a gillnet survey conducted from 1977-1981, the majority of which were captured in July in the area from Merrymeeting Bay and upriver as far as Gardiner, ME (NMFS and USFWS, 1998; ASMFC 2007). The low salinity values for waters above Merrymeeting Bay are consistent with values found in other rivers where successful Atlantic sturgeon spawning is known to occur.

Several threats play a role in shaping the current status of Gulf of Maine DPS Atlantic sturgeon. Historical records provide evidence of commercial fisheries for Atlantic sturgeon in the Kennebec and Androscoggin Rivers dating back to the 17th century (Squiers *et al.*, 1979). In 1849, 160 tons of sturgeon was caught in the Kennebec River by local fishermen (Squiers *et al.*, 1979). Following the 1880's, the sturgeon fishery was almost non-existent due to a collapse of the sturgeon stocks. All directed Atlantic sturgeon fishing as well as retention of Atlantic sturgeon by catch has been prohibited since 1998. Nevertheless, mortalities associated with bycatch in fisheries occurring in state and federal waters still occurs. In the marine range, Gulf of Maine DPS Atlantic sturgeon are incidentally captured in federal and state managed fisheries, reducing survivorship of subadult and adult Atlantic sturgeon (Stein *et al.*, 2004; ASMFC 2007). As explained above, we have estimates of the number of subadults and adults that are killed as a result of bycatch in fisheries authorized under Northeast FMPs. At this time, we are not able to quantify the impacts from other threats or estimate the number of individuals killed as a result of other anthropogenic threats. Habitat disturbance and direct mortality from anthropogenic sources are the primary concerns.

Riverine habitat may be impacted by dredging and other in-water activities, disturbing spawning habitat and also altering the benthic forage base. Many rivers in the Gulf of Maine region have navigation channels that are maintained by dredging. Dredging outside of Federal channels and in-water construction occurs throughout the Gulf of Maine region. While some dredging projects operate with observers present to document fish mortalities, many do not. To date we have not received any reports of Atlantic sturgeon killed during dredging projects in the Gulf of Maine region; however, as noted above, not all projects are monitored for interactions with fish. At this time, we do not have any information to quantify the number of Atlantic sturgeon killed or disturbed during dredging or in-water construction projects are also not able to quantify any effects to habitat.

Connectivity is disrupted by the presence of dams on several rivers in the Gulf of Maine region, including the Penobscot and Merrimack Rivers. While there are also dams on the Kennebec, Androscoggin and Saco Rivers, these dams are near the site of natural falls and likely represent the maximum upstream extent of sturgeon occurrence even if the dams were not present. Because no Atlantic sturgeon are known to occur upstream of any hydroelectric projects in the Gulf of Maine region, passage over hydroelectric dams or through hydroelectric turbines is not a source of injury or mortality in this area. While not expected to be killed or injured during passage at a dam, the extent that Atlantic sturgeon are affected by the existence of dams and their operations in the Gulf of Maine region is currently unknown. The documentation of an Atlantic sturgeon larvae downstream of the Brunswick Dam in the Androscoggin River suggests that Atlantic sturgeon spawning may be occurring in the vicinity of at least that project and therefore, may be affected by project operations. The range of Atlantic sturgeon in the Penobscot River is limited by the presence of the Veazie and Great Works Dams. Together these dams prevent Atlantic sturgeon from accessing approximately 29 km of habitat, including the presumed historical spawning habitat located downstream of Milford Falls, the site of the Milford Dam. While removal of the Veazie and Great Works Dams is anticipated to occur in the near future, the presence of these dams is currently preventing access to significant habitats within the Penobscot River. While Atlantic sturgeon are known to occur in the Penobscot River, it is unknown if spawning is currently occurring or whether the presence of the Veazie and Great Works Dams affects the likelihood of spawning occurring in this river. The Essex Dam on the Merrimack River blocks access to approximately 58% of historically accessible habitat in this river. Atlantic sturgeon occur in the Merrimack River but spawning has not been documented. Like the Penobscot, it is unknown how the Essex Dam affects the likelihood of spawning occurring in this river.

Gulf of Maine DPS Atlantic sturgeon may also be affected by degraded water quality. In general, water quality has improved in the Gulf of Maine over the past decades (Lichter *et al.* 2006; EPA, 2008). Many rivers in Maine, including the Androscoggin River, were heavily polluted in the past from industrial discharges from pulp and paper mills. While water quality has improved and most discharges are limited through regulations, many pollutants persist in the benthic environment. This can be particularly problematic if pollutants are present on spawning and nursery grounds as developing eggs and larvae are particularly susceptible to exposure to contaminants.

There are no empirical abundance estimates for the Gulf of Maine DPS. The Atlantic sturgeon

SRT (2007) presumed that the Gulf of Maine DPS was comprised of less than 300 spawning adults per year, based on abundance estimates for the Hudson and Altamaha River riverine populations of Atlantic sturgeon. Surveys of the Kennebec River over two time periods, 1977-1981 and 1998-2000, resulted in the capture of nine adult Atlantic sturgeon (Squiers, 2004). However, since the surveys were primarily directed at capture of shortnose sturgeon, the capture gear used may not have been selective for the larger-sized, adult Atlantic sturgeon; several hundred subadult Atlantic sturgeon were caught in the Kennebec River during these studies.

Summary of the Gulf of Maine DPS

Spawning for the Gulf of Maine DPS is known to occur in the Kennebec and recent evidence suggests it may also be occurring in the Androscoggin. Spawning may be occurring in other rivers, such as the Sheepscot or Penobscot, but has not been confirmed. There are indications of increasing abundance of Atlantic sturgeon belonging to the Gulf of Maine DPS. Atlantic sturgeon continue to be present in the Kennebec River; in addition, they are captured in directed research projects in the Penobscot River, and are observed in rivers where they were unknown to occur or had not been observed to occur for many years (e.g., the Saco, Presumpscot, and Charles rivers). These observations suggest that abundance of the Gulf of Maine DPS of Atlantic sturgeon is sufficient such that recolonization to rivers historically suitable for spawning may be occurring. However, despite some positive signs, there is not enough information to establish a trend for this DPS.

Some of the impacts from the threats that contributed to the decline of the Gulf of Maine DPS have been removed (e.g., directed fishing), or reduced as a result of improvements in water quality and removal of dams (e.g., the Edwards Dam on the Kennebec River in 1999). There are strict regulations on the use of fishing gear in Maine state waters that incidentally catch sturgeon. In addition, there have been reductions in fishing effort in state and federal waters, which most likely would result in a reduction in bycatch mortality of Atlantic sturgeon. A significant amount of fishing in the Gulf of Maine is conducted using trawl gear, which is known to have a much lower mortality rate for Atlantic sturgeon caught in the gear compared to sink gillnet gear (ASMFC, 2007). Atlantic sturgeon from the GOM DPS are not commonly taken as bycatch in areas south of Chatham, MA, with only 8 percent (e.g., 7 of the 84 fish) of interactions observed in the Mid Atlantic/Carolina region being assigned to the Gulf of Maine DPS (Wirgin and King, 2011). Tagging results also indicate that Gulf of Maine DPS fish tend to remain within the waters of the Gulf of Maine and only occasionally venture to points south. However, data on Atlantic sturgeon incidentally caught in trawls and intertidal fish weirs fished in the Minas Basin area of the Bay of Fundy(Canada) indicate that approximately 35 percent originated from the Gulf of Maine DPS (Wirgin *et al.*, in draft).

As noted previously, studies have shown that in order to rebuild, Atlantic sturgeon can only sustain low levels of bycatch and other anthropogenic mortality (Boreman, 1997; ASMFC, 2007; Kahnle *et al.*, 2007; Brown and Murphy, 2010). NMFS has determined that the Gulf of Maine DPS is at risk of becoming endangered in the foreseeable future throughout all of its range (i.e., is a threatened species) based on the following: (1) significant declines in population sizes and the protracted period during which sturgeon populations have been depressed; (2) the limited amount of current spawning; and, (3) the impacts and threats that have and will continue to affect recovery.

3.3.2 New York Bight DPS of Atlantic sturgeon

The New York Bight DPS includes the following: all anadromous Atlantic sturgeon spawned in the watersheds that drain into coastal waters from Chatham, MA to the Delaware-Maryland border on Fenwick Island. Within this range, Atlantic sturgeon historically spawned in the Connecticut, Delaware, Hudson, and Taunton Rivers (Murawski and Pacheco, 1977; Secor, 2002; ASSRT, 2007). Spawning still occurs in the Delaware and Hudson Rivers, but there is no recent evidence (within the last 15 years) of spawning in the Connecticut and Taunton Rivers (ASSRT, 2007). Atlantic sturgeon that are spawned elsewhere continue to use habitats within the Connecticut and Taunton Rivers as part of their overall marine range (ASSRT, 2007; Savoy, 2007; Wirgin and King, 2011).

The abundance of the Hudson River Atlantic sturgeon riverine population prior to the onset of expanded exploitation in the 1800s is unknown but has been conservatively estimated at 10,000 adult females (Secor, 2002). Current abundance is likely at least one order of magnitude smaller than historical levels (Secor, 2002; ASSRT, 2007; Kahnle *et al.*, 2007). As described above, an estimate of the mean annual number of mature adults (863 total; 596 males and 267 females) was calculated for the Hudson River riverine population based on fishery-dependent data collected from 1985-1995 (Kahnle *et al.*, 2007). Kahnle *et al.* (1998; 2007) also showed that the level of fishing mortality from the Hudson River Atlantic sturgeon fishery during the period of 1985-1995 exceeded the estimated sustainable level of fishing mortality for the riverine population and may have led to reduced recruitment. No data on abundance of juveniles are available prior to the 1970s; however, two estimates of immature Atlantic sturgeon have been calculated for the Hudson River population, one for the 1976 year class and one for the 1994 year class. Dovel and Berggren (1983) marked immature fish from 1976-1978. Estimates for the 1976 year class at age were approximately 25,000 individuals. Dovel and Berggren estimated that in 1976 there were approximately 100,000 juvenile (non-migrant) Atlantic sturgeon from approximately 6 year classes, excluding young of year.

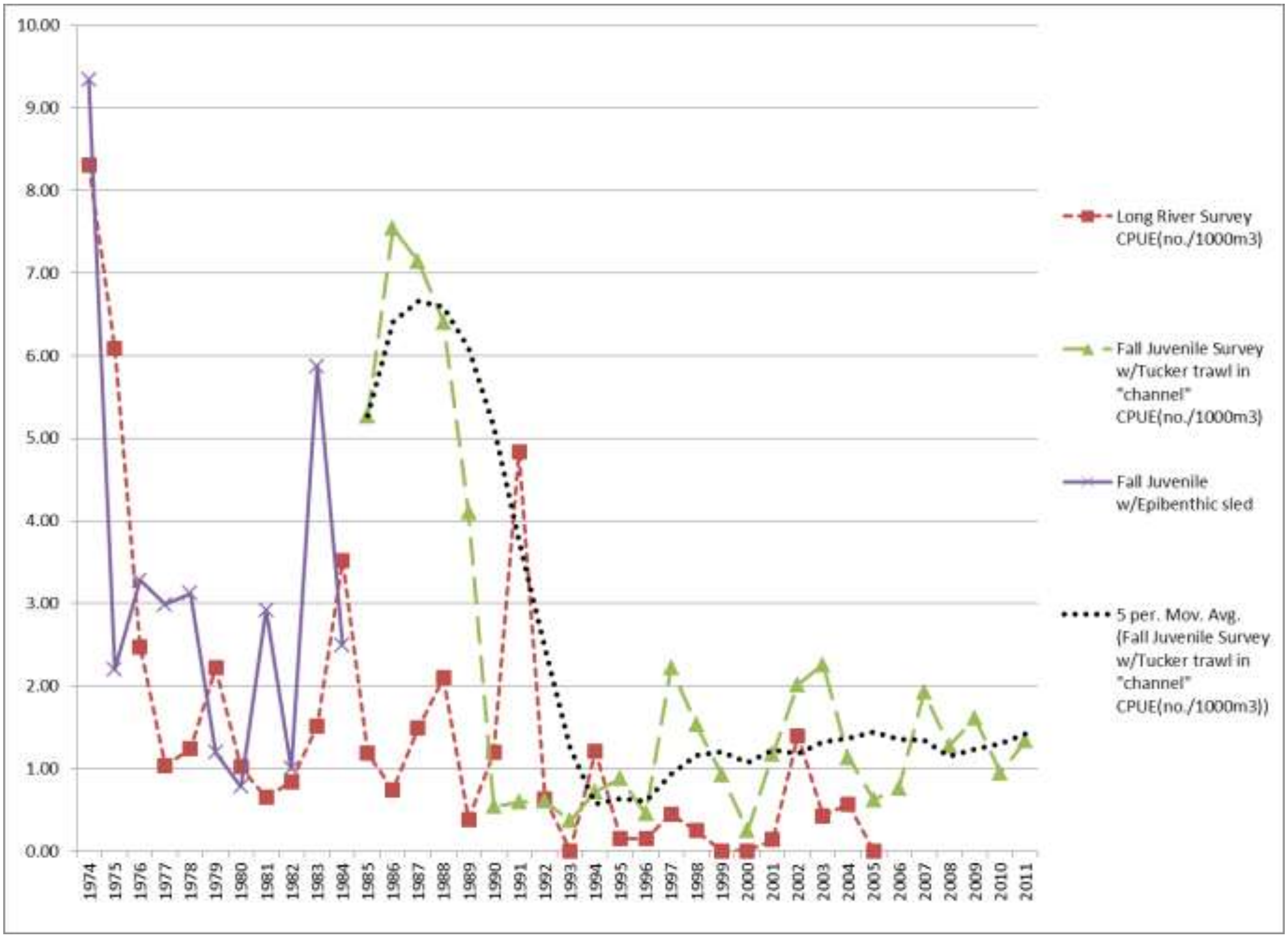
In October of 1994, the NYDEC stocked 4,929 marked age-0 Atlantic sturgeon, provided by a USFWS hatchery, into the Hudson Estuary at Newburgh Bay. These fish were reared from Hudson River brood stock. In 1995, Cornell University sampling crews collected 15 stocked and 14 wild age-1 Atlantic sturgeon (Peterson *et al*. 2000). A Petersen mark-recapture population estimate from these data suggests that there were 9,529 (95% CI = 1,916 – 10,473) age-0 Atlantic sturgeon in the estuary in 1994. Since 4,929 were stocked, 4,600 fish were of wild origin, assuming equal survival for both hatchery and wild fish and that stocking mortality for hatchery fish was zero.

Information on trends for Atlantic sturgeon in the Hudson River are available from a number of long term surveys. From July to November during 1982-1990 and 1993, the NYSDEC sampled the abundance of juvenile fish in Haverstraw Bay and the Tappan Zee Bay. The CPUE of immature Atlantic sturgeon was 0.269 in 1982 and declined to zero by 1990. This study has not been carried out since this time.

The Long River Survey (LRS) samples ichthyoplankton river-wide from the George Washington Bridge (rkm 19) to Troy (rkm 246) using a stratified random design (CONED 1997). These data, which are collected from May-July, provide an annual index of juvenile Atlantic sturgeon in the Hudson River estuary since 1974. The Fall Juvenile Survey (FJS), conducted from July – October by the utilities, calculates an annual index of the number of fish captured per haul. Between 1974 and 1984, the shoals in the entire river (rkm 19-246) were sampled by epibenthic sled; in 1985 the gear was changed to a three-meter beam trawl. While neither of these studies were designed to catch sturgeon, given their consistent implementation over time they provide indications of trends in abundance, particularly over long time series. When examining CPUE, these studies suggest a sharp decline in the number of young Atlantic sturgeon in the early 1990s. While the amount of interannual variability makes it difficult to detect short term trends, a five year running average of CPUE from the FJS indicates a slowly increasing trend since about 1996. Interestingly, that is when the in-river fishery for Atlantic sturgeon closed. While that fishery was not targeting juveniles, a reduction in the number of adult mortalities would be expected to result in increased recruitment and increases in the number of young Atlantic sturgeon in the river. There also could have been bycatch of juveniles that would have suffered some mortality.

In 2000, the NYSDEC created a sturgeon juvenile survey program to supplement the utilities' survey; however, funds were cut in 2000, and the USFWS was contracted in 2003 to continue the program. In 2003 – 2005, 579 juveniles were collected (N = 122, 208, and 289, respectively) (Sweka et al. 2006). Pectoral spine analysis showed they ranged from 1 – 8 years of age, with the majority being ages 2 – 6. There has not been enough data collected to use this information to detect a trend, but at least during the 2003-2005 period, the number of juveniles collected increased each year which could be indicative of an increasing trend for juveniles.

As evidenced by estimates of juvenile abundance, the Atlantic sturgeon population in the Hudson River has declined over time. Peterson et al. (2000) found that the abundance of age-1 Atlantic sturgeon in the Hudson River declined 80% from 1977 to 1995. Similarly, longterm indices of juvenile abundance (the Hudson River Long River and Fall Shoals surveys) demonstrate a longterm declining trend in juvenile abundance. The figure below (Figure 7) illustrates the CPUE of Atlantic sturgeon in the two longterm surveys of the Hudson River. Please note that the Fall Shoals survey switched gear types in 1985. We do not have the CPUE data for the Long River Survey for 2006-2011.



CPUE for the Fall Juvenile Survey for the most recent five year period (2007-2011) is approximately 27% of the CPUE from 1985-1990, but is more than two times higher than the CPUE from 1991-1996 which may be suggestive of an increasing trend in juvenile abundance. Given the high variability between years, it is difficult to use this data to assess short term trends, however, when looking at a five-year moving average, the index appears to be increasing from lows in the early 1990s, but is still much lower than the 1970s and 1980s.

There is no abundance estimate for the Delaware River population of Atlantic sturgeon. Harvest records from the 1800's indicate that this was historically a large population with an estimated 180,000 adult females prior to 1890 (Secor and Waldman, 1999; Secor, 2002). Sampling in 2009 to target young-of- the year (YOY) Atlantic sturgeon in the Delaware River (i.e., natal sturgeon) resulted in the capture of 34 YOY, ranging in size from 178 to 349 mm TL (Fisher, 2009) and the collection of 32 YOY Atlantic sturgeon in a separate study (Brundage and O'Herron in Calvo *et al.*, 2010). Genetics information collected from 33 of the 2009 year class YOY indicates that at least 3 females successfully contributed to the 2009 year class (Fisher, 2011). Therefore, while the capture of YOY in 2009 provides evidence that successful spawning is still occurring in the Delaware River, the relatively low numbers suggest the existing riverine population is limited in size.

Several threats play a role in shaping the current status and trends observed in the Delaware River and Estuary. In-river threats include habitat disturbance from dredging, and impacts from historical pollution and impaired water quality. A dredged navigation channel extends from Trenton seaward through the tidal river (Brundage and O'Herron, 2009), and the river receives significant shipping traffic. Vessel strikes have been identified as a threat in the Delaware River; however, at this time we do not have information to quantify this threat or its impact to the population or the New York Bight DPS. Similar to the Hudson River, there is currently not enough information to determine a trend for the Delaware River population.

Summary of the New York Bight DPS

Atlantic sturgeon originating from the New York Bight DPS spawn in the Hudson and Delaware rivers. While genetic testing can differentiate between individuals originating from the Hudson or Delaware river the available information suggests that the straying rate is high between these rivers. There are no indications of increasing abundance for the New York Bight DPS (ASSRT, 2009; 2010). Some of the impact from the threats that contributed to the decline of the New York Bight DPS have been removed (e.g., directed fishing) or reduced as a result of improvements in water quality since passage of the Clean Water Act (CWA). In addition, there have been reductions in fishing effort in state and federal waters, which may result in a reduction in bycatch mortality of Atlantic sturgeon. Nevertheless, areas with persistent, degraded water quality, habitat impacts from dredging, continued bycatch in state and federally-managed fisheries, and vessel strikes remain significant threats to the New York Bight DPS.

In the marine range, New York Bight DPS Atlantic sturgeon are incidentally captured in federal and state managed fisheries, reducing survivorship of subadult and adult Atlantic sturgeon (Stein *et al.*, 2004; ASMFC 2007). As explained above, currently available estimates indicate that at least 4% of adults may be killed as a result of bycatch in fisheries authorized under Northeast FMPs. Based on mixed stock analysis results presented by Wirgin and King (2011), over 40 percent of the Atlantic sturgeon bycatch interactions in the Mid Atlantic Bight region were sturgeon from the New York Bight DPS. Individual-based assignment and mixed stock analysis of samples collected from sturgeon captured in Canadian fisheries in the Bay of Fundy indicated that approximately 1-2% were from the New York Bight DPS. At this time, we are not able to quantify the impacts from other threats or estimate the number of individuals killed as a result of other anthropogenic threats.

Riverine habitat may be impacted by dredging and other in-water activities, disturbing spawning habitat and also altering the benthic forage base. Both the Hudson and Delaware rivers have navigation channels that are maintained by dredging. Dredging is also used to maintain channels in the nearshore marine environment. Dredging outside of Federal channels and in-water construction occurs throughout the New York Bight region. While some dredging projects operate with observers present to document fish mortalities many do not. We have reports of one Atlantic sturgeon entrained during hopper dredging operations in Ambrose Channel, New Jersey. At this time, we do not have any information to quantify the number of Atlantic sturgeon killed or disturbed during dredging or in-water construction projects, we are also not able to quantify any effects to habitat.

In the Hudson and Delaware Rivers, dams do not block access to historical habitat. The Holyoke Dam on the Connecticut River blocks further upstream passage; however, the extent that Atlantic sturgeon would historically have used habitat upstream of Holyoke is unknown. Connectivity may be disrupted by the presence of dams on several smaller rivers in the New York Bight region. Because no Atlantic sturgeon occur upstream of any hydroelectric projects in the New York Bight region, passage over hydroelectric dams or through hydroelectric turbines is not a source of injury or mortality in this area. The extent that Atlantic sturgeon are affected by operations of dams in the New York Bight region is currently unknown.

New York Bight DPS Atlantic sturgeon may also be affected by degraded water quality. In general, water quality has improved in the Hudson and Delaware over the past decades (Lichter *et al.* 2006; EPA, 2008). Both the Hudson and Delaware rivers, as well as other rivers in the New York Bight region, were heavily polluted in the past from industrial and sanitary sewer discharges. While water quality has improved and most discharges are limited through regulations, many pollutants persist in the benthic environment. This can be particularly problematic if pollutants are present on spawning and nursery grounds as developing eggs and larvae are particularly susceptible to exposure to contaminants.

Vessel strikes occur in the Delaware River. Twenty-nine mortalities believed to be the result of vessel strikes were documented in the Delaware River from 2004 to 2008, and at least 13 of these fish were large adults. Given the time of year in which the fish were observed (predominantly May through July, with two in August), it is likely that many of the adults were migrating through the river to the spawning grounds. Because we do not know the percent of total vessel strikes that the observed mortalities represent, we are not able to quantify the number of individuals likely killed as a result of vessel strikes in the New York Bight DPS.

