



NOAA FISHERIES

Protected Resources Division

This Biological Opinion is no longer active.

Please visit

<http://www.greateratlantic.fisheries.noaa.gov/protected/section7/bo/actbo.html>

to find active Biological Opinions.



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

APR 25 2012

**NATIONAL MARINE FISHERIES SERVICE
ENDANGERED SPECIES ACT
BIOLOGICAL OPINION**

Agency: National Marine Fisheries Service, Northeast Fisheries Science Center, Maine Field Station

Activity Considered: F/NER/2011/06273

Conducted by: National Marine Fisheries Service
Northeast Region

Date Issued: _____

Approved by: 
fos Daniel S. Morris
Acting Regional Administrator

INACTIVE



Table of Contents

| | |
|--|-----------|
| 1. INTRODUCTION AND BACKGROUND | 4 |
| 1.1. Consultation History..... | 4 |
| 1.2. Application of ESA Section 7(a)(2) Standards – Analytical Approach | 4 |
| 2. DESCRIPTION OF THE PROPOSED ACTION | 5 |
| 2.1. Proposed Research Activities..... | 5 |
| 2.1.1 Beach Seine Activities | 5 |
| 2.1.2 Fyke Netting Activities | 7 |
| 2.1.3 Trawling Activities..... | 10 |
| 2.1.4 Hydroacoustic Activities (Mobile) | 12 |
| 2.1.5 Hydroacoustic Activities (Stationary)..... | 14 |
| 2.1.6 Pop Net Activities | 14 |
| 2.1.7 Plankton survey Activities..... | 16 |
| 2.1.8 Environmental monitoring Activities..... | 16 |
| 2.1.9 Habitat Mapping Activities | 17 |
| 2.1.10 Avian Survey Activities | 17 |
| 2.2. Action Area | 19 |
| 3. RANGEWIDE STATUS OF AFFECTED SPECIES AND CRITICAL HABITAT... 20 | 20 |
| 3.1. Shortnose Sturgeon..... | 20 |
| 3.1.1. Species Description | 20 |
| 3.1.2. Status and Trends of Shortnose Sturgeon Rangewide | 25 |
| 3.1.3. Summary of Factors Affecting Recovery of Shortnose Sturgeon..... | 25 |
| 3.1.4 Status of the Shortnose Sturgeon in the Action Area | 27 |
| 3.1.5. Factors Affecting Shortnose Sturgeon in the Action Area..... | 32 |
| 3.1.5.1 Dams and Hydroelectric Facilities | 32 |
| 3.1.5.2 Contaminants and Water Quality | 32 |
| 3.1.5.3 Conservation and Recovery Actions | 33 |
| 3.2. Atlantic Sturgeon | 33 |
| 3.2.1. Species Description | 33 |
| 3.2.2. Status and Trends of Atlantic Sturgeon Rangewide..... | 36 |
| 3.2.3. Summary of Factors Affecting Recovery of Atlantic Sturgeon | 38 |
| 3.2.4 Determination of Distinct Population Segment in the action area | 40 |
| 3.2.5. Status of the Atlantic Sturgeon in the Action Area | 40 |
| 3.2.6. Factors Affecting Atlantic Sturgeon in the Action Area | 49 |
| 3.2.6.1 Dams and Hydroelectric Facilites..... | 49 |
| 3.2.6.2 Contaminants and Water Quality | 49 |
| 3.2.6.3 Conservation and Recovery Actions | 50 |
| 4. ENVIRONMENTAL BASELINE OF THE ACTION AREA | 50 |
| 4.1. Formal or Early Section 7 Consultations | 50 |
| 4.2. Other Federal Actions in the Action Area | 51 |
| 4.3. Non-Federal Regulated Fishery Operations..... | 51 |
| 4.4. Global Climate Change | 51 |
| 4.5. Cumulative Threats from other sources in the Action Area..... | 52 |
| 4.6. Summary and Synthesis of Status of the Species and Environmental Baseline.... | 54 |