Studies have shown that to rebuild, Atlantic sturgeon can only sustain low levels of anthropogenic mortality (Boreman, 1997; ASMFC, 2007; Kahnle *et al.*, 2007; Brown and Murphy, 2010). There are no empirical abundance estimates of the number of Atlantic sturgeon in the New York Bight DPS. As described in the final listing rule, NMFS has determined that the New York Bight DPS is currently at risk of extinction due to: (1) precipitous declines in population sizes and the protracted period in which sturgeon populations have been depressed; (2) the limited amount of current spawning; and (3) the impacts and threats that have and will continue to affect population recovery.

4.0 ENVIRONMENTAL BASELINE

The Environmental Baseline provides a snapshot of a species health or status at a given time within the action area and is used as the biological basis upon which to analyze the effects of the proposed action. Assessment of the environmental baseline includes an analysis of 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 biological opinion includes the effects of several activities that may affect the survival and recovery of the endangered species and critical habitat in the action area. The activities that shape the environmental baseline in the action area of this consultation generally include: hydroelectric operations, water quality impacts, scientific research, commercial and recreational fisheries, and recovery activities associated with reducing those impacts.

Activities occurring in the action area have the potential to impact shortnose sturgeon, Atlantic sturgeon, and GOM DPS of Atlantic salmon. Despite improvements in water quality and the elimination of directed fishing for these species, all three species still face numerous threats in this river system. As noted above, the total effect of hydroelectric facilities in the Kennebec River Basin on sturgeon is largely unknown; however, it is certain that they negatively affect Atlantic salmon habitat and connectivity within the Kennebec River.

As described above, the action area is limited to the area where direct and indirect effects will be experienced. Text above also considered effects of ongoing activities that are outside the action area but may be affecting individual Atlantic salmon, designated critical habitat for the same, as well as Atlantic and shortnose sturgeon in the action area. The discussion below focuses on effects of state, federal or private actions, other than the action under consideration, that occur solely in the action area.

4.1 Federal Actions that have Undergone Formal or Early Section 7 Consultation

While NMFS has engaged in several ESA section 7 consultations to address the effects of federal actions on threatened and endangered species in the lower Kennebec River, no formal or early consultations on the effects of actions authorized, funded or carried out by Federal agencies are on- going, or have been completed on activities occurring in this action area.

4.2 Scientific Studies

MDMR is authorized under the USFWS' endangered species blanket permit (No. 697823) to conduct monitoring, assessment, and habitat restoration activities for listed Atlantic salmon populations in Maine. The extent of take from MDMR activities during any given year is not expected to exceed 2% of any life stage being impacted, except that for adults, it would be less than 1%. MDMR will continue to conduct Atlantic salmon research and management activities in all GOM DPS rivers while the proposed action is carried out. The information gained from these activities will be used to further salmon conservation actions in the GOM DPS.

USFWS is also authorized under an ESA section 10 endangered species blanket permit to conduct the conservation hatchery program at the Craig Brook and Green Lake National Fish Hatcheries. The mission of the hatcheries is to raise Atlantic salmon parr and smolts for stocking into selected Atlantic salmon rivers in Maine. Over 90% of adult returns to the GOM DPS are currently provided through production at the hatcheries. The hatcheries provide a significant buffer from extinction for the species. NMFS is also a sub-permittee under USFWS' ESA section 10 endangered species blanket permit.

Research activities for shortnose sturgeon conducted by University of Maine investigators are authorized through scientific research permits issued by NMFS. Permit number 16306 was recently issued (May 2012), and will extend until 2017. The research team consists of scientists from MDMR, USGS, UM, and the University of Southern Maine. Their research objectives are to: 1) use mark-recapture techniques to generate population estimates and to define stock structure and distribution 2) determine the degree of demographic correspondence and connectivity of local in-river sturgeon populations, 3) identify habitat use, movement patterns, and life history characteristics of shortnose sturgeon in Maine waters. The treatments would include weighing, measuring, photographing, anesthetize, inserting PIT tag, Floy/T-bar tag insertion, tissue sample, blood sample, boroscope, gastric lavage, fin ray section, apical spine sample, and external satellite tagging. Not all specimens sampled would receive all treatments. The research sites include the Penobscot, Kennebec, Saco, and Merrimack Rivers. Additionally, several smaller coastal rivers in Maine and New Hampshire will also be surveyed. The Section 10 permit allows the directed non-lethal take of 7,205 shortnose sturgeon of various life stages over the duration of the permit, with 200 deliberate mortalities of early life stage (ELS) occurring annually. The Biological Opinion issued as a result of section 7 consultation on the effects of the directed take authorized under Permit 16306, concluded that this take is not likely to jeopardize the continued existence of any ESA-listed species under NMFS jurisdiction

4.3 State or Private Activities in the Action Area

Publically Owned Waste Treatment Facility
As mentioned above, there is one publically owned wastewater treatment facility in the action area with a single outfall to the Kennebec River. While owned and operated by the City of Richmond, the facility is authorized under the National Pollution Discharge and Elimination System (NPDES) which the EPA deferred to Maine state control on January 12, 2001. Located two kilometers downstream of the existing bridge on the west bank near Richmond, the US EPA classifies the facility as a minor discharger of effluents based on factors such as flow volume, toxic pollutant potential, and public health impacts. The facility is authorized to discharge an average of 0.30 million gallons per day of primary treated wastewater under the Maine Pollution Discharge Elimination System (MPDES) permit number ME0100587.

Mining
Located approximately three kilometers upstream of the actual bridge site on the east (Dresden) side of the river are operating sand and gravel pits. This commercial quarry encompasses nearly 20 hectares (46 acres) and includes no less than 12 liquid filled pits. While the chemical constituents of the variously colored fluids could not be ascertained, liquid mine waste has often proven to be detrimental to aquatic life. Although the quarry is on the opposite side of Cedar Grove Road, the Kennebec River is less than 200 meters from the nearest open pit. The liquid within the pits is currently confined, but prolonged heavy rain or significant snow melt may create run-off that would likely impact the action area.

Construction and Dredging Projects
In-water or nearshore construction and demolition projects may interfere with normal shortnose sturgeon migratory movements and disturb seasonal aggregation areas. Unless appropriate precautions are made, internal damage and/or death may result from blasting projects. Maintenance dredging of Federal navigation channels and other areas can adversely affect or jeopardize shortnose sturgeon populations. Hydraulic dredges can lethally take sturgeon by entraining sturgeon in dredge drag arms and impeller pumps. Mechanical dredges have also been documented to lethally take shortnose sturgeon. In addition to direct effects, dredging operations may also impact shortnose sturgeon by destroying benthic feeding areas, disrupting spawning migrations, and filling spawning habitat with re-suspended fine sediments. However,

no dredge projects are scheduled during the two-year construction period.

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).

4.4 Impacts of Other Human Activities in the Action Area

Water Quality and Contamination
Contaminants, including toxic metals, polychlorinated aromatic hydrocarbons (PAHs), pesticides, and 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) and to benthic feeders such as shortnose 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).

Contaminant analysis conducted in 2003 on tissues from a shortnose sturgeon from the Kennebec River revealed the presence of 14 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.

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 (82.4°F) (Flourney *et al.* 1992). At elevated temperatures, concomitant low levels of dissolved oxygen may be lethal.

Recreational Fishing
Unauthorized take of Atlantic salmon, Atlantic sturgeon, and shortnose sturgeon is prohibited by the ESA. However, these and other listed species are taken incidentally in various fisheries along the East Coast, and may be targeted by poachers (NMFS 1998).

Adult Atlantic salmon don't usually feed while in freshwater, but Atlantic and shortnose sturgeon do; this may increase the potential for sturgeon to be incidentally caught in recreational fisheries. The bycatch of Atlantic or shortnose sturgeon in recreational fisheries in the Kennebec River has not been well documented due to confusion over distinguishing between Atlantic sturgeon and shortnose sturgeon and likely apprehension to report illegal bycatch to authorities. Due to a lack of reporting, no information on the number of listed salmon or sturgeon caught and released or killed in recreational fisheries in the action area is available.

5. CLIMATE CHANGE

The discussion below presents background information on global climate change and information on past and predicted future effects of global climate change throughout the range of the listed species considered here. Climate change is relevant to the Status of the Species, Environmental Baseline and Cumulative Effects sections of this Opinion; rather than include partial discussion in several sections of this Opinion, we are synthesizing this information into one discussion. Consideration of effects of the proposed action in light of predicted changes in environmental conditions due to anticipated climate change are included in the Effects of the Action section below (Section 6.0).

5.1 Background Information on Anticipated Global Climate Change

The global mean temperature has risen 0.76ºC (1.36°F) over the last 150 years, and the linear trend over the last 50 years is nearly twice that for the last 100 years (IPCC 2007) and precipitation has increased nationally by 5%-10%, mostly due to an increase in heavy downpours (NAST 2000). There is a high confidence, based on substantial new evidence, that observed changes in marine systems are associated with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels, and circulation. Ocean acidification resulting from massive amounts of carbon dioxide and other pollutants released into the air can have major adverse impacts on the calcium balance in the oceans. Changes to the marine ecosystem due to climate change include shifts in ranges and changes in algal, plankton, and fish abundance (IPCC 2007); these trends are most apparent over the past few decades. Information on future impacts of climate change in the action area is discussed below.

Climate model projections exhibit a wide range of plausible scenarios for both temperature and precipitation over the next century. Both of the principal climate models used by the National Assessment Synthesis Team (NAST) project warming in the southeast by the 2090s, but at different rates (NAST 2000): the Canadian model scenario shows the southeast U.S. experiencing a high degree of warming, which translates into lower soil moisture as higher temperatures increase evaporation; the Hadley model scenario projects less warming and a significant increase in precipitation (about 20%). The scenarios examined, which assume no major interventions to reduce continued growth of world greenhouse gases (GHG), indicate that temperatures in the U.S. will rise by about 3^{o}-5^{o}C (5^{o}-9^{o}F) on average in the next 100 years which is more than the projected global increase (NAST 2000). A warming of about 0.2^{o}C (0.4°F) per decade is projected for the next two decades over a range of emission scenarios (IPCC 2007). This temperature increase will very likely be associated with more extreme precipitation and faster evaporation of water, leading to greater frequency of both very wet and very dry conditions. Climate warming has resulted in increased precipitation, river discharge, and glacial and sea-ice melting (Greene *et al.* 2008).

The past three decades have witnessed major changes in ocean circulation patterns in the Arctic, and these were accompanied by climate associated changes as well (Greene *et al.* 2008). Shifts in atmospheric conditions have altered Arctic Ocean circulation patterns and the export of freshwater to the North Atlantic (Greene *et al.* 2008, IPCC 2007). With respect specifically to the North Atlantic Oscillation (NAO), changes in salinity and temperature are thought to be the result of changes in the earth's atmosphere caused by anthropogenic forces (IPCC 2007). The NAO impacts climate variability throughout the northern hemisphere (IPCC 2006). Data from the 1960s through the present show that the NAO index has increased from minimum values in the 1960s to strongly positive index values in the 1990s and somewhat declined since (IPCC 2007). This warming extends over 1000m (0.62 miles) deep and is deeper than anywhere in the world oceans and is particularly evident under the Gulf Stream/ North Atlantic Current system (IPCC 2007). On a global scale, large discharges of freshwater into the North Atlantic subarctic seas can lead to intense stratification of the upper water column and a disruption of North Atlantic Deepwater (NADW) formation (Greene *et al.* 2008, IPCC 2007). There is evidence that the NADW has already freshened significantly (IPCC 2007). This in turn can lead to a slowing down of the global ocean thermohaline (large-scale circulation in the ocean that transforms low-density upper ocean waters to higher density intermediate and deep waters and returns those waters back to the upper ocean), which can have climatic ramifications for the whole earth system (Greene *et al.* 2008).

While predictions are available regarding potential effects of climate change globally, it is more difficult to assess the potential effects of climate change over the next few decades on coastal and marine resources on smaller geographic scales, such as the Kennebec River, especially as climate variability is a dominant factor in shaping coastal and marine systems. The effects of future change will vary greatly in diverse coastal regions for the U.S. Warming is very likely to continue in the U.S. over the next 25 to 50 years regardless of reduction in GHGs, due to emissions that have already occurred (NAST 2000). It is very likely that the magnitude and frequency of ecosystem changes will continue to increase in the next 25 to 50 years, and it is possible that the rate of change will accelerate. Climate change can cause or exacerbate direct stress on ecosystems through high temperatures, a reduction in water availability, and altered frequency of extreme events and severe storms. Water temperatures in streams and rivers are likely to increase as the climate warms and are very likely to have both direct and indirect effects on aquatic ecosystems. Changes in temperature will be most evident during low flow periods when they are of greatest concern (NAST 2000). In some marine and freshwater systems, shifts in geographic ranges and changes in algal, plankton, and fish abundance are associated with high confidence with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels and circulation (IPCC 2007).

A warmer and drier climate is expected to result in reductions in stream flows and increases in water temperatures. Expected consequences could be a decrease in the amount of dissolved oxygen in surface waters and an increase in the concentration of nutrients and toxic chemicals due to reduced flushing rate (Murdoch *et al.* 2000). Because many rivers are already under a great deal of stress due to excessive water withdrawal or land development, and this stress may be exacerbated by changes in climate, anticipating and planning adaptive strategies may be critical (Hulme 2005). A warmer-wetter climate could ameliorate poor water quality conditions in places where human-caused concentrations of nutrients and pollutants other than heat currently degrade water quality (Murdoch *et al.* 2000). Increases in water temperature and changes in seasonal patterns of runoff will very likely disturb fish habitat and affect recreational uses of lakes, streams, and wetlands. Surface water resources in the southeast are intensively managed with dams and channels and almost all are affected by human activities; in some systems water quality is either below recommended levels or nearly so. A global analysis of the potential effects of climate change on river basins indicates that due to changes in discharge and water stress, the area of large river basins in need of reactive or proactive management interventions in response to climate change will be much higher for basins impacted by dams than for basins with free-flowing rivers (Palmer *et al.* 2008). Human-induced disturbances also influence coastal and marine systems, often reducing the ability of the systems to adapt so that systems that might ordinarily be capable of responding to variability and change are less able to do so. Because stresses on water quality are associated with many activities, the impacts of the existing stresses are likely to be exacerbated by climate change. Within 50 years, river basins that are impacted by dams or by extensive development may experience greater changes in discharge and water stress than unimpacted, free-flowing rivers (Palmer *et al.* 2008).

While debated, researchers anticipate: 1) the frequency and intensity of droughts and floods will change across the nation; 2) a warming of about 0.2^{o}C (0.4°F) per decade; and 3) a rise in sea level (NAST 2000). A warmer and drier climate will reduce stream flows and increase water temperature resulting in a decrease of dissolved oxygen (DO) and an increase in the concentration of nutrients and toxic chemicals due to reduced flushing. Sea level is expected to continue rising: during the 20th century global sea level has increased 15 to 20 cm (6-8 inches).

5.2 Species Specific Information on Climate Change Effects

5.2.1 Effects to Atlantic Salmon and Critical Habitat

Atlantic salmon may be especially vulnerable to the effects of climate change in New England, since the areas surrounding many river catchments where salmon are found are heavily populated and have already been affected by a range of stresses associated with agriculture, industrialization, and urbanization (Elliot *et al*. 1998). Climate effects related to temperature regimes and flow conditions determine juvenile salmon growth and habitat (Friedland1998). One study conducted in the Connecticut and Penobscot rivers, where temperatures and average discharge rates have been increasing over the last 25 years, found that dates of first capture and median capture dates for Atlantic salmon have shifted earlier by about 0.5 days/ year, and these consistent shifts are correlated with long-term changes in temperature and flow (Juanes *et al*. 2004). Temperature increases are also expected to reduce the abundance of salmon returning to home waters, particularly at the southern limits of Atlantic salmon spatial distribution (Beaugrand and Reid 2003).

One recent study conducted in the United Kingdom that used data collected over a 20-year period in the Wye River found Atlantic salmon populations have declined substantially and this decline was best explained by climatic factors like increasing summer temperatures and reduced discharge more than any other factor (Clews *et al*. 2010). Changes in temperature and flow serve as cues for salmon to migrate, and smolts entering the ocean either too late or too early would then begin their post-smolt year in such a way that could be less optimal for opportunities to feed, predator risks, and/or thermal stress (Friedland 1998). Since the highest mortality affecting Atlantic salmon occurs in the marine phase, both the temperature and the productivity of the coastal environment may be critical to survival (Drinkwater *et al.* 2003). Temperature influences the length of egg incubation periods for salmonids (Elliot *et al*. 1998) and higher water temperatures could accelerate embryo development of salmon and cause premature emergence of fry.

Since fish maintain a body temperature almost identical to their surroundings, thermal changes of a few degrees Celsius can critically affect biological functions in salmonids (NMFS and USFWS 2005). While some fish populations may benefit from an increase in river temperature for greater growth opportunity, there is an optimal temperature range and a limit for growth after which salmonids will stop feeding due to thermal stress (NMFS and USFWS 2005). Thermally stressed salmon also may become more susceptible to mortality from disease (Clews *et al*. 2010). A study performed in New Brunswick found there is much individual variability between Atlantic salmon and their behaviors and noted that the body condition of fish may influence the temperature at which optimal growth and performance occur (Breau *et al*. 2007).

The productivity and feeding conditions in Atlantic salmon's overwintering regions in the ocean are critical in determining the final weight of individual salmon and whether they have sufficient energy to migrate upriver to spawn (Lehodey *et al*. 2006). Survival is inversely related to body size in pelagic fishes, and temperature has a direct effect on growth that will affect growth-related sources of mortality in post-smolts (Friedland 1998). Post-smolt growth increases in a linear trend with temperature, but eventually reaches a maximum rate and decreases at high temperatures (Brett 1979 *in* Friedland 1998). When at sea, Atlantic salmon eat crustaceans and small fishes, such as herring, sprat, sand-eels, capelin, and small gadids, and when in freshwater, adults do not feed but juveniles eat aquatic insect larvae (FAO 2012). Since ocean acidification is reducing the carbonate availability necessary for shell formation, species with calcium carbonate skeletons, such as the crustaceans that salmon sometimes eat, are particularly susceptible to ocean acidification, (Wood *et al*. 2008). Climate change is likely to affect the abundance, diversity, and composition of plankton, and these changes may have important consequences for higher trophic levels like Atlantic salmon (Beaugrand and Reid 2003).

In addition to temperature, stream flow is also likely to be impacted by climate change and is vital to Atlantic salmon survival. In-stream flow defines spatial relationships and habitat suitability for Atlantic salmon and since climate is likely to affect in-stream flow, the physiological, behavioral, and feeding-related mechanisms of Atlantic salmon are also likely to be impacted (Friedland 1998). With changes in in-stream flow, salmon found in smaller river systems may experience upstream migrations that are confined to a narrower time frame, as small river systems tend to have lower discharges and more variable flow (Elliot *et al*. 1998). The changes in rainfall patterns expected from climate change and the impact of those rainfall patterns on flows in streams and rivers may severely impact productivity of salmon populations (Friedland 1998). More winter precipitation falling as rain instead of snow can lead to elevated winter peak flows which can scour the streambed and destroy salmon eggs (Battin *et al*. 2007, Elliot *et al*. 1998). Increased sea levels in combination with higher winter river flows could cause degradation of estuarine habitats through increased wave damage during storms (NSTC 2008). Since juvenile Atlantic salmon are known to select stream habitats with particular characteristics, changes in river flow may affect the availability and distribution of preferred habitats (Riley *et al*. 2009). Unfortunately, the critical point at which reductions in flow begin to have a damaging impact on juvenile salmonids is difficult to define, but generally flow levels that promote upstream migration of adults are likely adequate to encourage downstream movement of smolts (Hendry *et al*. 2003).

Humans may also seek to adapt to climate change by manipulating water sources, for example in response to increased irrigation needs, which may further reduce stream flow and biodiversity (Bates *et al*. 2008). Water extraction is a high level threat to Atlantic salmon, as adequate water quantity and quality are critical for all life stages of Atlantic salmon (NMFS and USFWS 2005). Climate change will also affect precipitation, with northern areas predicted to become wetter and southern areas predicted to become drier in the future (Karl *et al*. 2009). Droughts may further exacerbate poor water quality and impede or prevent migration of Atlantic salmon (Riley *et al*. 2009).

It is anticipated that these climate change effects could significantly affect the functioning of the Atlantic salmon critical habitat. Increased temperatures will affect the timing of upstream and downstream migration and make some areas unsuitable as temporary holding and resting areas. Higher temperatures could also reduce the amount of time that conditions are appropriate for migration (<23 degrees Celsius), which could affect an individual's ability to access suitable spawning habitat. In addition, elevated temperatures will make some areas unsuitable for spawning and rearing due to effects to egg and embryo development.

5.2.2 Shortnose Sturgeon

Global climate change may affect shortnose sturgeon in the future. Rising sea level may result in the salt wedge moving upstream in affected rivers. Shortnose sturgeon spawning occurs in fresh water reaches of rivers because early life stages have little to no tolerance for salinity. Similarly, juvenile shortnose sturgeon have limited tolerance to salinity and remain in waters with little to no salinity. If the salt wedge moves further upstream, shortnose sturgeon spawning and rearing habitat could be restricted. In river systems with dams or natural falls that are impassable by sturgeon, the extent that spawning or rearing may be shifted upstream to compensate for the shift in the movement of the salt wedge would be limited. While there is an indication that an increase in sea level rise would result in a shift in the location of the salt wedge, for most spawning rivers there are no predictions on the timing or extent of any shifts that may occur; thus, it is not possible to predict any future loss in spawning or rearing habitat. However, in all river systems, spawning occurs miles upstream of the salt wedge. It is unlikely that shifts in the location of the salt wedge would eliminate freshwater spawning or rearing habitat. If habitat was severely restricted, productivity or survivability may decrease.

The increased rainfall predicted by some models in some areas may increase runoff and scour spawning areas and flooding events could cause temporary water quality issues. Rising temperatures predicted for all of the U.S. could exacerbate existing water quality problems with DO and temperature. While this occurs primarily in rivers in the southeast U.S. and the Chesapeake Bay, it may start to occur more commonly in the northern rivers. Shortnose sturgeon are tolerant to water temperatures up to approximately 28°C (82.4°F); these temperatures are experienced naturally in some areas of rivers during the summer months. If river temperatures rise and temperatures above 28°C are experienced in larger areas, sturgeon may be excluded from some habitats.

Increased droughts (and water withdrawal for human use) predicted by some models in some areas may cause loss of habitat including loss of access to spawning habitat. Drought conditions in the spring may also expose eggs and larvae in rearing habitats. If a river becomes too shallow or flows become intermittent, all shortnose sturgeon life stages, including adults, may become susceptible to stranding. Low flow and drought conditions are also expected to cause additional water quality issues. Any of the conditions associated with climate change are likely to disrupt river ecology causing shifts in community structure and the type and abundance of prey. Additionally, cues for spawning migration and spawning could occur earlier in the season causing a mismatch in prey that are currently available to developing shortnose sturgeon in rearing habitat; however, this would be mitigated if prey species also had a shift in distribution or if developing sturgeon were able to shift their diets to other species.

5.2.3 Atlantic Sturgeon

Global climate change may affect all DPSs of Atlantic sturgeon in the future; however, effects of increased water temperature and decreased water availability are most likely to effect the South Atlantic and Carolina DPSs. Rising sea level may result in the salt wedge moving upstream in affected rivers. Atlantic sturgeon spawning occurs in fresh water reaches of rivers because early life stages have little to no tolerance for salinity. Similarly, juvenile Atlantic sturgeon have limited tolerance to salinity and remain in waters with little to no salinity. If the salt wedge moves further upstream, Atlantic sturgeon spawning and rearing habitat could be restricted. In river systems with dams or natural falls that are impassable by sturgeon, the extent that spawning or rearing may be shifted upstream to compensate for the shift in the movement of the salt wedge would be limited. While there is an indication that an increase in sea level rise would result in a shift in the location of the salt wedge, at this time there are no predictions on the timing or extent of any shifts that may occur; thus, it is not possible to predict any future loss in spawning or rearing habitat. However, in all river systems, spawning occurs miles upstream of the salt wedge. It is unlikely that shifts in the location of the salt wedge would eliminate freshwater spawning or rearing habitat. If habitat was severely restricted, productivity or survivability may decrease.

The increased rainfall predicted by some models in some areas may increase runoff and scour spawning areas and flooding events could cause temporary water quality issues. Rising temperatures predicted for all of the U.S. could exacerbate existing water quality problems with dissolved oxygen (DO) and temperature. While this occurs primarily in rivers in the southeast U.S. and the Chesapeake Bay, it may start to occur more commonly in the northern rivers. Atlantic sturgeon prefer water temperatures up to approximately 28°C (82.4°F); these temperatures are experienced naturally in some areas of rivers during the summer months. If river temperatures rise and temperatures above 28°C are experienced in larger areas, sturgeon may be excluded from some habitats.

Increased droughts (and water withdrawal for human use) predicted by some models in some areas may cause loss of habitat including loss of access to spawning habitat. Drought conditions in the spring may also expose eggs and larvae in rearing habitats. If a river becomes too shallow or flows become intermittent, all Atlantic sturgeon life stages, including adults, may become susceptible to strandings or habitat restriction. Low flow and drought conditions are also expected to cause additional water quality issues. Any of the conditions associated with climate change are likely to disrupt river ecology causing shifts in community structure and the type and abundance of prey. Additionally, cues for spawning migration and spawning could occur earlier in the season causing a mismatch in prey that are currently available to developing sturgeon in rearing habitat.

5.3 Anticipated Effects of Climate Change in the Action Area

Information on how climate change will impact the action area is extremely limited. Available information on climate change related effects for the Kennebec River watershed largely focus on effects that rising water levels may have on the human environment or landscape level changes (see UMass Assessment of Landscape Changes). Available information is summarized in Jacobson et al. 2009. This report indicates that for Maine, regional sea surface temperatures have increased almost 2° Fahrenheit since 1970 (as measured in Boothbay), and the rate of sea-level rise has intensified. Tide-gauge records in Portland, Maine, show a local relative sea-level rise of approximately eight inches since 1912. Earlier snowmelt, peak river flows, and ice-out have been observed in Maine lakes. Models suggest that in the future temperatures will be warmer and there will be more precipitation in all seasons.

Sea level rise could result in the northward movement of the salt wedge in the Kennebec River. Potential negative effects of a shift in the salt wedge include restricting the habitat available for early life stages and juvenile sturgeon which are intolerant to salinity and are present exclusively upstream of the salt wedge. While there is an indication that an increase in sea level rise would result in a shift in the location of the salt wedge, at this time there are no predictions on the timing or extent of any shift that may occur.

As noted above, warming trends are evident. However, while it is possible to examine past water temperature data and observe a warming trend, there are not currently any predictions on potential future increases in water temperature in the action area specifically or the Kennebec River generally.

Sea surface temperatures have fluctuated around a mean for much of the past century, as measured by continuous 100+ year records at Woods Hole (Mass.), and Boothbay Harbor (Maine) and shorter records from Boston Harbor and other bays. Periods of higher than average temperatures (in the 1950s) and cooler periods (1960s) have been associated with changes in the North Atlantic Oscillation (NAO), which affects current patterns. Over the past 30 years however, records indicate that ocean temperatures in the Northeast have been increasing; for example, Boothbay Harbor's temperature has increased by about 1°C since 1970. For marine waters, the model projections are for an increase of somewhere between 3-4°C by 2100 and a pH drop of 0.3-0.4 units by 2100 (Frumhoff *et al.* 2007). Assuming that these predictions also apply to the action area, one could anticipate similar conditions in the action area over that same time period; considering that the proposed action will occur until 2019, we could predict an increase in ambient water temperatures of 0.034-0.045 per year for an overall increase of 0.24-0.32°C .

As there is significant uncertainty in the rate and timing of change as well as the effect of any changes that may be experienced in the action area due to climate change, it is difficult to predict the impact of these changes on shortnose and Atlantic sturgeon and Atlantic salmon. However, the short time period over which the proposed actions will occur (i.e., through November 2019) suggests that there are not likely to be major climate related changes experienced.

Over time, the most likely effect to shortnose and Atlantic sturgeon would be if sea level rise was great enough to consistently shift the salt wedge far enough north which would restrict the range of juvenile sturgeon and may affect the development of these life stages. Upstream shifts in spawning or rearing habitat in the Kennebec River are limited by the existence of the Lockwood Dam which is impassable by sturgeon. Similarly, the upstream movement of sturgeon is limited by the Brunswick Dam in the Androscoggin River. The available habitat for juvenile sturgeon could decrease over time; however, even if the saltwedge shifted several miles upstream, it seems unlikely that the decrease in available habitat would have a significant effect on juvenile sturgeon because there would still be many miles of available low salinity habitat between the salt wedge and the Lockwood or Brunswick dams.

In the action area, it is possible that changing seasonal temperature regimes could result in changes in the timing of seasonal migrations through the area as sturgeon and salmon make seasonal movements. For sturgeon, there could be shifts in the timing of spawning; presumably, if water temperatures warm earlier in the spring, and water temperature is a primary spawning cue, spawning migrations and spawning events could occur earlier in the year. However, because spawning is not triggered solely by water temperature, but also by day length (which would not be affected by climate change) and river flow (which could be affected by climate change), it is not possible to predict how any change in water temperature or river flow alone will affect the seasonal movements of sturgeon through the action area. For salmon, there could be shifts in the timing of downstream movements by smolts or shifts in the timing of returns to the river by adults. However, during the seven year time period considered here, major shifts in seasonal migrations due to climate change are unlikely given the relatively slow rate of predicted climate change.

Any forage species that are temperature dependent may also shift in distribution as water temperatures warm. However, because we do not know the adaptive capacity of these individuals or how much of a change in temperature would be necessary to cause a shift in distribution, it is not possible to predict how these changes may affect foraging sturgeon or salmon. If sturgeon or salmon distribution shifted along with prey distribution, it is likely that there would be minimal, if any, impact on the availability of food. Similarly, if sturgeon shifted to areas where different forage was available and sturgeon were able to obtain sufficient nutrition from that new source of forage, any effect would be minimal. The greatest potential for effect to forage resources would be if sturgeon or salmon shifted to an area or time where insufficient forage was available; however, the likelihood of this happening seems low because sturgeon and salmon feed on a wide variety of species and in a wide variety of habitats.

Limited information on the thermal tolerances of Atlantic and shortnose sturgeon is available. Atlantic sturgeon have been observed in water temperatures above 30°C in the south (see Damon-Randall *et al.* 2010); in the wild, shortnose sturgeon are typically found in waters less than 28°C. In the laboratory, juvenile Atlantic sturgeon showed negative behavioral and bioenergetics responses (related to food consumption and metabolism) after prolonged exposure to temperatures greater than 28°C (82.4°F) (Niklitschek 2001). Tolerance to temperatures is thought to increase with age and body size (Ziegweid *et al.* 2008 and Jenkins *et al.* 1993), however, no information on the lethal thermal maximum or stressful temperatures for subadult or adult Atlantic sturgeon is available. Shortnose sturgeon, have been documented in the lab to experience mortality at temperatures of 33.7°C (92.66°F) or greater and are thought to experience stress at temperatures above 28°C. For purposes of considering thermal tolerances, we consider Atlantic sturgeon to be a reasonable surrogate for shortnose sturgeon given similar geographic distribution and known biological similarities.

Normal surface water temperatures in the Kennebec River can be as high as 25°C at some times and in some areas during the summer months; temperatures in deeper waters and near the bottom are cooler. A predicted increase in water temperature of 3-4°C within 100 years is expected to result in temperatures approaching the preferred temperature of shortnose and Atlantic sturgeon (28°C) on more days and/or in larger areas. This could result in shifts in the distribution of sturgeon out of certain areas during the warmer months. Information from southern river systems suggests that during peak summer heat, sturgeon are most likely to be found in deep water areas where temperatures are coolest. Thus, we could expect that over time, sturgeon would shift out of shallow habitats on the warmest days. This could result in reduced foraging opportunities if sturgeon were foraging in shallow waters.

As described above, over the long term, global climate change may affect shortnose and Atlantic sturgeon by affecting the location of the salt wedge, distribution of prey, water temperature and water quality. Atlantic salmon are likely to be affected not only by conditions in rivers but also oceanic conditions. However, there is significant uncertainty, due to a lack of scientific data, on the degree to which these effects may be experienced and the degree to which shortnose or Atlantic sturgeon or Atlantic salmon will be able to successfully adapt to any such changes. Any activities occurring within and outside the action area that contribute to global climate change are also expected to affect listed species and their habitat within the action area. While we can make some predictions on the likely effects of climate change on these species, without modeling and additional scientific data these predictions remain speculative. Additionally, these predictions do not take into account the adaptive capacity of these species which may allow them to deal with change better than predicted.

The effects of climate change will likely increase during the life span of the new bridge. Less snow will likely fall each winter only to be replaced by rain. The corresponding increase in flow rates during winter may result in unanticipated scour, pier undercutting, and the premature failure of the abutments. Additionally, increased rainfall will result in more run-off which in turn will likely reduce water quality in the action area.

As sea level rises due to melting polar ice, the salt wedge in the river is expected to shift further upstream. Over the long term, this could change the habitat characteristics of the action area.

Another potential impact of climate change is the disruption of the synchronization of naturally occurring biological events. If adult salmon encounter riverine temperatures greater than 23^{o}C, they are likely to abandon their upstream spawning migration resulting in depressed reproductive success rates. If the outmigrating salmon smolt prey base is not immediately available in the lower Kennebec River due to climate change, juvenile salmon marine survival rates are likely to decline.

6. EFFECTS OF THE ACTION

This section of the Opinion describes the effects of the various construction activities, and 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). We have not identified any interrelated or interdependent actions. This Opinion examines the likely effects (direct and indirect) of the proposed action on Atlantic salmon, Atlantic and shortnose sturgeon in the action area and their habitat within the context of each species' current status, the environmental baseline and cumulative effects. This Opinion also examines the likely effects (direct and indirect) of the proposed action on critical habitat designated for the GOM DPS of Atlantic salmon.

Beyond the bridge footprint, the Richmond–Dresden Bridge replacement is not expected to affect the Kennebec River Salmon Habitat Recovery Unit (SHRU) which encompasses the range of shortnose sturgeon, Atlantic sturgeon, and Atlantic salmon in the Kennebec River. Short-term, construction related effects are expected to occur largely in the lower Kennebec River, mostly downstream from the project footprint towards Swan Island and the confluence with the Eastern River. Effects of this action will not likely be realized in Merrymeeting Bay. The tides will influence the direction of the sediment plume. As such, the overall transport of sediment will be minimal.

6.1 Effects of Bridge Construction and Demolition – Salmon and Sturgeon

6.1.1 Underwater Noise

Noise will be generated by heavy equipment (e.g., pile drivers, drills, hoe rams, excavators, etc.) operating in-water during the construction of the new bridge and demolition of the old bridge. Approximately 60 pairs of sheetpiles will be required to build the cofferdams required for the pier installation while an undetermined number of H-piles may be necessary to provide support for temporary trestles and falsework. FHWA anticipates that the majority of the piles will be installed using a vibratory hammer, but some may require "seating" by an impact hammer. The installation of sheetpiles and H piles during the first year of construction will create the greatest amount of noise. Geotechnical drilling may be needed to bore steel pipe sockets into bedrock. Sound levels generated by construction activities are dependent not only on the pile, hammer, and drill characteristics, but also on the bathymetry of the basin, temperature, salinity, current, water temperature, substrate, and benthic environment.

Background Information on Fish and Underwater Noise
An acoustic field from any source consists of a propagating pressure wave, generated from particle motions in the medium that causes compression and rarefaction. This sound wave

consists of both pressure and particle motion components that propagate from the source. All fishes have sensory systems to detect the particle motion component of a sound field, while fishes with a swim bladder (a chamber of air in the abdominal cavity) may also be able to detect the pressure component. Fish with swim bladders can be categorized into two groups; physoclist and physostomes. Physoclisti are fishes that lack a connection between the gas bladder and the alimentary canal. Physostomes are fish with ducted swim bladders (e.g., salmon, trout, pike, sturgeon, and catfish, among others). In physostomous fish, the swim bladder is directly connected to the esophagus by a thin tube, allowing the fish to expel air from the swim bladder through this tube and out of the mouth. Pressure detection is primarily found in fishes where the swim bladder (or other air chamber) lies very close to the ear, whereas fishes in which there is no air chamber near the ear primarily detect particle motion (Popper *et al.* 2003; Popper and Schilt 2008; Popper and Fay 2010). When a fish is exposed to a sound wave, gas in the swim bladder expands more than surrounding tissue during periods of under pressure and contracts more than surrounding tissue during periods of overpressure (CALTRANS 2009). This can cause the swim bladder to oscillate and result in tissue damage, including rupture of the swim bladder. Further, indirect effects of hearing loss in fish may relate to the fish's reduced fitness, which may increase the animal's vulnerability to predators and result in the fish's inability or reduced success in locating prey, inability to communicate, or inability to sense their physical environment (CALTRANS 2009).

The intensity of a sound wave in water can be expressed in several different ways, but always in terms of decibels relative to 1 micro-Pascal (dB re: µPa). Decibels are a log scale; each 10 dB increase is a ten-fold increase in sound pressure. Accordingly, a 10 dB increase is a 10x increase in sound pressure, and a 20 dB increase is a 100x increase in sound pressure (NMFS 2011).

The following are commonly used measures of sound:

- Peak sound pressure level (SPL): the maximum sound pressure level (highest level of sound) in a signal measured in dB re 1 µPa.

- Sound exposure level (SEL): the integral of the squared sound pressure over the duration of the pulse (e.g., a full pile driving strike.) SEL is the integration over time of the square of the acoustic pressure in the signal and is thus an indication of the total acoustic energy received by an organism from a particular source (such as pile strikes).
  Measured in dB re $1\mu Pa^2$-s.

- Single Strike SEL: the amount of energy in one strike of a pile.

- Cumulative SEL (cSEL or SEL_{cum}): the energy accumulated over multiple strikes. cSEL indicates the full energy to which an animal is exposed during any kind of signal. The rapidity with which the cSEL accumulates depends on the level of the single strike SEL. The actual level of accumulated energy (cSEL) is the logarithmic sum of the total number of single strike SELs. Thus, cSEL (dB) = Single-strike SEL + $10\log_{10}(N)$; where N is the number of strikes.

- Root Mean Square (RMS): the average level of a sound signal over a specific period of time.

Summary of Available Information on Underwater Noise and Fish

Sturgeon rely primarily on particle motion to detect sounds (Lovell *et al.* 2005). While there are no data both in terms of hearing sensitivity and structure of the auditory system for shortnose or Atlantic sturgeon, there are data for the closely related lake sturgeon (Lovell *et al.* 2005; Meyer *et al.* 2010), which for the purpose of considering acoustic impacts can be considered as a surrogate for shortnose and Atlantic sturgeon.

The available data suggest that lake sturgeon can hear sounds from below 100 Hz to 800 Hz (Lovell *et al.* 2005; Meyer *et al.* 2010). As noted by FHWA, since these two studies examined responses of the ear and did not examine whether fish would behaviorally respond to sounds detected by the ear, it is hard to determine thresholds for hearing (that is, the lowest sound levels that an animal can hear at a particular frequency) using information from these studies.

The swim bladder of sturgeon is relatively small compared to other species (Beregi *et al.* 2001). While there are no data that correlate effects of noise on fishes and swim bladder size, the potential for damage to body tissues from rapid expansion of the swim bladder likely is reduced in a fish where the structure occupies less of the body cavity, and, thus, is in contact with less body tissue. Although there are no experimental data that enable one to predict the potential effects of sound on sturgeon, the physiological effects of pile driving on sturgeon may actually be less than on other species due to the small size of their swim bladder.

Sound is an important source of environmental information for most vertebrates (e.g., Fay and Popper, 2000). Fish are thought to use sound to learn about their general environment, the presence of predators and prey, and, for some species, for acoustic communication. As a consequence, sound is important for fish survival, and anything that impedes the ability of fish to detect a biologically relevant sound could affect individual fish.

Richardson *et al.* (1995) defined different zones around a sound source that could result in different types of effects on fish. There are a variety of different potential effects from any sound, with a decreasing range of effects at greater distances from the source. Thus, very close to the source, effects may range from mortality to behavioral changes. Somewhat further from the source mortality is no longer an issue, and effects range from physiological to behavioral. As one gets even further, the potential for effects declines. The actual nature of effects, and the distance from the source at which they could be experienced will vary and depend on a large number of factors, such as fish hearing sensitivity, source level, how the sounds propagate away from the source and the resultant sound level at the fish, whether the fish stays in the vicinity of the source, the motivation level of the fish, etc.

Underwater sound pressure waves can injure or kill fish (Reyff 2003, Abbott and Bing-Sawyer 2002, Caltrans 2001, Longmuir and Lively 2001, Stotz and Colby 2001). Fish with swim bladders, including shortnose and Atlantic sturgeon are particularly sensitive to underwater impulsive sounds with a sharp sound pressure peak occurring in a short interval of time (Caltrans 2001). As the pressure wave passes through a fish, the swim bladder is rapidly squeezed due to the high pressure, and then rapidly expanded as the under pressure component of the wave passes through the fish. The pneumatic pounding on tissues contacting the swim bladder may rupture capillaries in the internal organs as indicated by observed blood in the abdominal cavity, and maceration of the kidney tissues (Caltrans 2001).

There are limited data from other projects to demonstrate the circumstances under which immediate mortality occurs: mortality appears to occur when fish are close (within a few feet to 30 feet) to driving of relatively large diameter piles. Studies conducted by California Department of Transportation (Caltrans, 2001) showed some mortality for several different species of wild fish exposed to driving of steel pipe piles 8 feet in diameter, whereas Ruggerone *et al.* (2008) found no mortality to caged yearling coho salmon (*Oncorhynchus kisutch*) placed as close as 2 feet from a 1.5 foot diameter pile and exposed to over 1,600 strikes. As noted above, species are thought to have different tolerances to noise and may exhibit different responses to the same noise source.

Physiological effects that could potentially result in mortality may also occur upon sound exposure as could minor physiological effects that would have no effect on fish survival. Potential physiological effects are highly diverse, and range from very small ruptures of capillaries in fins (which are not likely to have any effect on survival) to severe hemorrhaging of major organ systems such as the liver, kidney, or brain (Stephenson *et al.*, 2010). Other potential effects include rupture of the swim bladder (the bubble of air in the abdominal cavity of most fish species that is involved in maintenance of buoyancy). See Halvorsen *et al.* 2011 for a review of potential injuries from pile driving.

Effects on body tissues may result from barotrauma or result from rapid oscillations of air bubbles. Barotrauma occurs when there is a rapid change in pressure that directly affects the body gasses. Gas in the swim bladder, blood, and tissue of fish can experience a change in state, expand and contract during rapid pressure changes, which can lead to tissue damage and organ failure (Stephenson *et al.* 2010).

Related to this are changes that result from very rapid and substantial excursions (oscillations) of the walls of air-filled chambers, such as the swim bladder, striking near-by structures. Under normal circumstances the walls of the swim bladder do not move very far during changes in depth or when impinged upon by normal sounds. However, very intense sounds, and particularly those with very sharp onsets (also called “rise time”) will cause the swim bladder walls to move much greater distances and thereby strike near-by tissues such as the kidney or liver. Rapid and frequent striking (as during one or more sound exposures) can result in bruising, and ultimately in damage, to the nearby tissues.

There is some evidence to suggest that very intense signals may not necessarily have substantial physiological effects and that the extent of effect will vary depending on a number of factors including sound level, rise time of the signal, duration of the signal, signal intensity, etc. For example, investigations on the effects of very high intensity sonar showed no damage to ears and other tissues of several different fish species (Kane *et al.* 2010). Some studies involving exposure of fish to sounds from seismic air guns, signal sources that have very sharp onset times, as found in pile driving, also did not result in any tissue damage (Popper *et al.* 2007; Song *et al.*

2008). However, the extent that results from one study are comparable to another is difficult to determine due to difference in species, individuals, and experimental design. Recent studies of the effects of pile driving sounds on fish showed that there is a clear relationship between onset of physiological effects and single strike and cumulative sound exposure level, and that the initial effects are very small and would not harm an animal (and from which there is rapid and complete recovery), whereas the most intense signals (e.g., >210 dB cumulative SEL) may result in tissue damage that could have long-term mortal effects (Halvorsen *et al.* 2011; Casper *et al.* 2011, in prep.)

Criteria for Assessing the Potential for Physiological Effects – Salmon and Sturgeon
The Fisheries Hydroacoustic Working Group (FHWG) was formed in 2004 and consists of biologists from NMFS, USFWS, FHWA, and the California, Washington and Oregon DOTs, supported by national experts on sound propagation activities that affect fish and wildlife species of concern. In June 2008, the agencies signed an MOA documenting criteria for assessing physiological effects of pile driving on fish. The criteria were developed for the acoustic levels at which physiological effects to fish could be expected. It should be noted, that these are onset of physiological effects (Stadler and Woodbury, 2009), and not levels at which fish are necessarily mortally damaged. These criteria were developed to apply to all species, including listed green sturgeon and Pacific salmon, which are biologically similar to shortnose and Atlantic sturgeon and Atlantic salmon respectively, and for these purposes can be considered a surrogate. The interim criteria are:

- Peak SPL: 206 decibels relative to 1 micro-Pascal (dB re 1 µPa).
- cSEL: 187 decibels relative to 1 micro-Pascal-squared second (dB re 1µPa^2-s) for fishes above 2 grams (0.07 ounces).
- cSEL: 183 dB re 1µPa^2-s for fishes below 2 grams (0.07 ounces).

We have relied on these criteria in determining the potential for physiological effects in ESA Section 7 consultations. At this time, they represent the best available information on the thresholds at which physiological effects to sturgeon are likely to occur. It is important to note that physiological effects may range from minor injuries from which individuals are anticipated to completely recover with no impact to fitness to significant injuries that will lead to death. The severity of injury is related to the distance from the pile being installed and the duration of exposure. The closer to the source and the greater the duration of the exposure, the higher likelihood of significant injury.