| | | |
|---------|---|----|
| 4.6.1. | Summary of Information on Shortnose Sturgeon in the Action Area | 54 |
| 4.6.2 | Summary of Information on Atlantic Sturgeon in the Action Area | 55 |
| 5. | EFFECTS OF THE ACTION | 57 |
| 5.1. | Effects to Shortnose Sturgeon From Research Activities | 57 |
| 5.1.1. | Effect of Beach Seine Activities | 57 |
| 5.1.2. | Anticipated Capture Rates..... | 58 |
| 5.1.3. | Entrapment and Handling | 58 |
| 5.1.4. | Migrational Delays..... | 58 |
| 5.1.5. | Effects of Fyke Netting Activities | 59 |
| 5.1.6. | Anticipated Capture Rates..... | 59 |
| 5.1.7. | Entrapment and Handling | 62 |
| 5.1.8. | Migrational Delays..... | 63 |
| 5.1.9. | Effects of Trawling | 63 |
| 5.1.10. | Anticipated Capture Rates..... | 64 |
| 5.1.11. | Entrapment and Handling | 65 |
| 5.1.12. | Migrational Delays..... | 65 |
| 5.1.13 | Effects of Other Research Activities | 65 |
| 5.2. | Effects to Atlantic Sturgeon From Research Activities | 66 |
| 5.2.1. | Effects of Beach Seine Activities | 67 |
| 5.2.2. | Anticipated Capture Rates..... | 67 |
| 5.2.3. | Entrapment and Handling | 68 |
| 5.2.4. | Migrational Delays..... | 68 |
| 5.2.5 | Effects of Fyke Netting Activities | 68 |
| 5.2.6. | Anticipated Capture Rates..... | 68 |
| 5.2.7. | Entrapment and Handling | 71 |
| 5.2.8. | Migrational Delays..... | 71 |
| 5.2.9. | Effects of Trawling | 72 |
| 5.2.10. | Anticipated Capture Rates..... | 72 |
| 5.2.11. | Entrapment and Handling | 73 |
| 5.2.12. | Migrational Delays..... | 73 |
| 5.2.13 | Effects of Other Research Activities | 73 |
| 6. | CUMULATIVE EFFECTS | 74 |
| 7. | INTERGRATION AND SYNTHESIS OF EFFECTS | 75 |
| 7.1 | Shortnose Sturgeon | 75 |
| 7.2. | Atlantic Sturgeon | 79 |
| 7.2.1 | Gulf of Maine DPS of Atlantic Sturgeon | 79 |
| 7.2.2 | New York Bight DPS of Atlantic Sturgeon..... | 82 |
| 8. | CONCLUSION | 84 |
| 9. | INCIDENTAL TAKE STATEMENT | 85 |
| 9.1. | Amount or Extent of Take | 85 |
| 9.2. | Reasonable and Prudent Measures | 87 |
| 9.3. | Terms and Conditions | 87 |
| 10. | CONSERVATION RECOMMENDATIONS | 89 |
| 11. | REINITIATION NOTICE | 89 |
| 12. | LITERATURE CITED | 90 |

1. INTRODUCTION AND BACKGROUND

This constitutes the National Marine Fisheries Service's (NMFS) biological opinion (Opinion), issued in accordance with Section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 et seq.), on the impacts to threatened and endangered species of the proposed Penobscot Estuarine Fish Community and Ecosystem Survey to be funded and carried out by the (NMFS Northeast Fisheries Science Center (NEFSC) Maine Field Station.

This Opinion is based in part upon NMFS' independent evaluation of the following: the Biological Assessment (BA) prepared by the NEFSC and received on December 23, 2011, and other sources of information. A complete administrative record of this consultation will be kept at the NMFS Northeast Regional Office. Formal consultation was initiated on December 23, 2011.

1.1 Consultation History

In 2010, the NEFSC conducted a pilot scale feasibility study to explore beach seining and fyke netting in limited areas of the Penobscot River. Consultation on the effects of the pilot study was completed in August 2010. It was determined that the proposed action was not likely to adversely affect shortnose sturgeon. No shortnose sturgeon were observed during the study.

In the fall of 2010, NEFSC and NMFS Protected Resources Division (PRD) staff discussed the sampling proposed for 2011. Like in 2010, the 2011 sampling plan was established to aid in the design of broader long term comprehensive ecosystem survey. Based on the geographic scope of the study and the proposed sampling methods, PRD recommended that NEFSC initiate Section 7 consultation to consider the effects of the proposed action on shortnose sturgeon.

On January 5, 2011, NMFS PRD received a request from the NEFSC for formal Section 7 consultation regarding the effects of the proposed fisheries study in the Penobscot River. The January 5, 2011, letter contained a Biological Assessment prepared by NEFSC concerning the effects of the project on listed shortnose sturgeon. A biological opinion (BO) was issued on March 28, 2011 which analyzed the effects of NEFSC research activities in 2011 and provided an incidental take authorization for shortnose sturgeon.

On December 23, 2011, NMFS PRD received a request from the NEFSC for formal Section 7 consultation regarding the effects of the proposed ecosystem survey to be conducted from 2012-2016 in the Penobscot River. The December 23, 2011, letter contained a Biological Assessment prepared by NEFSC concerning the effects of the project on listed shortnose sturgeon and proposed Atlantic sturgeon. As the submission from NEFSC contained all of the information necessary to conduct Section 7 consultation, the date of that letter serves as the date of initiation of this consultation.

1.2 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 United States Fish and Wildlife Service (USFWS). In conducting analyses of actions under Section 7 of the ESA, NMFS takes 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);
- Evaluates 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);
- Evaluates 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);
- Determines 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 5);
- Determines and evaluates any cumulative effects within the action area (Section 6); and,
- Evaluates 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 7).

In completing the last step, NMFS determines 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, NMFS 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, NMFS must rely on the best available scientific and commercial data.