A recent peer-reviewed study from the Transportation Research Board (TRB) of the National Research Council of the National Academies of Science describes a carefully controlled experimental study of the effects of pile driving sounds on fish (Halvorsen *et al.* 2011). This investigation documented effects of pile driving sounds (recorded by actual pile driving operations) under simulated free-field acoustic conditions where fish could be exposed to signals that were precisely controlled in terms of number of strikes, strike intensity, and other parameters. The study used Chinook salmon and determined that onset of physiological effects that have the potential of reduced fitness, and thus a potential effect on survival, started at above 210 dB re 1 µPa^2·s cSEL. Smaller injuries, such as ruptured capillaries near the fins, which the authors noted were not expected to impact fitness, occurred at lower noise levels. The peak noise level that resulted in physiological effects was about the same as the FHWG criteria.

Based on the available information, for the purposes of this Opinion, we consider the potential for physiological effects upon exposure to 206dB re 1 µPa peak and 187 dB re 1 $µPa^2$-s cSEL. Use of the 183 dB re 1 $µPa^2$-s cSEL threshold, is not appropriate for this consultation because all listed fish in the action area will be larger than 2 grams. As explained here, physiological effects could range from minor injuries that a fish is expected to completely recover from with no impairment to survival to major injuries that increase the potential for mortality, or result in death.

Available Information for Assessing Behavioral Effects

Results of empirical studies of hearing of fishes, amphibians, birds, and mammals (including humans), in general, show that behavioral responses vary substantially, even within a single species, depending on a wide range of factors, such as the motivation of an animal at a particular time, the nature of other activities that the animal is engaged in when it detects a new stimulus, the hearing capabilities of an animal or species, and numerous other factors (Brumm and Slabbekoorn 2005). Thus, it may be difficult to assign a single criterion above which behavioral responses to noise would occur.

In order to be detected, a sound must be above the “background” level. Additionally, results from some studies suggest that sound may need to be biologically relevant to an individual to elicit a behavioral response. For example, in an experiment on responses of American shad to sounds produced by their predators (dolphins), it was found that if the predator sound is detectable, but not very loud, the shad will not respond (Plachta and Popper 2003). But, if the sound level is raised an additional 8 or 10 dB, the fish will turn and move away from the sound source. Finally, if the sound is made even louder, as if a predator were nearby, the American shad go into a frenzied series of motions that probably helps them avoid being caught. It was speculated by the researchers that the lowest sound levels were those recognized by the American shad as being from very distant predators, and thus, not worth a response. At somewhat higher levels, the shad recognized that the predator was closer and then started to swim away. Finally, the loudest sound was thought to indicate a very near-by predator, eliciting maximum response to avoid predation. Similarly, results from Doksaeter *et al.* (2009) suggest that fish will only respond to sounds that are of biological relevance to them. This study showed no responses by free-swimming herring (*Clupea* spp.) when exposed to sonars produced by naval vessels; but, sounds at the same received level produced by major predators of the herring (killer whales) elicited strong flight responses. Sound levels at the fishes from the sonar in this experiment were from 197 dB to 209 dB (rms) re 1 µPa at 1,000 to 2,000Hz.

For purposes of assessing behavioral effects of pile driving at several West Coast projects, NMFS has employed a 150dB re 1 µPa RMS SPL criterion at several sites including the San Francisco-Oakland Bay Bridge and the Columbia River Crossings. For the purposes of this consultation we will use 150 dB re 1 µPa RMS as a conservative indicator of the noise level at which there is the potential for behavioral effects. That is not to say that exposure to noise levels of 150 dB re 1 µPa RMS will always result in behavioral modifications or that any behavioral modifications will rise to the level of “take” (i.e., harm or harassment) but that there is the potential, upon exposure to noise at this level, to experience some behavioral response.

Behavioral responses could range from a temporary startle to avoidance of an ensonified area.

As hearing generalists, sturgeon rely primarily on particle motion to detect sounds (Lovell *et al.* 2005), which does not propagate as far from the sound source as does pressure. However, a clear threshold for particle motion was not provided in the Lovell study. In addition, flanking of the sounds through the substrate may result in higher levels of particle motion at greater distances than would be expected from the non-flanking sounds. Unfortunately, data on particle motion from pile driving is not available at this time, and we are forced to rely on sound pressure level criteria. Although we agree that more research is needed, the studies noted above support the 150 dB re 1 µPa RMS criterion as an indication for when behavioral effects could be expected. We are not aware of any studies that have considered the behavior of shortnose or Atlantic sturgeon in response to pile driving noise. However, given the available information from studies on other fish species, we consider 150 dB re 1 µPa RMS to be a reasonable estimate of the noise level at which exposure may result in behavioral modifications.

There is not an extensive body of literature on effects of anthropogenic sounds on fish behavior, and many of these studies were conducted under conditions that make the interpretation of the results uncertain. The results of the studies, summarized below, suggest that there is a potential for underwater sound of certain levels and frequencies to affect behavior of fish, but that it varies with fish species and the existing hydroacoustic environment. In addition, behavioral response may change over time as fish individuals habituate to the presence of the sound. Behavioral responses to other noise sources, such as noise associated with vessel traffic, and the results of noise deterrent studies, are also summarized below.

Mueller-Blenke *et al.* (2010), attempted to evaluate response of Atlantic cod (*Gadus morhua*) and Dover sole (*Solea solea*) held in large pens to playbacks of pile driving sounds recorded during construction of Danish wind farms. The investigators reported that a few representatives of both species exhibited some movement response, reported as increased swimming speed or freezing to the pile-driving stimulus at peak sound pressure levels ranging from 144 to 156 dB re 1 µPa for sole and 140 to 161 dB re 1 µPa for cod. These results must be interpreted cautiously as fish position was not able to be determined more frequently than once every 80 seconds.

Feist (1991) examined the responses of juvenile pink (*Oncorhyncus gorbuscha*) and chum (*O. keta*) salmon behavior during pile driving operations. Feist had observers watching fish schools in less than 1.5 m water depth and within 2 m of the shore over the course of a pile driving operation. The report gave limited information on the types of piles being installed and did not give pile size. Feist did report that there were changes in distribution of schools at up to 300 m from the pile driving operation, but that of the 973 schools observed, only one showed any overt startle or escape reaction to the onset of a pile strike. There was no statistical difference in the number of schools in the area on days with and without pile driving, although other behaviors changed somewhat.

Any analysis of the Feist data is complicated by a lack of data on pile type, size and source sound level. Without this data, it is very difficult to use the Feist data to help understand how fish would respond to pile driving and whether such sounds could result in avoidance or other behaviors. It is interesting to note that the size of the stocks of salmon never changed, but appeared to be transient, suggesting that normal fish behavior of moving through the study area was taking place no differently during pile driving operations than in quiet periods. This may suggest that the fish observed during the study were not avoiding pile driving operations.

Andersson *et al.* (2007) presents information on the response of sticklebacks (*Gasterosteus aculeatus*), a hearing generalist, to pure tones and broadband sounds from wind farm operations. Sticklebacks responded by freezing in place and exhibiting startle responses at SPLs of 120 dB (re: 1µPa) and less. Purser and Radford (2011) examined the response of three-spined sticklebacks to short and long duration white noise. This exposure resulted in increased startle responses and reduced foraging efficiency, although they did not reduce the total number of prey ingested. Foraging was less efficient due to attacks on non-food items and missed attacks on food items. The SPL of the white noise was reported to be similar (at frequencies between 100 and 1000 Hz) to the noise environment in a shoreline area with recreational speedboat activity. While this does not allow a comparison to the 150 dB re 1 µPa RMS guideline, it does demonstrate that significant noise-induced effects on behavior are possible, and that behaviors other than avoidance can occur.

Several of the studies (Andersson *et al.* 2007, Purser and Radford 2011, Wysocki *et al.* 2007) support our use of the 150 dB re 1 µPa RMS as a threshold for examining the potential for behavioral responses. We will use 150 dB re 1 µPa RMS as a guideline for assessing when behavioral responses to pile driving noise may be expected. The effect of any anticipated response on individuals will be considered in the effects analysis below.

6.1.1.1 Pile driving

Records from numerous construction projects and academic research were consolidated into the *Technical Guidance for Assessment and Mitigation of the Hydroacoustic Effects of Pile Driving on Fish*, which was developed for the California Department of Transportation (CALTRANS) by the environmental consulting firms of ICF Jones & Stokes Associates and Illingworth and Rodkin, Inc. in 2009. Table 5, excerpted from the CALTRANS manual, reflects expected noise levels from pile installation using an impact hammer and a vibratory hammer on piles made of different materials, and of varying dimensions. Note that all noise levels expressed in the table are from un-attenuated sources (i.e., measured at the source). At this time, we expect that the proposed action will involve the installation of sheetpiles and H piles.

IMPACT HAMMER

	Pile Size	Water Depth	**Average Sound Pressure (dB)** PEAK	RMS	SEL
Timber (12" diameter	1 ft	NA	177	165	157
Concrete (24" diameter)	2 ft	15 ft	185	170	160
Steel, H (12" diameter)	1 ft	15 ft	190	175	160
Steel Sheet (24" wide)	2 ft	15 ft	205	190	180
Steel Pipe (12" diameter)	1 ft	15 ft	192	177	NA
Steel Pipe (36" diameter)	3 ft	15 ft	208	190	180

VIBRATORY HAMMER

Timber (12" diameter)	1 ft	NA	<177	<165	<157
Concrete (24" diameter)	2 ft	15 ft	<185	<170	<160
Steel, H (12" diameter)	1 ft	15 ft	165	150	150
Steel Sheet (24" wide)	2 ft	45 ft	182	165	165
Steel Pipe (12" diameter)	1 ft	15 ft	171	155	155
Steel Pipe (36" diameter)	3 ft	15 ft	180	170	170

Table 5. Summary of near-source (10-meter) unattenuated sound pressures for pile driving using two different types of hammers on various pile types and sizes**.**

As evidenced above, installation of the steel sheetpiles is likely to generate peak noise of 205dB re 1uPa with an impact hammer and 182 dB re 1uPa when installed with a vibratory hammer. These are the measures of sound within 10 meters of the pile being driven. The installation of H piles will result in sound levels of 190 dB re 1uPa when installed with an impact hammer and 165 dB re 1uPa when installed with a vibratory hammer.

Based on pier geometry, MDOT anticipates that nearly 60 pairs of 24-inch wide sheetpiles will be driven in order to complete one cofferdam, and there will be six cofferdams erected. Each cofferdam will take up to two weeks to be installed. Additionally, dozens of H piles will likely be driven to support falsework, trestles and work platforms. Depending on the substrate and thickness of sediment, the driven depth of each pile will likely vary. All piles will be driven by a vibratory hammer, and an impact hammer will be used as little as possible.

Installation of piles with a vibratory hammer is not expected to result in peak noise levels greater than 206 dB re 1 µPa or cSEL greater than 187 dB re 1 µPa^2-s. Thus, we do not anticipate any injury or physiological effects due to exposure to noise associated with the installation of piles with a vibratory hammer. Given the extremely small footprint of the area where noise greater than 150 dB re 1 µPa RMS will be experienced (i.e., within 20 meters of the pile being installed), it is extremely unlikely that the behavior of any individual sturgeon or salmon would be affected by noise associated with the installation of piles with a vibratory hammer. Even if a sturgeon or salmon was within 20 meters of the pile being installed, we expect that the behavioral response would, at most, be limited to movement outside the area where noise greater than 150 dB re 1 µPa RMS would be experienced (i.e., moving to an area at least 20 meters from the pile). Because this area is very small and it would take very little energy to make these movements, the effect to any individual sturgeon or salmon would be insignificant. Based on this analysis, all effects to sturgeon and salmon exposed to noise associated with the installation of piles with a vibratory hammer will be insignificant and discountable.

Final installation of at least some of the sheetpiles and H piles will be done with an impact hammer. The available information indicates that installation of these types of piles is unlikely to result in peak levels of 206 dB re 1uPa or greater. However, there is the potential for exposure to cSEL greater than 187 dB re 1uPa. All acoustic effects of driving piles with an impact hammer will be mitigated by using devices such as cushions and blocks that can attenuate the sound by as much as 26 dB when used in tandem (CALTRANS 2009). Sound pressure waves also abate naturally at an average rate of 5 dB per doubling of distance from the source. During the installation of piles, underwater noise levels will be monitored and sound attenuation measures will be put in place to eliminate the potential for re is the potential for sturgeon and salmon to be exposed to noise levels greater than 187 dB re 1uPa cSEL. Therefore, we do not anticipate that any salmon or sturgeon will be exposed to injurious levels of noise.

Noise minimization measures for the bridge construction include an in-water work window where noise levels >150 dB $_{\mathrm{RMS}}$ re 1µPa shall not exceed 12 consecutive hours on any given day, and a 12 hour recovery period (i.e., in-water noise below 150 dB $_{\mathrm{RMS}}$ re 1µPa or ambient levels) will be provided between work days. Behavioral responses are expected to be temporally and spatially limited to the area and time when underwater noise levels are greater than 150dB RMS and as such will be limited to only several hours at a time, and always less than 12 hours per day. Behavioral responses could range from a temporary startle to avoidance of the ensonified area. We have determined that any behavioral responses, including in the worst case, complete avoidance of the ensonified area, would have insignificant and discountable effects to individuals.

While individuals may be displaced from, or avoid, the ensonified area: (1) there will always be a zone of passage(≥ 50 meters) with noise levels less than 150 dB re 1µPa RMS; (2) any changes in movements would be limited to a 12 hour period when pile driving would be occurring; (3) it is extremely unlikely that there would be any significant delay to the spawning migration or abandonment of spawning migrations; (4) there is not expected to be any increase in energy expenditure that has any detectable effect on the physiology of any individuals or any future effect on growth, reproduction, or general health, and, (5) any minor changes in behavior resulting from exposure to increased underwater noise associated with the bridge replacement will not preclude any migrating fish from completing any essential behaviors such as resting, foraging or migrating, or that the fitness of any individuals will be affected.

Based on the noise mitigation efforts written into the proposed action, e.g., equipment adjustments, bubble curtains, and operating time limits, we expect all effects to listed species in the action area exposed to elevated sound pressure waves associated this project will be insignificant and discountable.

6.1.1.2 Drilling

Drilling is considered a continuous noise source and generate noise and vibrations when in operation as a result of friction between the drill face and the material it is boring through (i.e., rock is denser than sand or silt, so there is greater friction, and therefore, higher noise and vibration levels than for softer materials (Transit Link Consultants 2008). The generated noise and vibration from the drill produces sound waves that will transverse the sediment to the inlet’s bottom above the drill. As sound waves propagate from the inlets bottom, transmission loss occurs resulting in the attenuation of noise and vibration levels as the distance from the sound source (i.e., the drill) increases. Sound loss for a specific site is dependent on bottom composition, bathymetric profile, absorption of the sound by water, and scattering due to air bubbles or suspended sediment (Transit Link Consultants 2008). In general, spreading loss rates for large boring drills, such as a ground tunnel boring machine (TBM), range from a 3 to 6 dB decrease per doubling of distance and from 10 to 20 dB per 10- fold increase in distance (Transit Link Consultants 2008). As the drill that may be used to install steel pipes for falsework will be much smaller in size than a TBM, it is likely that the spreading loss rate will be even greater as the vibrations produced from a smaller drill will be much smaller in magnitude. In addition, as the particular drill type and how the drill will be operated is dependent on the contractor and his/her equipment, and this information is not available to the FWHA at this time, the FWHA could not provide NMFS with an estimate of the sound levels produced by drilling operations under the proposed project. As such, NMFS will use the noted spreading loss rates and levels of noise produced by a TBM as a reference point for assessing the impacts of drilling on listed fish species. Based on the above information, the sound levels produced by drilling are likely below the range that could negatively affect Atlantic salmon, Atlantic sturgeon, or shortnose sturgeon.

NMFS has consulted on several projects that involved hard rock drilling, both in the Northeast Region and the Northwest region. For all projects, it was determined that noise generated during hard rock drilling would likely remain well below the noise levels likely to result in physiological or behavioral effects (i.e., 206 dB $_{\text{PEAK}}$ re 1 µPa; 187 dB $_{\text{CSEL}}$ re 1 µPa for physiological effects; and 150 dB $_{\text{PEAK}}$ re 1 µPa for behavioral effects). This conclusion is further supported by analysis completed by NMFS Northwest Region on bridge projects carried out in Washington State where NMFS concluded that oscillating and rotating steel casements for drilled shafts are not likely to elevate underwater sound to a level that is likely to cause injury or noise that would cause adverse changes to fish behavior. Based on this analysis, all effects to listed species in the action area exposed to noise associated with geo-technical rock drilling will be insignificant and discountable.

6.1.1.3 Demolition

A hydraulic rock breaker (hoe ram) is a powerful percussion hammer fitted to an excavator for demolishing rock. Powered by a hydraulic feed from the excavator, a hoe ram can deliver 250 - 1100 blows per minute. A hoe ram generates subsurface sound pressure waves by rapidly chiseling or hammering exposed rock. The excavation performance of a hoe ram diminishes sharply as the rock resistance grows, e.g. limestone (softer) compared to granite (harder). Although peak sound levels generated by hydraulic rock breakers can be substantially less than those produced by explosive demolitions, the total energy imparted can be comparable to blasting because the hoe ram operates continuously and requires more time to break the rock (Torano *et al.* 2006). MDOT anticipates up to 14 days for the demolition of one pier.

Information provided to us by the New York City Department of Environmental Protection (NYDEP) suggests that a hoe ram produces noise levels in open air of approximately 89 dB re: 20 µPa approximately 30 meters from the site under construction, but underwater noise levels produce by a hoe ram were not measured (NMFS 2012). Because specific information regarding in-water sound was lacking from the NYDEP report, a conservative estimate of the underwater noise levels produced by a hoe ram was calculated. Resulting from the differences in reference measurements of water and air (i.e., water is re: 1 µPa, and air is re: 20 µPa), it is known that the intensity of sound in water is greater than that in air, and that intensity measurements of equal pressures in air and water differ by 62 dB (i.e., underwater noise levels are approximately 62 dB above noise levels in air (NOAA Acoustics Monitoring Program; www.pmel.noaa.gov/vents/acoustics/tutorial/8-conversion.htm1).

Based on this information, pier demolition using a hydraulic hoe ram will likely produce underwater noise levels approaching 151 dB $_{\text{RMS}}$ re: 1µPa approximately 30 meters from the rock being demolished. The effects of the pier demolition from the hoe ram are not likely to cross the injury threshold (i.e., 206 dB $_{PEAK}$ re 1 µPa; 187 dB $_{CSEL}$ re 1 µPa) at any distance from the source. Due to the average underwater noise attenuation of 5 decibels per doubling of distance, sound pressure levels in excess of 150 dB $_{RMS}$ re: 1µPa should not be experienced beyond 60 meters. Therefore, effects to listed species, such as behavior modification, due to sound pressure waves generated by a hoe ram will be spatially limited (<60 meters), and not anticipated across the entire width of the river.

6.1.1.4 Blasting

In order to remove the old piers, blasting may be required. The use of explosives produces a pressure wave that radiates from the detonation site. The typical pressure wave from an explosion consists of an instantaneous increase to the peak pressure, followed by a slower (but still very fast) logarithmic decay to below ambient hydrostatic pressure (SAIC, 2000 and Wright & Hopsky, 1998). Most blast injuries to fish involve damage to air- or gas containing organs, such as swim bladders. Fish with swim bladders, such as salmon, are more susceptible to barotrauma. During exposure to explosive shock waves, the swim bladder oscillates and may rupture, in turn causing hemorrhage in surrounding organs resulting in death (Wiley et al. 1981).

The strength of the wave depends on the type and amount of explosives, the manner and depth at which the charges are placed, and the proximity of the detonation to the rock/water interface. As burn rates (detonation velocity) differ for explosive types, so too does the corresponding pressure wave. A slower burning explosive, such as trinitrotoluene, (TNT) "pushes" the substrate and generates a reduced pressure wave compared to a faster burning explosive such as C-4 or a water- gel emulsion that "shatters" the substrate and produces a much stronger pressure wave (personal conversation, US Army, EOD 2012). High explosives have an abrupt rise time, short duration, and a much greater negative pressure than do slower burning explosives. The rapid pressure changes and resulting damage to the swim bladder may be the causative factor of mortality in fish exposed to high explosive pressure waveforms (Keeven & Hempen,1997). As sound waves propagate from the source (such as explosions, hydraulic rock breaking, or drilling), transmission loss occurs, resulting in the attenuation of pressure waves as the distance from the sound source increases. Transmission loss and attenuation for a specific site depends on water depth, temperature, and salinity, tidal exchange, substrate composition, bathymetric profile, and scattering due to air bubbles or suspended sediment (Transit Link Consultants, 2008). Additionally, as the explosives are detonated in rock, the shock wave propagates and is attenuated at a specific rate. As the pressure wave passes through the rock/water interface, the propagation and attenuation rates change due to the different impedance created in the water. As a result, the land/water boundary should be considered the "source", and future calculations should be based on those levels- not on a continuation of the original shock wave (Oriard,2002). When the stress wave travels into a new medium with different impedance, a fraction of the energy will be reflected and another fraction will be transmitted (Persson, Holmberg, and Lee, 1994).

While there is limited information on the effects on fish from noise exposure from drilling, hydraulic rock breaking, or blasting, more information on the effects of noise exposure from other underwater activities, such as pile driving is available. Through analysis of sound waves generated by pile driving and the observed effects on fish, Popper et al. (2006) proposed an acoustic threshold for injury to fish exposed to underwater noise. For purposes of this section 7 consultation on GOM DPS Atlantic salmon, Atlantic sturgeon, and shortnose sturgeon, we are using thes same criterion as detailed above as a proxy for analyzing the effects experienced by these species from blasting.

Calculations will be made to determine approximate charge weights for rock removal while remaining below the injury threshold (SPL below 206 dB $_{\text{PEAK}}$ re 1 µPa and below 187 dB $_{\text{CSEL}}$). In an assessment of US Navy munitions, the Federation of American Scientists (2006) determined that due to the complex nature of explosions, it is not possible to predict easily the magnitude of these blast effects. However, there is a vast collection of experimental data from the explosion of 1 kg of TNT, which has been chosen as the reference explosion. The values for an arbitrary open-air explosion can be found by relating it to the reference explosion through a relation known as the scaling law. It relates the distances at which the same effect will be felt for different explosive amounts. The scaling factor is Wl/3, where W= the equivalent amount of TNT (in kg). W is found by multiplying the mass of the explosive by its relative strength (RS).

Explicitly: dW= do W1/3
where:
do is the distance from 1 kg TNT
dW is the distance from the W kg of TNT equivalent.

According to an Effective Blast Design and Optimization guidance document published by Terra Dinamica (1998), open-water blasting effects can be predicted for charges varying from 0.5 lbs. (.23 kg) to 55 lbs. (25 kg) of TNT by using the following equation:

PWS= 21,600 (W^l/3/lD)^1.13
where:
PWS = Peak Water Shock at point of interest (PSI)
D = Distance to the point of interest in feet
W = Charge Weight in pounds (lbs.)

Scaled Distance for Water Shock
SDw= W^1/3/D

PWS = 21,600 (1/SDw)^1.13

MDOT will design any necessary blasting so that it occurs without the potential for harassment, injury or mortality of any listed species. We will confirm that when we review the blasting plan. In addition, MDOT will conduct hydroacoustic monitoring if blasting is required. In the unexpected event that noise levels from blasting exceed initial calculations and/or rise to a level such that injury, mortality or harassment of listed species is likely, further mitigation will be required. Based on this information, sound and pressure produced by blasting when conducted in accordance with the conditions stipulated in this consultation will be below levels that could injure or kill listed species or result in behavioral modifications. As such, effects to GOM DPS Atlantic salmon, Atlantic sturgeon, and shortnose sturgeon from exposure to underwater acoustic disturbance associated with blasting operations will be discountable and insignificant.

6.1.2 Sediments and Turbidity

During the construction phase, several proposed actions will likely disturb sediments and increase turbidity. These actions include: the deposition of large rip-rap on the river bottom to serve as temporary roads; sheetpile driving for cofferdam installation, the use of barges and other vessels used to access mid-span piers and to serve as work platforms; and the installation of H piles for temporary work trestles. All temporarily emplaced structures, and the old piers and abutments must be removed during the second year of the project which will likely generate a significant, but temporary increase in suspended sediment.

The demolition of the old bridge decking and superstructure will likely be conducted by cranes positioned on the old bridge, or on waterborne barges moving from center back towards the shore. As components are dismantled, they will likely be placed on a barge positioned below the bridge or into large trucks on the bridge for further removal. As the barges and support vessels are positioned to best demolish the bridge superstructure and decking, an increase in suspended sediment will occur. The demolition of the old bridge piers will likely be conducted by barge mounted excavators using hoe rams. As the existing plans call for the removal of the old piers to 1-4 feet below the current riverbed, a significant amount of sediment will be re-suspended. By virtue of their size and location, the demolition of the old bridge abutments allows the use a turbidity curtain which will effectively trap disturbed sediment and prevent construction rubble from entering the water column.

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 (1993) demonstrated lethal effects to fish at concentrations of 580.0 mg/L to 700,000.0 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 0.0 and 75:0 mg/L (Breitburg 1988 *in* Burton 1993). Studies with striped bass adults showed that pre-spawners did not avoid concentrations of 954.0 to 1,920.0 mg/L to reach spawning sites (Summerfelt and Moiser 1976; Combs 1979 *in* Burton 1993). As such, shortnose sturgeon are assumed to be as least as tolerant to suspended sediment as other estuarine fish such as striped bass. The TSS levels expected (10.0-120.0 mg/L) are below those shown to have an adverse effect on fish (580.0 mg/L for the most sensitive species, with 1,000.0 mg/L more typical; see summary of scientific literature in Burton 1993).

Salmonid response to sedimentation and elevated turbidity has been extensively researched because of its protected status, iconic stature, and its economic value. While all life stages are susceptible to adverse effects from excessive turbidity, sessile life stages such as eggs, are the most sensitive (Baum 1997; Fay *et al.* 2006). However, no salmon eggs or early life stages are anticipated in the action area. As the lower Kennebec River serves as a migratory pathway, adult salmon will pass through the action area. Dill et al. (2002) cited Newcomb and Jensen (1996) when noting "that more than 6 days of exposure to TSS greater than 10 mg/l is a moderate stress for juvenile and adult salmonids. A single day of exposure to TSS in excess of 50 mg/l is also a moderate stress." Sigler *et al.* (1984) found that turbidities of 25 nephlometric turbidity units (NTU) or greater caused a reduction in juvenile salmonid growth. The longer the duration of high turbidity the more damage is likely to fish and other aquatic organisms (Newcombe and MacDonald, 1991). At levels as high as 2,400 NTUs experienced for over a 24 hour period, Atlantic salmon showed no direct mortality, but were more at risk from predation (EPA 2003).

The effects to listed species, such as behavior modification due to an increase in TSS will likely be spatially limited to a few hundred meters up and down stream, and not anticipated to extend across the entire width of the river. We anticipate any migrating salmon will quickly navigate the sediment plume in a matter of minutes or hours and continue moving past the action area. As such, any direct adverse effects from an increase in turbidity are discountable. However, an indirect effect of elevated turbidity is reduced visibility and the increased potential for a listed species to become entrapped within a cofferdam. Potential effects from entrapment are discussed below.

6.1.3 Exposure to Contaminants

Use of heavy equipment in or near a water body increases the risk of contaminants (e.g., fuel, oil, etc.) being introduced into the Kennebec River. Chemical contaminants can enter into waterbodies through direct contact with contaminated surfaces or by the introduction of storm or washwater runoff and can remain in solution in the water column or deposit on the existing substrate. Research has shown that exposure to contaminants can reduce reproductive capacity, growth rates, and resistance to disease, and may lead to lower survival rates for salmon (Arkoosh *et al.* 1998a, 1998b). The risk for contaminants entering the Kennebec River would increase during construction, possibly degrading habitat conditions.

To reduce the potential for introducing contaminants into the river during construction activities, the FHWA will require the contractor to follow several best management practices including: a) no equipment, materials, or machinery shall be stored, cleaned, fueled, or repaired within any wetland or watercourse; b) dumping of oil or other deleterious materials on the ground will be forbidden; c) the contractor shall provide a means of catching, retaining, and properly disposing of drained oil, removed oil filters, or other deleterious material; and d) all oil spills shall be reported immediately to the appropriate regulatory body. These BMPs will reduce the likelihood of any contaminant releases into the river during construction activities. Based on implementation of this plan, it is extremely unlikely that there would be a release of contaminants into the river. As such, any adverse effects to GOM DPS of Atlantic salmon, their designated critical habitat, Atlantic or shortnose sturgeon from contaminants leaked or spilled from heavy equipment in the action area is be discountable.

As noted earlier, the State of Maine has designated the action area as “impaired” by virtue of legacy dioxin and polychlorinated biphenyls. However, without a thorough chemical evaluation of the sediment, it is impossible to determine the current concentrations of PCB or other toxins present in the action area. Accordingly, it would be equally difficult to predict the concentration of toxins that would be mobilized into the water column during bridge construction and demolition. Although there are no criterion for acute exposure to PCBs, there are criteria for chronic exposure. Chronic exposure criteria for PCBs is 0.014 µg/L in freshwater and 0.03 µg/L in saltwater.

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 is the calculation of acute (criteria maximum concentration (CMC)) and chronic (criterion continuous concentration (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 incompliance with these levels will not experience any impairment of growth, survival or reproduction.

Data on toxicity as it relates to shortnose and Atlantic sturgeon is extremely limited. 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 believes it is reasonable to consider that the CMC and CCC criteria are applicable to NMFS listed species 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 marine mammals and sea turtles and their prey. These criteria are designed to not only prevent mortality but to prevent all "unacceptable effects", which, as noted above, is defined by EPA to include not only lethal effects but also effects that impair growth, survival and reproduction.

Expected water concentrations of the contaminants that may be mobilized during the bridge replacement are well below the MDEP and EPA water quality criteria. Based on this reasoning outlined above, for the purposes of this consultation, we consider that the exposure to contaminants at levels below the acute and chronic water quality criteria will not cause effects that impair growth, survival and reproduction of listed species. Therefore, the effect of any exposure to these contaminants at levels that are far less that the relevant water quality standards, which by design are consistent with, or more stringent than, EPA's aquatic life criteria, will be insignificant on Atlantic salmon, and Atlantic and shortnose sturgeon

6.1.4 Potential for Entrapment in Cofferdams - Atlantic Salmon

Any Atlantic salmon returning to spawn in the Kennebec River or its tributaries such as Togus Stream or the Sandy River could be expected to enter the river system as late as September. Out migrating smolts stocked in the Sandy River would likely pass through the action area in April, May, and June. Therefore, Atlantic salmon could be expected in the action area at anytime between April and September with the highest likelihood being in late April to mid-June. Adult Atlantic salmon are not expected to linger in the action area because the lower Kennebec River does not provide suitable habitat for spawning or rearing. Atlantic salmon smolts are biologically driven to outmigration and normally cannot remain in fresh water.

The closure of the six cofferdams will likely only take a few hours for each cofferdam. Since the six cofferdams will likely be closed during daylight hours, migrating adult salmon are more likely be become entrapped than the smolts who generally migrate at night. However, as the FHWA has not provided a definitive timeline for each phase of construction, we must assume that both adult and juvenile Atlantic salmon will be exposed to the full range of effects, albeit for a brief period.

Any Atlantic salmon trapped within the cofferdams would experience a delay in migration. Based on the number of cofferdams to be closed, the time period over which cofferdams will be constructed and the number of Atlantic salmon in the area, we anticipate that no more than two adults and no more than one juvenile (smolt) Atlantic salmon will be captured within the cofferdams constructed for this project. Therefore, we anticipate an insignificant delay in migration of up to two adult Atlantic salmon in the Kennebec River during their spawning migrations, and a temporary delay in migration of up to one juvenile Atlantic salmon (smolt) during their seaward migration. Any fish trapped within the closed cofferdam will be promptly removed as described in the fish handling and evacuation section in Appendix B.

Prior to closing the cofferdam, it will be inspected using a submerged camera, electronic telemetry, or by SCUBA divers. Observers are also required to monitor the closing of the cofferdam. Once sealed, dewatering will commence under supervision of the FHWA and MDOT. Should a listed species of fish be found within the cofferdam, it will be evacuated in a timely manner so as to reduce the time the fish is held in captivity.

Capturing and handling salmon causes physiological stress and can cause physical injury although these effects can be kept to a minimum through proper handling procedures. The MDOT fish evacuation plan focuses on minimizing such stresses by requiring minimal handling time; minimal time that fish are held out of the water; and using transfer containers with aerated stream water of ambient temperature where required. Impacts to Atlantic salmon will be further minimized by requiring that only qualified biologists (either from MDOT or fishery agencies) handle the fish. The contractor and its employees may not handle any ESA listed species.

Accordingly, the effects of any entrapment will be limited to minor injuries such as abrasions and stress from which all affected individuals will fully recover without any future reduction in survival or reproductive fitness.

6.1.5 Potential for Entrapment in Cofferdams – Shortnose and Atlantic sturgeon

Here, we consider the potential for sturgeon to become trapped within cofferdams as they are closed. In general, we expect that the potential for entrapment is low because fish are likely to avoid the immediate work area due to the noise and presence of equipment in the water. Adult and juvenile sturgeon that are moving through the action area are unlikely to become entrapped in the cofferdam as it is closed but, given the number of cofferdams being installed and the relative narrowness of the river in the action area, it is possible. Over the project life, we do not expect more than one shortnose sturgeon and one Atlantic sturgeon to be entrapped within the cofferdams. This Atlantic sturgeon could be from the Gulf of Maine or New York Bight DPS. Any fish trapped within a closed cofferdam will removed as described in the fish handling and evacuation section in Appendix B. Accordingly, the effects of any entrapment will be limited to minor injuries from which all affected individuals will fully recover without any future reduction in survival or fitness. Any delays to normal behaviors will be limited to the short time it will take to carry out the fish evacuation procedures.

Both Atlantic and shortnose sturgeon may spawn upstream of the action area. Mobile larvae sturgeon have limited swimming ability and may be present within the water column. As such, this life stage is most vulnerable to passive transport. As larvae have limited mobility, it is reasonable to expect that some number of Atlantic and shortnose sturgeon larvae would be entrapped within the cofferdam.

Telemetry of spawning fish throughout the species range indicates that spawning occurs during a few days to 2-3 weeks (Androscoggin River - Squiers 2003; Merrimack River - Kieffer & Kynard 1996; Connecticut River - Buckley & Kynard; Delaware River - O'Herron *et al.* 1993; and Savannah River - Hall *et al.* 1991). The end of spawning is easily determined because adult fish leave the spawning area and move downstream, some at the rapid rate of 32 km per day (Buckley & Kynard 1985; Hall *et al*. 1991; Kieffer & Kynard 1996).

Sturgeon eggs are demersal and adhere to the substrate where they are deposited. Eggs and larvae are likely to remain concentrated near the spawning area for up to 4 weeks post-spawning, after which larvae disperse into the tidal river. Sturgeon larvae are believed to begin downstream migrations at about 20mm total length (0.75 inches). Recent laboratory studies of Connecticut River larvae found most ceased downstream migration after 2 days, although some emigration continued for 14 days (C. Cauthron & B. Kynard unpublished data). This is sufficient time to move many kilometers downstream and potentially into the action area. Even though the cofferdams are surveyed prior to getting sealed, larval sturgeon are unlikely to be seen given their small size. Therefore, we expect that larvae will be trapped in any cofferdams closed during the late spring or early summer when mobile larvae are moving through the action area.

MDOT will use a large bore pump capable of passing small fish (<10 centimeters/4 inches) when dewatering the cofferdams. Water filled cofferdams will be pumped out with water discharged back into the river. Any sturgeon larvae present within the cofferdam would pass through the pump and also be discharged back into the river. The pump that would be used must have at least a 4" (101mm) clearance between any moving parts and be designed to pump small solids. Sturgeon larvae in the action area are expected to be approximately 20 mm TL (0.79 inch). Based on analysis done by Taft *et al*. on alewife and yellow perch larvae (which are of similar size to sturgeon larvae), approximately 10% of the 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.

The number of larvae trapped in the cofferdams will depend on the timing of spawning in relation to the time when the cofferdams are closed. Because MDOT can not predict exactly when the cofferdams will be closed, we can not determine how many cofferdams are likely to be closed during the period when larvae are moving downstream. We can also not predict the number of larvae likely to be entrapped. However, in the worst case, all six cofferdams would be closed during the period when larvae are moving downstream and all migrating larvae would be entrapped. This is unlikely to be the case because larval dispersal will occur over a several week period and because the actual time it takes to close the cofferdam is short. However, because we can not refine this worst case scenario, we have considered it to be possible. Cofferdams will only be installed in 2013. Therefore, in the worst case, 10% of all shortnose and Atlantic sturgeon larvae spawned in 2013 will be killed as a result of passing through the dewatering pumps.

6.2 Effects of the Action on Designated Critical Habitat of Atlantic Salmon

As discussed earlier, critical habitat for Atlantic salmon has been designated in the Kennebec River including the sections of river in the vicinity of the Richmond- Dresden Bridge. Within the action area of this consultation, the PCEs for Atlantic salmon include sites (routes) for migration (excluding marine migration). As spawning and/or rearing do not occur in the action area, that suite of PCEs does not apply. The analysis presented in the environmental baseline shows habitat indicators are properly functioning, and biological requirements of Atlantic salmon are currently being met in the action area.

<u>Physical and biological features of the migration PCE must include:</u>

1. Freshwater and estuary migratory sites free from physical and biological barriers that delay or prevent access of adult salmon seeking spawning grounds needed to support recovered populations. The bridge replacement will result in localized acoustic effects as well as an increase in turbidity which will not likely create a permanent barrier to migration or result in any significant delays.
2. Freshwater and estuary migration sites with pool, lake, and in-stream habitat that provide cool, oxygenated water and cover items (e.g., boulders, woody debris, and vegetation) to serve as temporary holding and resting areas during upstream migration of adult salmon. The placement of the rip-rap roads will temporarily alter the stream flow, but the bridge replacement is not expected to result in any long term alterations in the hydrology or hydraulics in the action area.
3. Freshwater and estuary migration sites with abundant, diverse native fish communities to serve as a protective buffer against predation. The placement of the rip-rap roads will likely result in temporary impacts to near shore forage grounds,

however, the bridge replacement does not pose a significant threat to the existing fish community.

4. Freshwater and estuary migration sites free from physical and biological barriers that delay or prevent emigration of smolts to the marine environment. The bridge replacement will likely result in minor delays (<24 hours), but this action is not expected to create a permanent barrier to migration or result in any significant delays.
5. Freshwater and estuary migration sites with sufficiently cool water temperatures and water flows that coincide with diurnal cues to stimulate smolt migration. The placement of the rip-rap roads will temporarily alter the stream flow, but the bridge replacement is not likely to create an impoundment, cause water temperature to rise, or to influence photoperiodicity.
6. Freshwater migration sites with water chemistry needed to support sea water adaptation of smolts. The bridge replacement is not expected to change water chemistry in the action area and it will likely remain tidal riverine with extremely low salinity.

Thus, NMFS expects the bridge replacement to cause temporary adverse effects to some essential features of critical habitat, including water quality, substrate, migration conditions, and forage grounds in a similar manner as present in the environmental baseline. However, NMFS expects these effects to be temporary, and ceasing upon completion of the project. Based on this analysis, all effects to designated critical habitat in the action area associated with the bridge replacement will be insignificant and discountable.

7. 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.

The effects of future state and private activities in the action area that are reasonably certain to occur are continuation of recreational fisheries, discharge of pollutants, and development and/or construction activities resulting in excessive water turbidity and habitat degradation.

Impacts to shortnose sturgeon, Atlantic sturgeon and Atlantic salmon from non-federal activities are largely unknown in the Kennebec River. It is possible that occasional recreational fishing for anadromous fish species may result in incidental takes of these species. There have been no documented takes of shortnose sturgeon from fisheries in the action area. The continued operations of these hook and line fisheries and other fisheries could result in future sturgeon or Atlantic salmon mortality and/or injury.

In December 1999, the State of Maine adopted regulations prohibiting all angling for sea-run salmon statewide. A limited catch-and-release fall fishery (September 15 to October 15) for Atlantic salmon in the Penobscot River was authorized by the MASC in 2007. The fishery was closed prior to the 2009 season. Despite strict state and federal regulations, both juvenile and adult Atlantic salmon remain vulnerable to injury and mortality due to incidental capture by recreational anglers and incidental catch in commercial fisheries. The best available information indicates that Atlantic salmon are still incidentally caught by recreational anglers. Evidence suggests that Atlantic salmon are also targeted by poachers (NMFS 2005). Commercial fisheries for elvers (juvenile eels) and alewives may also capture Atlantic salmon as bycatch. No estimate of the numbers of Atlantic salmon caught incidentally in recreational or commercial fisheries exists.

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 and Atlantic sturgeon are particularly vulnerable. Atlantic salmon are also vulnerable to impacts from pollution and are also likely to continue to be impacted by water quality impairments in the Kennebec River and its tributaries.

Contaminants associated with the action area are a legacy of previous industrial development along the waterfront. Many contaminants such as PCBs remain present in the environment for prolonged periods of time and thus would not disappear even after the contaminant input were to ceased. It is likely that shortnose sturgeon, Atlantic sturgeon and Atlantic salmon will continue to be affected by contaminants in the action area in the future.

Point sources of water pollution, such as the quarry (3 km upstream) and the Richmond sewage treatment facility (2 km downstream), will likely continue to impact the water quality in and around the action area. Changes in water chemistry/quality are likely with continued operation of these facilities. As a result, shortnose and Atlantic sturgeon foraging and/or distribution in the action area may be adversely affected.

Future non-point sources of contamination in the action area include atmospheric loading of pollutants, groundwater discharges, and vehicular leakage of contaminants. As such, continued chemical contamination may have an effect on listed species reproduction and survival.

As noted above, impacts to listed species from these activities are largely unknown. At present, we have 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.

8.0 INTEGRATION AND SYNTHESIS OF EFFECTS

In the discussion below, we consider whether the effects of the proposed action reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of the listed species in the wild by reducing the reproduction, numbers, or distribution of the GOM DPS of Atlantic salmon, shortnose sturgeon and the NYB and GOM DPSs of Atlantic sturgeon. The purpose of this analysis is to determine whether the proposed action, in the context established by the status of the species, environmental baseline, and cumulative effects, would jeopardize the continued existence of the GOM DPS of Atlantic salmon, shortnose sturgeon and the NYB and GOM DPSs of Atlantic sturgeon. As noted above, we have determined that all effects to critical habitat designated for the GOM DPS of Atlantic salmon will be insignificant and discountable.

In the NMFS/USFWS Section 7 Handbook, for the purposes of determining jeopardy, survival is defined as, “the species’ persistence as listed or as a recovery unit, beyond the conditions leading to its endangerment, with sufficient resilience to allow for the potential recovery from endangerment. Said in another way, survival is the condition in which a species continues to exist into the future while retaining the potential for recovery. This condition is characterized by a species with a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, which exists in an environment providing all requirements for completion of the species’ entire life cycle, including reproduction, sustenance, and shelter.”

Recovery is defined as, “Improvement in the status of listed species to the point at which listing is no longer appropriate under the criteria set out in section 4(a)(1) of the Act.” Below, for the GOM DPS of Atlantic salmon, shortnose sturgeon and the NYB and GOM DPSs of Atlantic sturgeon, the listed species that may be affected by the proposed action, we summarize the status of the species and consider whether the proposed action will result in reductions in reproduction, numbers or distribution of that species and then considers whether any reductions in reproduction, numbers or distribution resulting from the proposed action would reduce appreciably the likelihood of both the survival and recovery of that species, as those terms are defined for purposes of the Federal Endangered Species Act.

We have determined that the proposed action may result in the capture of a small number of Atlantic salmon and shortnose and Atlantic sturgeon within cofferdams construction during the bridge replacement and/or demolition activities. These captured fish will experience short delays to carrying out normal behaviors. Because of the BMPs that will be implemented during pile installation, bridge demolition and blasting, we do not anticipate the injury or mortality of any sturgeon or salmon.

8.1 GOM DPS of Atlantic Salmon

Atlantic salmon in the GOM DPS currently exhibit low spawning abundance, critically poor marine survival, and are confronted with a variety of anthropogenic threats. The abundance of Atlantic salmon in the GOM DPS has been low and either stable or declining over the past several decades. The proportion of fish that are of natural origin is very small (less than 10%) and is continuing to decline. The conservation hatchery program has assisted in slowing the decline and helping to stabilize populations at low levels, but has not contributed to an increase in the overall abundance of salmon and has not been able to halt the decline of the naturally reared component of the GOM DPS. Based on trap counts from the Lockwood Dam, an average of 22.7 adult salmon have returned to the Kennebec to spawn. The effects of the bridge replacement have the potential to impact, in some way, the entire spawning run.

Summary of Construction Effects

We have determined that all effects related to underwater noise and increased turbidity and suspension of contaminants will be insignificant and discountable. We expect that a small number of salmon will become entrapped within cofferdams constructed during 2013. We expect that no more than two adult salmon and 1 salmon smolt will be entrapped within a cofferdam and handling during evacuation. These estimates are based upon the worst case scenario, that all cofferdams are closed during the time of year when Atlantic salmon are migrating through the action area.

Capturing and handling salmon causes physiological stress and can cause physical injury although these effects can be kept to a minimum through proper handling procedures. The fish evacuation plan should minimize such stresses by requiring minimal handling time; minimal time that fish are held out of the water; and using transfer containers with aerated stream water of ambient temperature. Impacts to Atlantic salmon will be further minimized by requiring that only qualified biologists handle the fish. Given these minimization efforts, it is not expected that any of the entrapped fish will experience more than minor injuries.

Survival and Recovery Analysis
Jeopardy is defined as "an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, to determine if the proposed action will jeopardize the GOM DPS of Atlantic salmon, we conduct an analysis of the effects of the proposed action on survival and recovery.

The first step in conducting this analysis is to assess the effects of the proposed action on the survival of the species. Survival is defined as the condition in which a species continues to exist into the future while retaining the potential for recovery. This condition is characterized by a species with a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, which exists in an environment providing all requirements for completion of the species' entire life cycle, including reproduction, sustenance, and shelter (USFWS and NMFS 1998).

There are three criteria that are evaluated under the survival analysis: reproduction, numbers and distribution. We consider the number of returning adult Atlantic salmon, particularly 2SW females, to the natal streams is a measure of both the reproduction and numbers of the species. We consider the proportion of runs where pre-spawn Atlantic salmon are able to access high quality spawning and rearing habitat in the upper Kennebec River watershed as a reasonable and appropriate measure of distribution. As the vast majority of high quality spawning and rearing habitat in the Kennebec River basin exists in the Sandy River, we consider improved access to/from these areas to be critical to the survival and recovery of the species. The survival analysis assumes that the accessibility is maintained over the time period considered in this consultation.

The second step in conducting this analysis is to assess the effects of the proposed project on the recovery of the species. Recovery is defined as the improvement in the status of listed species to the point at which listing is no longer appropriate under the criteria set out in section 4(a)(1) of the ESA (50 CFR 402.02). As with the survival analysis, there are three criteria that are evaluated under the recovery analysis: reproduction, numbers and distribution. In the recovery analysis, the same measures are used to evaluate these criteria as are used in the survival analysis. However, unlike with survival, the recovery analysis requires an adjustment to the existing freshwater and marine survival rates to allow for a population that has a positive growth rate, so that it can be determined how the proposed project will affect the species ability to achieve recovery. Such an analysis could not be conducted under existing freshwater and marine survival conditions, since they do not allow a population trending towards recovery. The recovery condition includes existing dam passage rates, but does not include hatchery supplementation as it is assumed that in a recovered population, stocking will not be necessary to sustain a viable population.

The proposed construction activities will not result in the mortality of any Atlantic salmon. The proposed action will therefore, not affect the abundance of this species. There will also be no effects to reproduction. Effects to distribution will be limited to temporary capture of a small number of individuals in the cofferdams and movements around noisy or turbid areas. As explained fully below, we have determined that the proposed action will not reduce appreciably the likelihood of both the survival and recovery of the species.

Survival Analysis

Abundance and Reproduction

For the period of 1967 to 2003, approximately 10% of the wild and naturally reared origin adults returning to U.S. rivers (with monitoring facilities) were grilse and 86% were 2SW (USASAC 2004). An occasional 3SW salmon is found among returning adults. In Maine, 95 to 98% of the grilse are male while 55 to 75% of the 2SW and 3SW returns are female (Baum 1997). From when fish trapping and monitoring began at the Lockwood Dam in 2006, there have been an average of 22.7 adult salmon return annually (MDMR, 2012). Based on the statics provided above, we conclude that between 12 and 17 of those returning 2SW fish were female.

Based on historical records and the current trajectory it can be said that, although the Atlantic salmon population is still declining, the proposed bridge replacement will have no influence on the abundance of returning 2SW female Atlantic salmon to the Kennebec River and the GOM DPS of Atlantic salmon.

Distribution

We conducted a separate analysis to assess the effects of the bridge replacement on the distribution of Atlantic salmon in the Kennebec River watershed. In this analysis, the proportion of salmon that access habitat upstream of the action area is compared to the baseline condition and the condition after the bridge replacement. The analysis indicates that the proposed project is not anticipated to lead to any improvements or reduction in the distribution of Atlantic salmon in the Kennebec River, and GOM DPS as a whole. Therefore, the proposed action will not appreciably reduce the likelihood that the GOM DPS of Atlantic salmon will survive.

Recovery Analysis

In rare instances an action may not appreciably reduce the likelihood of a species survival (persistence) but may affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, we have determined that the proposed action will not appreciably reduce the likelihood that Atlantic salmon will survive in the wild. Here, we consider the potential for the action to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate.

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.

At existing freshwater and marine survival rates (the medians have been estimated by NMFS as 1.1% and 0.4%, respectively), it is unlikely that Atlantic salmon will be able to achieve recovery. As indicated in the survival analysis above, at current survival rates wild spawners are having a very small effect on the number of returning salmon. If hatchery supplementation were to cease, the population would decline rapidly, and recovery would not be possible. Therefore, a significant increase in either freshwater or marine survival (or a lesser increase in both) will be necessary to achieve recovery. The Atlantic Salmon Recovery Team (ASRT) created a conceptual model to indicate how marine and freshwater survival rates would need to change in order to recover Atlantic salmon (ASRT 2010). In Figure 7, the dot represents current marine and freshwater survival rates; the curved line represents all possible combinations of marine and freshwater survival rates that would result in a stable population with a growth rate of zero. If survival conditions are above the curved line, the population is growing, and, thus, trending towards recovery (lambda greater than one). The straight lines indicate the rates of freshwater survival that have been historically observed (Legault 2004). This model indicates that there are many potential routes to recovery; for example, recovery could be achieved by significantly increasing the existing marine survival rate while holding freshwater survival at existing levels, or, conversely, by significantly increasing freshwater survival while holding marine survival at today’s levels. Conceptually, however, the figure makes clear that an increase in both freshwater and marine survival will lead to the shortest and, therefore, most likely to occur, path to achieving a self-sustaining population that is trending towards recovery.

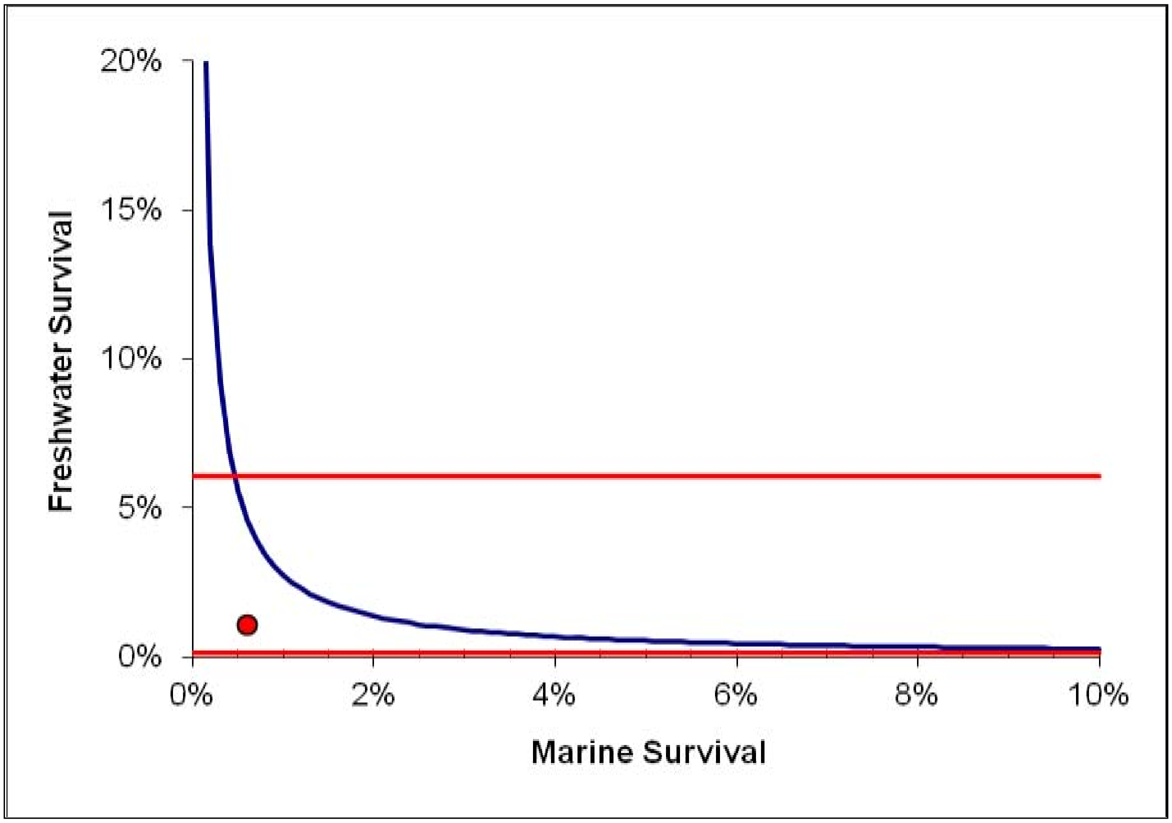


Figure 7. A conceptual model constructed by ASRT (2010) that demonstrates how changes in marine and freshwater survival will be necessary to recover the GOM DPS of Atlantic salmon. The dot represents current conditions, the curved line represents recovery, and the straight lines are the historic maximum and minimum freshwater survival.

In order to model the effect that the proposed action would have on recovery, marine and freshwater survival rates are increased to a point that will allow for the recovery of the species. To do this, assumptions are made about what constitutes a realistic increase in these parameters. In the mid-1980s to early 1990s there was a 50% to 70% decline in Atlantic salmon marine survival rates. This event is referred to as the regime shift (Chaput *et al.* 2005); the causes for which are unknown at this time (Windsor *et al.* 2012). Based on the smolt to adult return rate for wild fish in the Narraguagus River, USFWS (2012) estimated that the pre-regime shift marine survival rate ranged between 0.9% and 5.2%, with an average of 3.0%. A four-fold increase in the current median marine survival rate (from 0.4% to 1.7%) will allow for a rate that is within the range estimated to have existed prior to the regime shift.

Freshwater survival rates have historically ranged between 0.1% and 6.0%, with an average of 1.5% (Legault 2004). A two fold increase in the existing median freshwater survival rate (from 1.1% to 2.2%) creates a condition that is above the historical mean, but is within the range that has been observed and, when coupled with improved marine survival, will allow for a modest positive growth rate in the Atlantic salmon population.

Despite the threats faced by individual Atlantic salmon inside and outside of the action area, the proposed action will not increase the vulnerability of individual Atlantic salmon to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed action.

While we are not able to predict with precision how climate change will impact Atlantic salmon in the action area or how the species will adapt to climate change-related environmental impacts, no additional effects related to climate change to Atlantic salmon in the action area are anticipated over the life of the proposed action (i.e., through the construction period). We have considered the effects of the proposed action in light of cumulative effects explained above, including climate change, and have concluded that even in light of the ongoing impacts of these activities and conditions; the conclusions reached above do not change.

8.2 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 1,000 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.

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. 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. The lack of information on the status of some populations, such as that in the Chesapeake Bay, add uncertainty to any determination on the status of this species as a whole. Based on the best available information, NMFS believes that the status of shortnose sturgeon throughout their range is stable.

Shortnose sturgeon occur in the estuarine complex formed by the Sheepscot, Kennebec, and Androscoggin rivers. Fried and McCleave (1973) discovered shortnose sturgeon within Montsweag Bay in the Sheepscot River in 1971. This was the first reported occurrence of shortnose sturgeon in Maine. Shortnose were subsequently found in the Kennebec River by ME DMR in 1977 (Squiers and Smith, 1979). Sturgeon were tagged with Carlin tags from 1977 to 1980, with recoveries in each of the following years.

The Maine Department of Marine Resources (MDMR) conducted studies of shortnose sturgeon in the Kennebec River from 1996 through 2001. A Schnabel estimate using tagging and recapture data from 1998, 1999 and 2000 indicates an adult population estimate of 9,488 for the Kennebec- Androscoggin- Sheepscot estuarine complex (Squires 2003). This is the most recent population estimate for the Kennebec River shortnose sturgeon population; however, this estimate includes fish from the Androscoggin and Sheepscot rivers as well, but does not include an estimate of the size of the juvenile population.

In 1999, the Edward's Dam, which represented the first significant impediment to the northward migration of shortnose sturgeon in the Kennebec River, was removed. With the removal of the dam, approximately 17 miles of previously inaccessible sturgeon habitat north of Augusta was made available. In order to monitor the recolonization of the habitat above Edwards dam, MDMR conducted an ichthyoplankton survey from 1997 through 2001. Twelve sampling sites were established above the former dam site and thirteen sites were established below the former dam site. While no shortnose sturgeon eggs or larvae were collected above the former dam site in 2000 or 2001 (Wippelhauser 2003), small numbers of eggs and larvae were collected at sites in the first nine kilometers below the site (rkm 61-70). It is likely that the major spawning area for shortnose sturgeon in the Kennebec River is located in the first 11 km below the former Edwards Dam site (rkms 59-70; Tom Squiers, Maine Department of Marine Resources, Personal Communication). On May 11, 1999, 135 shortnose sturgeon were caught in the Kennebec River 10 km below Edwards dam (rkm 60), and were assumed to be on the spawning run. Water temperature was 14°C. While there have not been any directed studies to determine if shortnose sturgeon are utilizing the habitat above the former Edwards Dam, several shortnose sturgeon have been captured incidental to other studies in Waterville (and some at the base of the Lockwood Dam), 27 km above the former Edwards Dam, since its removal.

The Lockwood dam is located at the site of a natural falls (Ticonic Falls). It is not thought that shortnose sturgeon would have been able to pass upstream of these falls and Ticonic Falls is thought to be the natural upstream limit for shortnose sturgeon in the Kennebec River. The Schnabel estimate from 1998-2000 is the most recent population estimate for the Kennebec River shortnose sturgeon population; however, this estimate includes fish from the Androscoggin and Sheepscot rivers as well and does not include an estimate of the size of the juvenile population. A comparison of the population estimate for the estuarine complex from 1982 (Squiers et al. 1982) to 2000 (MDMR 2003) suggests that the adult population has grown by approximately 30% in the last twenty years. Based on this information, NMFS believes that the shortnose sturgeon population in the Kennebec River is increasing; however, without more information on the status of more recent year classes (i.e., juveniles) it is difficult to speculate about the long term survival and recovery of this population.

As described in the Status of the Species/Environmental Baseline, and Cumulative Effects sections above, shortnose sturgeon in the Kennebec River are affected by habitat alteration, bycatch in recreational fisheries, water quality, and in-water construction activities. It is difficult to quantify the number of shortnose sturgeon that may be affected in the Kennebec River each year due to anthropogenic sources. Through reporting requirements implemented under Section 7 and Section 10 of the ESA, for specific actions NMFS obtains some information on the number of incidental and directed takes of shortnose sturgeon each year. Typically, scientific research results in the capture and collection of less than 100 shortnose sturgeon in the Kennebec River each year, with little if any mortality. NMFS has sporadic reports of interactions or mortalities of shortnose sturgeon in the Kennebec River resulting from dredging or other in-water construction activities. NMFS has no quantifiable information on the effects of habitat alteration or water quality; in general, water quality has improved in the Kennebec River since the 1970s when the CWA was implemented and log drives were terminated. NMFS also has empirical evidence that shortnose sturgeon are expanding their range by undertaking coastal migrations into adjacent large rivers systems such as the Penobscot and Merrimack which suggests that the movement and distribution of shortnose sturgeon is not limited by habitat or water quality impairments. Despite these ongoing threats, there is evidence that the Kennebec River population of shortnose sturgeon experienced significant growth between the 1970s and 1990s and that the population is now stable at high numbers. Shortnose sturgeon in the Kennebec River continue to experience anthropogenic and natural sources of mortality. However, NMFS is not aware of any future actions that are reasonably certain to occur that are likely to change this trend or reduce the stability of the Kennebec River population. Also, as discussed above, NMFS does not expect shortnose sturgeon to experience any new effects associated with climate change during the proposed two- year construction/demolition period. As such, NMFS expects that numbers of shortnose sturgeon in the action area will continue to be stable at high levels over the two –year duration of the proposed action.

All effects of exposure to increased underwater noise, turbidity and contaminants will be insignificant and discountable. While individuals may be displaced from, or avoid, the ensonified area: (1) there will always be a zone of passage(≥ 50 meters) with noise levels less than 150 dB re 1µPa RMS; (2) any changes in movements would be limited to a 12 hour period when pile driving would be occurring; (3) it is extremely unlikely that there would be any significant delay to the spawning migration or abandonment of spawning migrations; (4) there is not expected to be any increase in energy expenditure that has any detectable effect on the physiology of any individuals or any future effect on growth, reproduction, or general health, and, (5) any minor changes in behavior resulting from exposure to increased underwater noise associated with the bridge replacement will not preclude any shortnose sturgeon from completing any essential behaviors such as resting, foraging or migrating, or that the fitness of any individuals will be affected. Behavioral responses are expected to be temporally and spatially limited to the area and time when underwater noise levels are greater than 150dB RMS and as such will be limited to only several hours at a time, and always less than 12 hours per day. Behavioral responses could range from a temporary startle to avoidance of the ensonified area. We have determined that any behavioral responses, including in the worst case, complete avoidance of the ensonified area, would have insignificant and discountable effects to individuals.

NMFS has estimated that the proposed bridge replacement will result in the capture and minor injury of no more than one adult of juvenile shortnose sturgeon. No mortality is anticipated. Physiological effects are expected to be limited to minor injuries from cofferdam entrapment such as abrasions and scale loss that will not impair the fitness of any individuals or affect survival.

In the worst case, all six cofferdams will be closed during the 2 to 3 week time period in late spring when shortnose sturgeon larvae are moving downstream through the action area. If all migrating larvae were trapped within cofferdams, they would all pass through dewatering pumps. We anticipate a mortality rate of 10% for all shortnose sturgeon larvae passing through the pumps. Therefore, in the worst case, 10% of all shortnose sturgeon larvae spawned in 2013 would be killed.

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 during the first year of construction when the cofferdams are initially closed and dewatered. The best available population estimates indicate that there are approximately 9,000 adult shortnose sturgeon in the Kennebec River and an unknown number of juveniles. Based on the number of adults in the population, at least 3,000 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 10% of the larvae spawned in the first year of the construction, would affect the ultimate size of that year class 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 a single year class 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 Kennebec River because, while it will result in behavioral changes for adults spawning in the action area (avoidance of the ensonified 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 10% of the larvae spawned during the first year of construction 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 the action will not impede shortnose sturgeon from accessing any seasonal concentration areas, including foraging, spawning or overwintering grounds in the Kennebec River. Further, the action is not expected to reduce the river by river distribution of shortnose sturgeon. Any effects to distribution will be minor and temporary and limited to the temporal and geographic scale of the area ensonified by pile driving operations.

Based on the information provided above, the exposure of shortnose sturgeon to the effects of the Richmond-Dresden Bridge replacement will not appreciably reduce the likelihood of survival of this species (i.e., it will not increase the risk of extinction faced by this species) given that: (1) the population trend of shortnose sturgeon in the Kennebec River is stable; (2) the level of mortality is small (10% of larvae in one year and no loss of juveniles or adults) and is expected to be undectable at the population level; (3) there will be no effect to the fitness of any individuals and no effect on reproductive output of the Kennebec River population of shortnose sturgeon or the species as a whole; (4) and, the action will have only a minor and temporary effect on the distribution of shortnose sturgeon in the action area (related to movements around the esonified area) and no effect on the distribution of the species throughout its range.

In rare instances, it may be determined that an action does not appreciably reduce the likelihood of a species' survival; however, that same action might affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, NMFS has determined that the proposed action will not appreciably reduce the likelihood that shortnose sturgeon will survive in the wild. Here, NMFS considers the potential for the action to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate. 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.

The proposed action is not expected to modify, curtail or destroy the range of the species since it will result in no reduction in the number of shortnose sturgeon in the Kennebec River 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. The proposed action will not utilize shortnose sturgeon for recreational, scientific or commercial purposes or affect the adequacy of existing regulatory mechanisms to protect this species. The proposed action is not likely to result in any mortality or reductions in fitness or future reproductive output and therefore, there is not expected to affect the persistence of the Kennebec River population of shortnose sturgeon or the species as a whole. There will not be a change in the status or trend of the Kennebec River population, which is stable at high numbers. As it will not affect the status or trend of this population, it will not affect the status or trend of the species as a whole. As there will be no reduction in numbers or future reproduction, the action would not cause any reduction in the likelihood of improvement in the status of shortnose sturgeon throughout their range. The effects of the proposed action will not delay the recovery timeframe or otherwise decrease the likelihood of recovery since the action will not cause any mortality or reduction of overall reproductive fitness for the species as a whole. The effects of the proposed action will also not reduce the likelihood that the status of the species can improve to the point where it is recovered and could be delisted. Therefore, 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, is not likely to appreciably reduce the survival and recovery of this species.

8.3 Gulf of Maine DPS of Atlantic Sturgeon

Individuals originating from the GOM DPS are likely to occur in the action area. The GOM DPS has been listed as threatened. While Atlantic sturgeon occur in several rivers in the GOM DPS, recent spawning has only been documented in the Kennebec and Androscoggin rivers. No population estimates are available; the ASSRT estimated that there were fewer than 300 adults spawning in the DPS each year. GOM origin Atlantic sturgeon are affected by numerous sources of human induced mortality and habitat disturbance throughout the riverine and marine portions of their range. While there are some indications that the status of the GOM DPS may be improving, there is currently not enough information to establish a trend for any life stage or for the DPS as a whole.

All effects of exposure to increased underwater noise, turbidity and contaminants will be insignificant and discountable. While individuals may be displaced from, or avoid, the ensonified area: (1) there will always be a zone of passage(≥ 50 meters) with noise levels less than 150 dB re 1µPa RMS; (2) any changes in movements would be limited to a 12 hour period when pile driving would be occurring; (3) it is extremely unlikely that there would be any significant delay to the spawning migration or abandonment of spawning migrations; (4) there is not expected to be any increase in energy expenditure that has any detectable effect on the physiology of any individuals or any future effect on growth, reproduction, or general health, and, (5) any minor changes in behavior resulting from exposure to increased underwater noise associated with the bridge replacement will not preclude any shortnose sturgeon from completing any essential behaviors such as resting, foraging or migrating, or that the fitness of any individuals will be affected. Behavioral responses are expected to be temporally and spatially limited to the area and time when underwater noise levels are greater than 150dB RMS and as such will be limited to only several hours at a time, and always less than 12 hours per day. Behavioral responses could range from a temporary startle to avoidance of the ensonified area. We have determined that any behavioral responses, including in the worst case, complete avoidance of the ensonified area, would have insignificant and discountable effects to individuals.

NMFS has estimated that the proposed bridge replacement will result in the capture and minor injury of no more than one adult or subadult Atlantic sturgeon; this could be a GOM DPS individual. No mortality is anticipated. Physiological effects are expected to be limited to minor injuries from cofferdam entrapment such as abrasions and scale loss that will not impair the fitness of any individuals or affect survival.

In the worst case, all six cofferdams will be closed during the 2 to 3 week time period in late spring when GOM DPS Atlantic sturgeon larvae are moving downstream through the action area. If all migrating larvae were trapped within cofferdams, they would all pass through dewatering pumps. We anticipate a mortality rate of 10% for all Atlantic sturgeon larvae passing through the pumps. Therefore, in the worst case, 10% of all GOM DPS Atlantic sturgeon larvae spawned in 2013 would be killed.

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 during the first year of construction when the cofferdams are initially closed and dewatered.

The death of 10% of the larvae spawned in the first year of the construction, would affect the ultimate size of that year class of Kennebec River Atlantic 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 Atlantic 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 a single year class would be detectable at the population level. Therefore, the loss of these Kennebec River Atlantic 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 Atlantic sturgeon in the Kennebec River because, while it will result in behavioral changes for adults spawning in the action area (avoidance of the ensonified 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 10% of the larvae spawned during the first year of construction 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 the action will not impede Atlantic sturgeon from accessing any seasonal concentration areas, including foraging, spawning or overwintering grounds in the Kennebec River. Further, the action is not expected to reduce the river by river distribution of shortnose sturgeon. Any effects to distribution will be minor and temporary and limited to the temporal and geographic scale of the area ensonified by pile driving operations.

Based on the information provided above, the exposure of GOM DPS Atlantic sturgeon to the effects of the Richmond-Dresden Bridge replacement will not appreciably reduce the likelihood of survival of this species (i.e., it will not increase the risk of extinction faced by this species) given that: (1) the level of mortality is small (10% of larvae in one year and no loss of juveniles, subadults or adults) and is expected to be undectable at the population level; (3) there will be no effect to the fitness of any individuals and no effect on reproductive output of the Kennebec River population of Atlantic sturgeon or the DPS as a whole; (4) and, the action will have only a minor and temporary effect on the distribution of Atlantic sturgeon in the action area (related to movements around the esonified area) and no effect on the distribution of the species throughout its range.

In rare instances, an action that does not appreciably reduce the likelihood of a species' survival might affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, NMFS has determined that the proposed action will not appreciably reduce the likelihood that the GOM DPS will survive in the wild. Here, NMFS considers the potential for the action to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate. 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.

The proposed action is not expected to modify, curtail or destroy the range of the species since it will result in no reduction in the number of GOM DPS Atlantic sturgeon and since it will not affect the overall distribution of GOM DPS Atlantic sturgeon other than to cause minor temporary adjustments in movements in the action area. The proposed action will not utilize GOM DPS Atlantic sturgeon for recreational, scientific or commercial purposes or affect the adequacy of existing regulatory mechanisms to protect this species. The proposed action is not likely to result in any mortality or reductions in fitness or future reproductive output and therefore, it is not expected to affect the persistence of the GOM DPS of Atlantic sturgeon. There will not be a change in the status or trend of the GOM DPS of Atlantic sturgeon. As there will be no reduction in numbers or future reproduction the action would not cause any reduction in the likelihood of improvement in the status of the GOM DPS of Atlantic sturgeon. The effects of the proposed action will not delay the recovery timeline or otherwise decrease the likelihood of recovery since the action will not cause any mortality or reduction of overall reproductive fitness for the species. The effects of the proposed action will also not reduce the likelihood that the status of the species can improve to the point where it is recovered and could be delisted. Therefore, the proposed action will not appreciably reduce the likelihood that the GOM DPS of Atlantic sturgeon can be brought to the point at which they are no longer listed as threatened. Based on the analysis presented herein, the proposed action, is not likely to appreciably reduce the survival and recovery of this species.

8.4 New York Bight DPS of Atlantic Sturgeon

The NYB DPS has been listed as endangered. While Atlantic sturgeon occur in several rivers in the NYB DPS, recent spawning has only been documented in the Delaware and Hudson rivers. As noted above, we expect approximately 7% of the Atlantic sturgeon in the action area to originate from the New York Bight DPS.

There is limited information on the demographics of the Hudson River population of Atlantic sturgeon. An annual mean estimate of 863 mature adults (596 males and 267 females) was calculated for the Hudson River based on fishery-dependent data collected from 1985-1995 (Kahnle *et al.* 2007). No data on abundance of juveniles are available prior to the 1970s; however, catch depletion analysis estimated conservatively that 6,000-6,800 females contributed to the spawning stock during the late 1800s (Secor 2002, Kahnle *et al*. 2005). Two estimates of immature Atlantic sturgeon have been calculated for the Hudson River population, one for the 1976 year class and one for the 1994 year class. Dovel and Berggren (1983) marked immature fish from 1976-1978. Estimates for the 1976 year class at age were approximately 25,000 individuals. Dovel and Berggren estimated that in 1976 there were approximately 100,000 juvenile (non-migrant) Atlantic sturgeon from approximately 6 year classes, excluding young of year.

In October of 1994, the NYDEC stocked 4,929 marked age-0 Atlantic sturgeon, provided by a USFWS hatchery, into the Hudson Estuary at Newburgh Bay. These fish were reared from Hudson River brood stock. In 1995, Cornell University sampling crews collected 15 stocked and

14 wild age-1 Atlantic sturgeon (Peterson *et al*. 2000). A Petersen mark-recapture population estimate from these data suggests that there were 9,529 (95% CI = 1,916 – 10,473) age-0 Atlantic sturgeon in the estuary in 1994. Since 4,929 were stocked, 4,600 fish were of wild origin, assuming equal survival for both hatchery and wild fish and that stocking mortality for hatchery fish was zero.

Information on trends for Atlantic sturgeon in the Hudson River are available from a number of long term surveys. From July to November during 1982-1990 and 1993, the NYSDEC sampled the abundance of juvenile fish in Haverstraw Bay and the Tappan Zee Bay. The CPUE of immature Atlantic sturgeon was 0.269 in 1982 and declined to zero by 1990. This study has not been carried out since this time.

The Long River Survey (LRS) samples ichthyoplankton river-wide from the George Washington Bridge (rkm 19) to Troy (rkm 246) using a stratified random design (CONED 1997). These data, which are collected from May-July, provide an annual index of juvenile Atlantic sturgeon in the Hudson River estuary since 1974. The Fall Juvenile Survey (FJS), conducted from July – October by the utilities, calculates an annual index of the number of fish captured per haul. Between 1974 and 1984, the shoals in the entire river (rkm 19-246) were sampled by epibenthic sled; in 1985 the gear was changed to a three-meter beam trawl. While neither of these studies were designed to catch sturgeon, given their consistent implementation over time they provide indications of trends in abundance, particularly over long time series. When examining CPUE, these studies suggest a sharp decline in the number of young Atlantic sturgeon in the early 1990s. While the amount of interannual variability makes it difficult to detect short term trends, a five year running average of CPUE from the FJS indicates a slowly increasing trend since about 1996. Interestingly, that is when the in-river fishery for Atlantic sturgeon closed. While that fishery was not targeting juveniles, a reduction in the number of adult mortalities would be expected to result in increased recruitment and increases in the number of young Atlantic sturgeon in the river. There also could have been bycatch of juveniles that would have suffered some mortality.

In 2000, the NYSDEC created a sturgeon juvenile survey program to supplement the utilities' survey; however, funds were cut in 2000, and the USFWS was contracted in 2003 to continue the program. In 2003 – 2005, 579 juveniles were collected (N = 122, 208, and 289, respectively) (Sweka et al. 2006). Pectoral spine analysis showed they ranged from 1 – 8 years of age, with the majority being ages 2 – 6. There has not been enough data collected to use this information to detect a trend, but at least during the 2003-2005 period, the number of juveniles collected increased each year which could be indicative of an increasing trend for juveniles.

NYB DPS origin Atlantic sturgeon are affected by numerous sources of human induced mortality and habitat disturbance throughout the riverine and marine portions of their range. The largest single source of mortality appears to be capture as bycatch in commercial fisheries operating in the marine environment. A bycatch estimate provided by NEFSC indicates that approximately 376 Atlantic sturgeon die as a result of bycatch each year. Mixed stock analysis from the NMFS NEFOP indicates that 49% of these individuals are likely to originate from the NYB and 91% of those likely originate from the Hudson River, for a total of approximately 167 adult and subadult mortalities annually. Because juveniles do not leave the river, they are not impacted by fisheries occurring in Federal waters. Bycatch and mortality also occur in state fisheries; however, the primary fishery that impacted juvenile sturgeon (shad), has now been closed and there is no indication that it will reopen soon. NYB DPS Atlantic sturgeon are killed as a result of anthropogenic activities in the Hudson River and other rivers; sources of potential mortality include vessel strikes and entrainment in dredges. As noted above, we expect the mortality of two Atlantic sturgeon as a result of the Tappan Zee Bridge replacement project; it is possible that these individuals could originate from the Hudson River. There could also be the loss of a small number of juveniles at other water intakes in the River including the Danskammer and Roseton plants.

NMFS has estimated that the proposed bridge replacement will result in the capture and injury of no more than one Atlantic sturgeon, which may be of NYB DPS origin. No mortality is anticipated. Physiological effects are expected to be limited to minor injuries such as abrasions and scale loss from entrapment within the cofferdam that will not impair the fitness of any individuals or affect survival.

Behavioral responses are expected to be temporally and spatially limited to the area and time when underwater noise levels are greater than 150dB $_{\text{RMS}}$ and as such will be limited to only several hours at a time, and always less than 12 hours per day. Behavioral responses could range from a temporary startle to avoidance of the ensonified area. We have determined that any behavioral responses, including in the worst case, complete avoidance of the ensonified area, would have insignificant and discountable effects to individuals.

While individuals may be displaced from, or avoid, the ensonified area: (1) there will always be a zone of passage($\geq$50 meters) with noise levels less than 150 dB $_{\text{RMS}}$ re 1µPa; (2) any changes in movements would be limited to a 12 hour period when pile driving would be occurring; (3) it is extremely unlikely that there would be any significant delay to the spawning migration or abandonment of spawning migrations; (4) there is not expected to be any increase in energy expenditure that has any detectable effect on the physiology of any individuals or any future effect on growth, reproduction, or general health, and, (5) any minor changes in behavior resulting from exposure to increased underwater noise associated with the bridge replacement will not preclude any shortnose sturgeon from completing any essential behaviors such as resting, foraging or migrating, or that the fitness of any individuals will be affected. The survival of any NYB DPS Atlantic sturgeon will not be affected by the proposed bridge replacement. As such, there will be no reduction in the numbers of NYB DPS Atlantic sturgeon and no change in the status of this species or its trend.

Reproductive potential of the NYB DPS is not expected to be affected in any way. As all sturgeon are anticipated to fully recover from any physiological impacts and any behavioral responses will not delay or disrupt any essential behavior including spawning, there will be no reduction in individual fitness or any future reduction in numbers of individuals. Additionally, any delay in migration to the spawning grounds will be limited to several hours and is not anticipated to impact the success of reproduction. The proposed action will also not affect the spawning grounds within the Hudson River which is one of two rivers within the NYB DPS where spawning is thought to occur. The action will also not create any barrier to pre-spawning sturgeon accessing the overwintering sites or the spawning grounds.

The proposed action is not likely to reduce distribution because the action will not impede NYB DPS Atlantic sturgeon from accessing any seasonal concentration areas, including foraging, spawning or overwintering grounds in the Kennebec River or elsewhere. Any effects to distribution will be minor and temporary and limited to the temporal and geographic scale of the area esonified by pile driving operations.

Based on the information provided above, the exposure of NYB DPS Atlantic sturgeon to the effects of the bridge replacement will not appreciably reduce the likelihood of survival of this species (i.e., it will not increase the risk of extinction faced by this species) given that: (1) there will be no mortality and therefore, no reduction in the numbers of NYB DPS Atlantic sturgeon; (2) there will be no effect to the fitness of any individuals and no effect on reproductive output of the NYB DPS of Atlantic sturgeon; (3) and, the action will have only a minor and temporary effect on the distribution of NYB DPS Atlantic sturgeon in the action area (related to movements around the esonified area) and no effect on the distribution of the species throughout its range.

In certain instances, an action that does not appreciably reduce the likelihood of a species' survival might affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, NMFS has determined that the proposed action will not appreciably reduce the likelihood that the NYB DPS will survive in the wild. Here, NMFS considers the potential for the action to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate. 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.

The proposed action is not expected to modify, curtail or destroy the range of the species since it will result in no reduction in the number of NYB DPS Atlantic sturgeon and since it will not affect the overall distribution of NYB DPS Atlantic sturgeon other than to cause minor temporary adjustments in movements in the action area. The proposed action will not utilize NYB DPS Atlantic sturgeon for recreational, scientific or commercial purposes or affect the adequacy of existing regulatory mechanisms to protect this species. The proposed action is not likely to result in any mortality or reductions in fitness or future reproductive output and therefore, there is not expected to affect the persistence of the NYB DPS of Atlantic sturgeon. There will not be a change in the status or trend of the NYB DPS of Atlantic sturgeon. As there will be no reduction in numbers or future reproduction the action would not cause any reduction in the likelihood of improvement in the status of the NYB DPS of Atlantic sturgeon. The effects of the proposed action will not shorten the recovery timeframe or otherwise decrease the likelihood of recovery since the action will not cause any mortality or reduction of overall reproductive fitness for the species. The effects of the proposed action will also not reduce the likelihood that the status of the species can improve to the point where it is recovered and could be delisted. Therefore, the proposed action will not appreciably reduce the likelihood that the

NYB DPS of Atlantic sturgeon can be brought to the point at which they are no longer listed as threatened. Based on the analysis presented herein, the proposed action is not likely to appreciably reduce the survival and recovery of this species.

9.0 CONCLUSION

After reviewing the best available information on the status of endangered and threatened species under NMFS jurisdiction in the Kennebec River, 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, Gulf of Maine Distinct Population Segment of Atlantic sturgeon, New York Bight Distinct Population Segment of Atlantic sturgeon, or Gulf of Maine Distinct Population Segment of Atlantic salmon. Furthermore, the proposed action is not expected to result in the destruction or adverse modification of Atlantic salmon critical habitat.

10.0 INCIDENTAL TAKE STATEMENT

Section 9(a)(1) of the ESA prohibits any taking (harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt to engage in any such conduct) of endangered species without a specific permit or exemption. Harm is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as spawning, rearing, feeding, and migrating (50 CFR §222.102; NMFS 1999b). 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). Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity by a Federal agency or applicant (50 CFR §402.02). 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 the incidental take statement.

The prohibitions against incidental take are currently in effect for the GOM DPS of Atlantic salmon, shortnose sturgeon, and all DPSs of Atlantic sturgeon except the threatened GOM DPS. A final section 4(d) rule for the GOM DPS of Atlantic sturgeon, which we anticipate to be published in the *Federal Register* soon, will apply the appropriate take prohibitions. The proposed 4(d) rule for the GOM DPS was published on June 10, 2011 (76 FR 34023) and includes prohibitions on take with very limited exceptions. The appropriate prohibitions on take of GOM DPS Atlantic sturgeon will take effect on the date the final 4(d) rule is effective and at that time, the take provided in this ITS will apply to the GOM DPS.

10.1 Amount or Extent of Incidental Take

This ITS serves two important functions: (1) it provides an exemption from the Section 9 prohibitions for any taking incidental to the proposed action that is in compliance with the terms and conditions; and (2) it provides the means to insure the action as it is carried out is not jeopardizing the continued existence of affected species by monitoring and reporting the progress of the action and its impact on the species such that consultation can be reinitiated if any of the criteria in 50 CFR 402.16 are met.

The measures described in this section are nondiscretionary. If the FHWA fails to carry out the terms and conditions of this incidental take statement, the protective coverage of Section 7(a)(2) may lapse. To monitor the effect of incidental take, the FHWA must require the MDOT to report the progress of the action and its effect on each listed species to NMFS, as specified in this incidental take statement (50 CFR §402.14(i)(3)).

The following sections describe the amount or extent of take that NMFS expects would result based on the anticipated effects of the proposed action. If the proposed action results in take of a greater amount or extent than that described, the FHWA would need to reinitiate consultation. The exempted take includes only take incidental to the proposed action.

10.1.1 Amount or Extent of Take of Atlantic Salmon

NMFS acknowledges that the new Richmond - Dresden bridge construction and old bridge demolition may adversely affect Atlantic salmon in the Kennebec River. Different phases of construction and demolition pose a variety of threats to salmon during their migration. Accordingly, the project is designed around risk reduction and mitigation measures developed to lessen the effects. As not all effects can be eliminated, the non-lethal incidental take of Atlantic salmon is expected to be harm in the form of delayed migration, abrasions, and scale loss stemming from temporary entrapment within a cofferdam.

The amount of incidental take is difficult to predict because of the following reasons: 1) the action area is comprised of a reach of river that serves primarily as a migratory corridor; and 2) we have no accurate population estimate of Atlantic salmon in the lower Kennebec River. However, we anticipate a likely delay in migration due to temporary entrapment of no more than two adult Atlantic salmon, and no more than one Atlantic salmon smolts attempting to navigate the Kennebec River action area. Adult salmon may be required to negotiate the action area during upstream spawning migration and again during their post-spawn return to the sea. Atlantic salmon smolts will only be passing through the action area once during their initial outmigration, and most likely do so under the cover of darkness when no construction activities are anticipated. Accordingly the anticipated take of adult salmon is double that of migrating smolts. No mortalities of any life stage are anticipated or exempted.

NMFS believes this level of incidental take is reasonable given action area’s role in salmon biology, the seasonal distribution, historical abundance of Atlantic salmon in the Kennebec River, and the number of cofferdams. In the accompanying biological opinion, NMFS determined that this level of anticipated take is not likely to result in jeopardy to the species. Since the anticipated take is in the form of temporary delay in migration due to entrapment, it is possible to monitor the exact numbers of takes of Atlantic salmon. NMFS will require observers to identify salmon trapped within each cofferdam (if any) to ascertain whether or not a take of Atlantic salmon has occurred.

10.1.2 Amount or Extent of Incidental Take of Shortnose sturgeon

Anticipated Take of Juvenile or Adult Shortnose sturgeon
We anticipate take via cofferdam entrapment of no more than one shortnose sturgeon. We expect trapped fish to be returned to the river with only minor injuries.

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. In order for larvae to be entrapped within a cofferdam, the cofferdam would need to be closed during the 2-3 week period when larvae are migrating downstream. 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.

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 a cofferdam is closed is impossible to predict. However, based on the number of adult shortnose sturgeon spawning in the Kennebec River in a given year, 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, and considering the very worst case scenario that all six cofferdams are closed during the time of year when larvae are migrating through the action area and all of them are trapped, NMFS has estimated that up to 100% of the larvae spawned in 2013 could be captured in a cofferdam; with no more than 10% of these larvae being killed. Therefore, NMFS has estimated that in 2013, no more than 10% of the larvae spawned would be killed due to being pumped out of an overtopped cofferdam.

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 or mortality. Because both the distribution and numbers of larvae in the action area 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 closing of cofferdams, the amount of take is difficult, if not impossible, to estimate. In addition, because shortnose sturgeon larvae are very small (20mm) and nearly impossible to observe with the naked eye in a cofferdam filled with water, 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.

As noted above, we have assumed the worst case, that all six cofferdams will be closed during the time of year that shortnose sturgeon larvae are present in the action area and that all larvae moving through the area are trapped in the cofferdams. We will consider take to have been exceeded if more than six cofferdams are constructed and closed within the time period when sturgeon are migrating through the action area or if mortality of larvae is greater than 10%. 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.

10.1.3 Amount or Extent of Incidental Take of GOM DPS Atlantic sturgeon

Anticipated Take of Subadult of Adult Atlantic sturgeon
We anticipate take via cofferdam entrapment of no more than one subadult or adult GOM DPS Atlantic sturgeon. We expect trapped fish to be returned to the river with only minor injuries.

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. In order for larvae to be entrapped within a cofferdam, the cofferdam would need to be closed during the 2-3 week period when larvae are migrating downstream. The capture of Atlantic sturgeon within the cofferdams will disturb sturgeon and their normal behaviors will be interrupted. 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.

The number of Atlantic sturgeon larvae present in the action area in a given year is impossible to predict; similarly, the number of Atlantic sturgeon larvae on a given date when a cofferdam is closed is impossible to predict. However, based on the number of adult Atlantic sturgeon spawning in the Kennebec River in a given year, 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, and considering the very worst case scenario that all six cofferdams are closed during the time of year when larvae are migrating through the action area and all of them are trapped, NMFS has estimated that up to 100% of the larvae spawned in 2013 could be captured in a cofferdam; with no more than 10% of these larvae being killed. Therefore, NMFS has estimated that in 2013, no more than 10% of the larvae spawned in the Kennebec River upstream of the action area would be killed due to being pumped out of an overtopped cofferdam.

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 or mortality. Because both the distribution and numbers of larvae in the action area 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 closing of cofferdams, the amount of take is difficult, if not impossible, to estimate. In addition, because sturgeon larvae are very small (20mm) and nearly impossible to observe with the naked eye in a cofferdam filled with water, 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.

As noted above, we have assumed the worst case, that all six cofferdams will be closed during the time of year that Atlantic sturgeon larvae are present in the action area and that all larvae moving through the area are trapped in the cofferdams. We will consider take to have been exceeded if more than six cofferdams are constructed and closed within the time period when sturgeon are migrating through the action area or if mortality of larvae is greater than 10%. NMFS believes this level of incidental take is reasonable given the seasonal distribution and abundance of Atlantic 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.

10.1.4 Amount or Extent of Incidental Take – New York Bight DPS of Atlantic sturgeon

We anticipate take via cofferdam entrapment of no more than one subadult NYB DPS Atlantic sturgeon. We expect trapped fish to be returned to the river with only minor injuries.

10.2 Reasonable and Prudent Measures

We expect that the FHWA will require MDOT to incorporate these RPMs and Terms and Conditions into any contracts or other project materials.

We have determined the following reasonable and prudent measures are necessary or appropriate to minimize and monitor impacts of incidental take of listed species:

1. Review best available science prior to construction and use it to adaptively manage the project protocol to incorporate any new practices which will minimize impacts to listed Atlantic salmon, Atlantic sturgeon and shortnose sturgeon.
2. Conduct all staging and preparatory actions, bridge construction and demolition, stabilization and recovery actions, and any other in-water and near-water activities by applying best management practices in a manner that minimizes incidental take of ESA-listed or proposed species and conserves the aquatic resources on which ESA-listed species depend.
3. Monitor underwater noise resulting from the installation of sheet and H piles.
4. Release all live salmon or sturgeon captured during cofferdam closures back into the Kennebec River at an appropriate location away from the pile driving activity that minimizes the additional risk of death or injury.
5. Report all salmon or sturgeon captures, injuries, or mortalities associated with the bridge project and any listed species sightings in the action area to NMFS.
6. Transfer any dead salmon or sturgeon to NMFS or to an appropriately permitted research facility identified by NMFS so that a necropsy can be undertaken to attempt to determine the cause of death.

7. Monitor sturgeon movements downstream of the bridge to determine if sturgeon are overwintering near Swan Island, and report on seasonal aggregations.

10.2 Terms and Conditions

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

1. To implement reasonable and prudent measure #1, FHWA must require MDOT to do the following:
    a. Prior to initiating construction activities, convene state and federal resources agencies to review the bridge replacement activities and review any new information for potential impacts that were not considered during consultation.
    b. If new methods of avoiding and/or minimizing incidental take are identified, the MDOT must seek review and approval from NMFS before construction activities commence with any changes in *i*) construction methods and actions; *ii*) take minimization activities; and *iii)* monitoring and contingency activities. Changes to the proposed action or this incidental take statement may trigger a requirement for reinitiation.

2. To implement reasonable and prudent measure #3, FHWA must require MDOT to prepare and implement a hydroacoustic monitoring plan. MDOT must provide NMFS a draft hydroacoustic monitoring plan (e.g., locations, personnel, and equipment) at least 30 days prior to implementation for NMFS approval. This monitoring plan will describe how MDOT will:
    a) Monitor Sound Pressure Level (SPL) during pile driving, rock drilling, and pier removal using a series of hydrophones and a digital recorder capable of operating at a minimum of 600,000 samples per second for a minimum of one second, with an adjustable trigger level, and a range of at least 30 psi.
    b) Ensure that the sound pressure levels at all hydrophones be maintained below 206 dB $_{\text{PEAK}}$ re 1 µPa and below 187 dB $_{\text{CSEL}}$ re 1 µPa. In-water noise levels greater than 150dB $_{\text{RMS}}$ re 1µ Pa measured at any hydrophone must not persist in excess of 12 consecutive hours on any given day, and a 12 hour recovery period (i.e., in-water noise below 150dB $_{\text{RMS}}$ re lµ Pa, or a return to ambient levels) must be provided between work days.
    c) Initially, a minimum of three hydrophones must be used, located approximately 10, 20, and 40 meters from the river- pile/pier interface. Additional hydrophones may be required to document sound levels remain below the previously established thresholds at mid-stream, and at the farthest bank.
    d) Mitigate excessive underwater noise (>206 dB $_{\text{PEAK}}$ re 1 µPa, 187 dB $_{\text{SEL}}$ re 1 µPa, or 150dB $_{\text{RMS}}$ re 1µ Pa in excess of 12 hours.) through passive measures such as changing hammer type, reducing driving duration, reducing force settings on the hammer, or through active measures such as a bubble curtain.
    e) Provide NMFS with daily acoustic monitoring reports as generated by the contractor. Electronic means of delivery e.g., email or fax is acceptable.

3. To implement reasonable and prudent measure #4, FHWA must require MDOT to develop and implement a monitoring plan to document and remove listed species entrapped during cofferdam closure. A draft plan must be provided to NMFS at least 30 days prior to installation of the first cofferdam. The monitoring plan must explain how MDOT will do the following: :
    a) During the closure of each cofferdam, i.e., the installation of the final sheetpile, a qualified observer must be present on site. The observer(s) will monitor for the presence of live, wounded, or dead fish. In the event that dead or wounded fish resulting from the construction activities are observed, MDOT must contact us immediately.
    b) Monitor and record water temperature during cofferdam construction and closure as a means of determining the likelihood of larval sturgeon in the action area. If/when water temperature exceeds 8° C during cofferdam dewatering, sample a portion of the water pumped from each cofferdam and inspect for sturgeon larvae. For each cofferdam closed when the water temperature is above 8° C, provide feedback to NMFS on any larvae passed through the pumps and any mortalities.
    c) Ensure any trapped salmon or sturgeon are collected with a net and are visually inspected for injuries in accordance with Appendix B. Live fish must be kept in the river, or held in an aerated live well. All collected fish must be inspected for a PIT tag with an appropriate PIT tag reader. Injured fish must be visually assessed, measured, photographed, released away from the site, and reported to NMFS. The reporting form included as Appendix C must be filled out and transmitted to NMFS using the procedures outlined below.
    d) Ensure cofferdams are dewatered using large bore pumps capable of passing small fish (>10 centimeters/ 4 inch clearance between moving parts) to adequately protect all life stages of listed species that may occur in the action area. Dewatering must not begin until the cofferdam is cleared by the observer.
    e) Ensure that fin clips are taken (according to the procedure outlined in Appendix D) of any sturgeon captured during the bridge replacement and that the fin clips are sent to NMFS for genetic analysis. Fin clips of mortalities must be taken prior to preservation of other fish parts or whole bodies.

4. To implement reasonable and prudent measure #5, FHWA must require MDOT to do the following:
    a. Contact NMFS (Max Tritt: by email (max.tritt@noaa.gov) or phone (207) 866-7356 or the Section 7 Coordinator by phone (978) 281-9208 or fax 978-281-9394) within 24 hours of any interactions with Atlantic sturgeon, shortnose sturgeon, or Atlantic salmon including non-lethal and lethal takes.
    b. In the event of any lethal takes, any dead specimens or body parts must be photographed, measured, and preserved (refrigerate or freeze) until disposal procedures are discussed with NMFS.

5. To implement reasonable and prudent measure #6, FHWA must require MDOT to do the following:

a. Submit annual reports at the end of each calendar year summarizing the results of the proposed action and any takes of listed species to NMFS by mail (to the attention of the Section 7 Coordinator, NMFS Protected Resources Division, Gloucester, MA. 01930).

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. If, during the course of the action, the level of incidental take is exceeded, re-initiation of consultation and review of the reasonable and prudent measures are required. FHWA and MDOT must immediately provide an explanation of the causes of the taking and review with NMFS the need for possible modification of the reasonable and prudent measures.

Specifically, these RPMs and Terms and Conditions will keep NMFS informed of when and where construction activities are taking place, and will require MDOT to report any take in a reasonable amount of time. The FHWA and MDOT have reviewed the RPMs and Terms and Conditions outlined above and all parties have agreed to implement all of these measures as described herein. 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, #2, and #3 as well as Terms and Conditions (#1-3) are necessary and appropriate as they will require that the MDOT and their contractors use best management practices and best available technology for the bridge replacement . This will ensure that take of listed Atlantic salmon, Atlantic sturgeon, and shortnose sturgeon is minimized to the extent practical. These procedures represent only a minor change to the proposed action as following these procedures should not increase the cost of the project or result in any delays or reduction of efficiency of the project.

RPM #4, #5, and #6 as well as Terms and Conditions (#4, #5, and #6) are necessary and appropriate to ensure the proper protocol and 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. These RPMs 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 #7 and corresponding Terms and Condition #7 are necessary and appropriate as they will require that MDOT monitor previous sturgeon overwintering sites in the fall, winter, and in the spring to determine if they are in fact being utilized, to what degree they are being used, and to gauge the effects of the actions on the overwintering population, if any. The reporting procedures are required as a means for NMFS to remain abreast of seasonal population trends in the action area and to ensure that MDOT is aware of the effects of their actions. These RPMs and the Terms and Conditions represent only a minor change as compliance will not result in any significant increase in cost, delay of the project or decrease in the efficiency of the project.

11.0 CONSERVATION RECOMMENDATIONS

In addition to Section 7(a)(2), which requires agencies to ensure that all projects will not jeopardize the continued existence of listed species, Section 7(a)(1) of the ESA places a responsibility on all federal agencies to "utilize their authorities in furtherance of the purposes of this Act by carrying out programs for the conservation of endangered 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. As such, NMFS recommends that the FHWA consider the following Conservation Recommendations:

1. The FHWA should use its authorities to stage the project such that cofferdams are not closed during the time of year when shortnose or Atlantic sturgeon larvae are migrating through the action area.

12.0 RE-INITIATION NOTICE

This concludes formal consultation concerning FHWA's bridge replacement project over the Kennebec River connecting Maine's Kennebec and Lincoln Counties. As provided in 50 CFR §402.16, re-initiation 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.

This opinion assumes that the bridge will be replaced within two years. If construction and or demolition is required for a period greater than two years, FHWA must re-initiate consultation with NMFS.

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APPENDIX A.

Matrix of Primary Constituent Elements (PCEs) and essential features for assessing the environmental baseline of the action area.

		Conservation Status Baseline		
PCE	Essential Features	Fully Functioning	Limited Function	Not Properly Functioning
A) Adult Spawning: (October 1st - December 14th)				
	Substrate	highly permeable course gravel and cobble between 1.2 to 10 cm in diameter	40- 60% cobble (22.5-256 mm dia.) 40-50% gravel (2.2 – 22.2 mm dia.); 10-15% course sand (0.5 -2.2 mm dia.), and <3% fine sand (0.06-0.05mm dia.)	more than 20% sand (particle size 0.06 to 2.2 mm), no gravel or cobble
	Depth	17-30 cm	30 - 76 cm	< 17 cm or > 76 cm
	Velocity	31 to 46 cm/sec.	8 to 31cm/sec. or 46 to 83 cm/sec.	< 5-8 cm/sec. or > 83cm/sec.
	Temperature	7^{o} to 10^{o}C	often between 7^{o} to 10^{o}C	always < 7^{o} or > 10^{o}C
	pH	> 5.5	between 5.0 and 5.5	< 5.0
	Cover	Abundance of pools 1.8-3.6 meters deep (McLaughlin and Knight 1987). Large boulders or rocks, over hanging trees, logs, woody debris, submerged vegetation or undercut banks	Limited availability of pools 1.8-3.6 meters deep (McLaughlin and Knight 1987). Large boulders or rocks, over hanging trees, logs, woody debris, submerged vegetation or undercut banks	Absence of pools 1.8-3.6 meters deep (McLaughlin and Knight 1987). Large boulders or rocks, over hanging trees, logs, woody debris, submerged vegetation or undercut banks

	Fisheries Interactions	Abundant diverse populations of indigenous fish species	Abundant diverse populations of indigenous fish species, low quantities of non-native species present	Limited abundance and diversity of indigenous fish species, abundant populations of non-native species
B) Embryo and Fry Development: (October 1st - April 14th)				
	Temperature	0.5^{o}C and 7.2^{o}C, averages nearly 6oC from fertilization to eye pigmentation	averages < 4oC, or 8 to 10^{o}C from fertilization to eye pigmentation	>10^{o}C from fertilization to eye pigmentation
	D.O.	at saturation	7-8 mg/L	< 7 mg/L
	pH	> 6.0	6 - 4.5	< 4.5
	Depth	5.3-15cm	NA	<5.3 or >15cm
	Velocity	4 – 15cm/sec.	NA	<4 or > 15cm/sec.
	Fisheries Interactions	Abundant diverse populations of indigenous fish species	Abundant diverse populations of indigenous fish species, low quantities of non-native species present	Limited abundance and diversity of indigenous fish species, abundant populations of non-native species

		Conservation Status Baseline		
PCE	Essential Features	Fully Functioning	Limited Function	Not Properly Functioning
C) Parr Development: (All year)				
	Substrate	gravel between 1.6 and 6.4 cm in diameter and boulders between 30 and 51.2 cm in diameter. May contain rooted	gravel < 1.2cm and/or boulders > 51.2. May contain rooted aquatic macrophytes	no gravel, boulders, or rooted aquatic macrophytes present

	aquatic macrophytes		
Depth	10cm to 30cm	NA	<10cm or >30cm
Velocity	7 to 20 cm/sec.	< 7cm/sec. or > 20 cm/sec.	velocity exceeds 120 cm/sec..
Temperature	15^{o} to 19^{o}C	generally between 7-22.5oC, but does not exceed 29oC at any time	stream temperatures are continuously <7oC or known to exceed 29oC
D.O.	> 6 mg/l	2.9 - 6 mg/l	< 2.9 mg/l
Food	Abundance of larvae of mayflies, stoneflies, chironomids, caddisflies, blackflies, aquatic annelids, and mollusks as well as numerous terrestrial invertebrates and small fish such as alewives, dace or minnows	Presence of larvae of mayflies, stoneflies, chironomids, caddisflies, blackflies, aquatic annelids, and mollusks as well as numerous terrestrial invertebrates and small fish such as alewives, dace or minnows	Absence of larvae of mayflies, stoneflies, chironomids, caddisflies, blackflies, aquatic annelids, and mollusks as well as numerous terrestrial invertebrates and small fish such as alewives, dace or minnows
Passage	No anthropogenic causes that inhibit or delay movement	Presence of anthropogenic causes that result in limited inhibition of movement	barriers to migration known to cause direct inhibition of movement
Fisheries Interactions	Abundant diverse populations of indigenous fish species	Abundant diverse populations of indigenous fish species, low quantities of non-native species present	Limited abundance and diversity of indigenous fish species, abundant populations of non-native species

		Conservation Status Baseline		
PCE	Essential Features	Fully Functioning	Limited Function	Not Properly Functioning
D) Adult migration: (April 15th- December 14th)				
	Velocity	30 cm/sec to 125 cm/sec	In areas where water velocity exceeds 125 cm/sec adult salmon require resting areas with a velocity of < 61 cm/s	sustained speeds > 61 cm/sec and maximum speed > 667 cm/sec
	D.O.	> 5mg/L	4.5-5.0 mg/l	< 4.5mg/L
	Temperature	14 – 20^{o}C	temperatures sometimes exceed 20oC but remain below 23^{o}C.	> 23^{o}C
	Passage	No anthropogenic causes that delay migration	Presence of anthropogenic causes that result in limited delays in migration	barriers to migration known to cause direct or indirect mortality of smolts
	Fisheries Interactions	Abundant diverse populations of indigenous fish species	Abundant diverse populations of indigenous fish species, low quantities of non-native species present	Limited abundance and diversity of indigenous fish species, abundant populations of non-native species
E) Juvenile Migration: (April 15th - June 14th)				
	Temperature	8 - 11oC	5 - 11^{o}C.	< 5oC or > 11oC
	pH	> 6	5.5 - 6.0	< 5.5
	Passage	No anthropogenic causes that delay migration	Presence of anthropogenic causes that result in limited delays in migration	barriers to migration known to cause direct or indirect mortality of smolts

APPENDIX B.

Fish Evacuation Plan

Water depths inside the cofferdams are expected to be as deep as 20 feet at the time of construction. It is likely that the noise from the installation of the sheet piles will encourage any fish in the area to move away from the cofferdam. To ensure that take of endangered species is minimized to the greatest extent practicable, the cofferdams will be inspected and a variety of fish evacuation attempts could be utilized. Maine DMR maintains an acoustic telemetry array in the Kennebec River/estuary and deploys a transponder in the vicinity of the bridge each year. MDOT will coordinate with MDMR and NMFS prior to the work to discuss the most recent results of tagged sturgeon activity in the area. Due to the work around the cofferdams and size of nets involved, assistance from the contractor is to be expected in this process. MDOT Environmental Office staff will follow the Maine Atlantic Salmon Commission Disinfection Procedures (below).

An adequate number of qualified biologists will be on the site during the evacuation. The qualified biologist will consist of MDOT Environmental Office Staff, other State of Maine employees, or hired consultants that have experience and are familiar with fish handling techniques. Consultants may not handle taken listed endangered or threatened species.

Methods of inspection:

- Sonar- fish detection with a fish finding sonar could be used to determine if there are any possible fish species trapped enclosed.

- Underwater Camera- the enclosed area can be surveyed by the use of an underwater camera to visually check for the species.

- Divers - A diver may be deployed to visually inspect the cofferdam depending on visibility limits and site conditions.

If it is reasonably determined that there are no endangered species trapped in the cofferdam using the above methods, no evacuation is necessary. If an endanger species is witnessed in the cofferdam, the steps below may be taken.

Methods of evacuation:

- The cofferdam will be partially de-constructed and inspected. This method could make it possible to herd the fish out of the area with a large net. If an Atlantic salmon is witnessed in the cofferdam, herding will be utilized to ensure an adult salmon is not captured in a gill net.

- A gill net may be utilized if sturgeon are witnessed in cofferdam and the cofferdam has been sealed. Gill nets are used to sample sturgeon in other reaches of the river and guidance provided in *A Protocol for Use of Shortnose and Atlantic Sturgeons*. NOAA Technical

Memorandum NMFS-OPR-18 will be utilized. A gill net will not be utilized if any Atlantic salmon are expected in the cofferdam.

- Fish will be placed in a tank large enough to hold them after removal from the net if required. The tank will be filled directly from the river as soon as the fish is netted to ensure temperature is comparable to the ambient river water.

APPENDIX C.

Incident Report: Take – Richmond – Dresden Bridge Replacement

Photographs should be taken and the following information should be collected from all salmon or sturgeon (alive and dead) found in association with the bridge replacement. Please submit all necropsy results (including sex and stomach contents) to NMFS upon receipt.

Observer's full name:____
Reporter’s full name:____

Species Identification:____

Describe construction activities ongoing within 24 hours of observation:____
____

Date animal observed:________________ Time animal observed: _______________________
Date animal collected:________________ Time animal collected:________________________

Environmental conditions at time of observation (i.e., tidal stage, weather):
____
____

Water temperature (°C) at site and time of observation:________________________
Describe location of fish and how it was documented (i.e., observer on boat):
____

Species Information:
Species ____________________________________

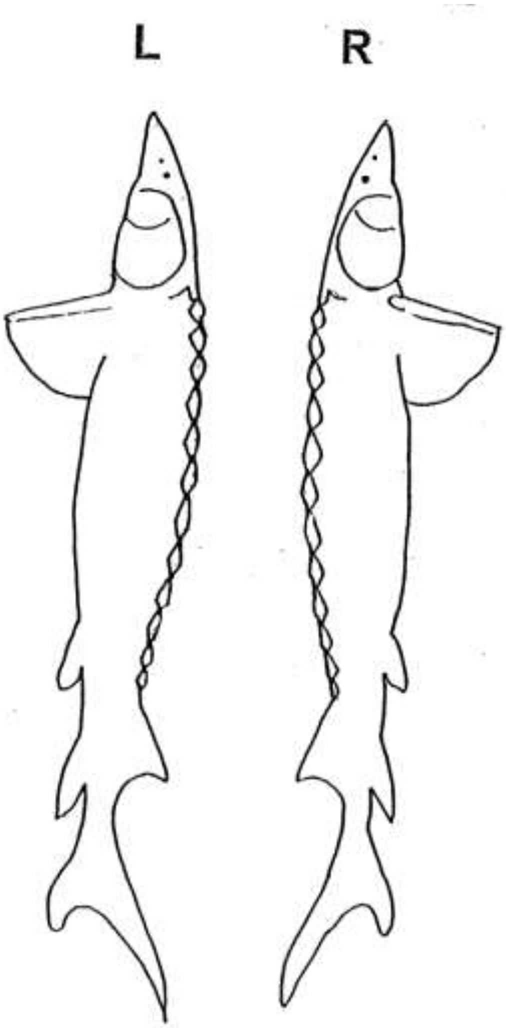
Fork length (or total length) ______________________ Weight ________________________

Condition of specimen/description of animal
____
____
____
____

Fish Decomposed: NO SLIGHTLY MODERATELY SEVERELY
Fish tagged: YES / NO *Please record all tag numbers.* Tag # ________________

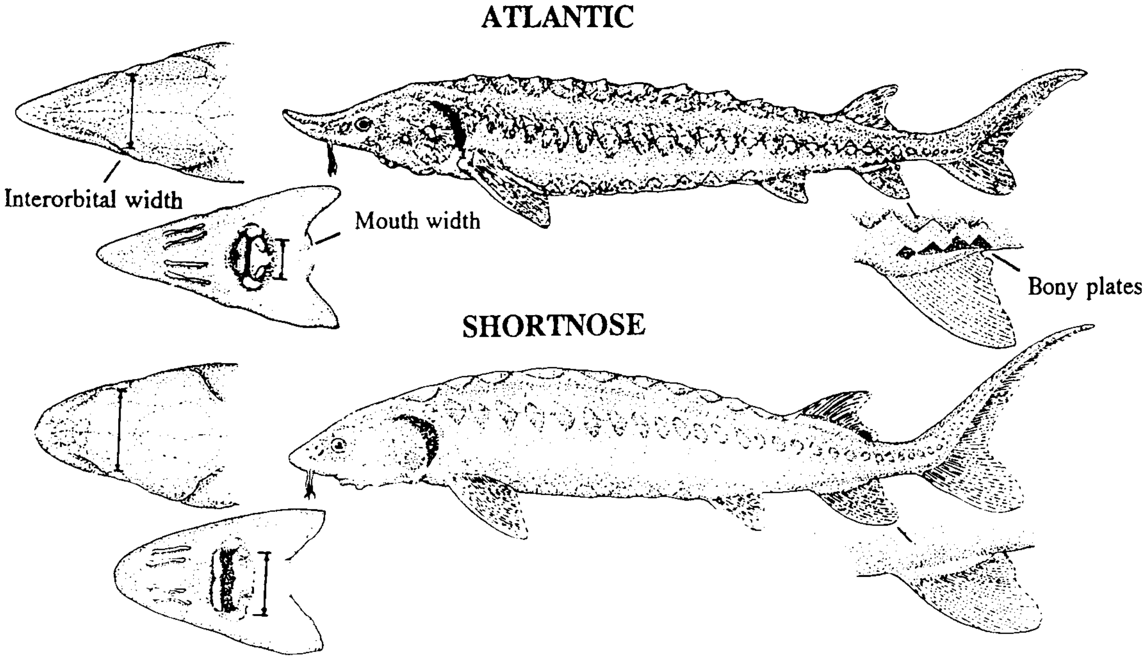
Photograph attached: YES / NO
(please label *species, date, geographic site* and *vessel name* on back of photograph)

Draw wounds, abnormalities, tag locations on diagram and briefly describe below



Description of fish condition:

Identification Key for Sturgeon Found in Northeast U.S. Waters



Distinguishing Characteristics of Atlantic and Shortnose Sturgeon

Characteristic	**Atlantic Sturgeon, *Acipenser oxyrinchus***	**Shortnose Sturgeon, *Acipenser brevirostrum***
Maximum length	> 9 feet/ 274 cm	4 feet/ 122 cm
Mouth	Football shaped and small. Width inside lips < 55% of bony interorbital width	Wide and oval in shape. Width inside lips > 62% of bony interorbital width
*Pre-anal plates	Paired plates posterior to the rectum & anterior to the anal fin.	1-3 pre-anal plates almost always occurring as median structures (occurring singly)
Plates along the anal fin	Rhombic, bony plates found along the lateral base of the anal fin (see diagram below)	No plates along the base of anal fin
Habitat/Range	Anadromous; spawn in freshwater but primarily lead a marine existence	Freshwater amphidromous; found primarily in fresh water but does make some coastal migrations

* From Vecsei and Peterson, 2004

APPENDIX D.

Procedure for obtaining fin clips from sturgeon for genetic analysis

Obtaining Sample

1. Wash hands and use disposable gloves. Ensure that any knife, scalpel or scissors used for sampling has been thoroughly cleaned and wiped with alcohol to minimize the risk of contamination.

2. For any sturgeon, after the specimen has been measured and photographed, take a one-cm square clip from the pelvic fin.

3. Each fin clip should be placed into a vial of 95% non-denatured ethanol and the vial should be labeled with the species name, date, name of project and the fork length and total length of the fish along with a note identifying the fish to the appropriate observer report. All vials should be sealed with a lid and further secured with tape Please use permanent marker and cover any markings with tape to minimize the chance of smearing or erasure.

Storage of Sample

1. If possible, place the vial on ice for the first 24 hours. If ice is not available, please refrigerate the vial. Send as soon as possible as instructed below.

Sending of Sample

1. Vials should be placed into Ziploc or similar resealable plastic bags. Vials should be then wrapped in bubble wrap or newspaper (to prevent breakage) and sent to:

   Julie Carter
   NOAA/NOS – Marine Forensics
   219 Fort Johnson Road
   Charleston, SC 29412-9110
   Phone: 843-762-8547

   a. Prior to sending the sample, contact Russ Bohl at NMFS Northeast Regional Office (978-282-8493) to report that a sample is being sent and to discuss proper shipping procedures.