2 DESCRIPTION OF THE PROPOSED ACTION

The NEFSC is continuing to develop and refine a long term study plan to evaluate the feasibility of various capture methods with the goal of establishing a comprehensive ecosystem survey to document the distribution and relative abundance of aquatic species in estuary and nearshore environments of the Penobscot River. The purpose of the proposed research survey is to develop consistent sampling methods and test efficacy of a variety of sampling techniques and gear types at numerous sites to measure estuary fish communities with a focus on diadromous fish species.

2.1 Proposed Research Activities

The proposed research project would use several gear types including mid-water trawling, fyke nets, beach seines, pop nets, and hydroacoustics to sample the fish and invertebrate community of the Penobscot estuary from the tidal portion of the river in Hampden through upper portions of Penobscot Bay near Islesboro (Figure 5). Sampling is proposed in multiple locations continuing annually from April 1, 2012 through November 31, 2016 (Figure 7). The proposed research activities and different gear types are outlined below.

2.1.1 Beach Seine Activities

NEFSC proposes to sample using a beach seine at 10-12 pre-selected sites bi-weekly from April to November during low tide. A total of 12 sites were identified in the proposed work plan as suitable long-term index sites for beach seining (Table 1 and Figure 7). Sites represent areas on both shores of the estuary as well as throughout the estuary salinity gradient (Figure 7). Sampling frequency will be spaced at approximately 7-14 days; this will be determined by weather, tides and other ongoing sampling efforts. Sampling will occur at, or near, low tide and upper and lower estuary sites will be sampled on separate days. Sampling will be conducted in favorable environmental conditions following water temperature thresholds identified in Table 4. The total annual effort will be approximately 14 sampling days and approximately 160 hauls.

Table 1: Beach seine site details for 2012-2016

| Site Code (incl. river km) | Site Name | Ecozone |
|----------------------------|--------------------------|---------|
| 1MAINST31.00 | Perc Plant | 2 |
| 1MAINST31.57 | Souadabscook Index | 2 |
| 1MAINST36.34 | Hughes Brothers | 2 |
| 1MAINST26.30 | Bald Hill Cove | 3 |
| 1MAINST27.66 | Snub Point | 3 |
| 1MAINST15.98 | Dracham Point | 4 |
| 1MAINST18.86 | Parker Point | 4 |
| 1MAINST21.75 | Oak Point | 4 |
| 1MAINST0.02-SC1 | Washout Eastern Channel | 6 |
| 1MAINST0.85-SC1 | Old Pier Eastern Channel | 6 |
| 1MAINST0.75 | Sandy Point | 6 |
| 1MAINST1.80 | South West Tip Verona | 6 |

The seines to be used are made of 5mm nylon mesh (delta style). The seines are 45.7m long by 2.4m high with a tapered 2.4m bag of 5mm mesh, with a weighted footrope and floats on the head rope. Wooden poles are lashed to the ends of each seine to aid in net retrieval. Beach seines will be deployed in an 'arc method' which involves deployment either by wading or via a small boat perpendicular to the shore. The seine will be deployed close (+/- 1 hour) to slack low tide to counter the effect of the current on interfering with the functioning of the net. The net will be towed against the current in a sweep encompassing as much of the net's area as possible. To deploy the beach seine and sample any catch should take approximately 5 minutes to haul and 10-15 minutes to process. Crews will consist of a NOAA-certified boat operator and/or a crew leader plus two to three additional biologists.

Biological data will be obtained from all species captured in the beach seine gear. The resultant fish catch will be sorted, identified to species, enumerated and total length measured. Where

there are numerous (>30) individuals of one species, a subsample of 30 individuals' total length will be measured. When possible the subsample of 30 individuals will be weighed to determine an average weight to develop biomass estimates for the entire catch. All fish will be released immediately after biological work-up. Crustaceans will be enumerated to lowest possible taxon group and carapace width taken. Large numbers of smaller pelagic crustaceans (e.g., sand shrimp) will be measured volumetrically and sample counts will be used to get an estimated total count. All unknown species and a periodic sample of individuals will be sacrificed and preserved in alcohol for positive identification in the lab. Additional selected species may be photographed, retained periodically for voucher collections or other research. All data will be recorded on the datasheet including time, date, tide, max seine depth, seine width, weather conditions, environmental parameters and crew. Resultant data will produce catch per unit effort (CPUE) values in fish per hour per set for the various species intercepted.

2.1.2 Fyke Netting Activities

NEFSC proposes to deploy fyke nets at six sites for ongoing systematic sampling from 2012-2016 (Table 2). It is important to choose the correct sampling locations in order to maximize gear effectiveness and increase spatial and temporal distribution. Site selection was determined in consultation with the University of Maine (UM) and Maine Department Marine Resources (MEDMR) to minimize any likelihood of encountering or capturing Atlantic or shortnose sturgeon.

The NEFSC proposes to fish two sizes of fyke nets (2m and 1m) in various locations throughout the study area. The fyke nets are constructed of successively smaller plastic coated square metal tube frames that are covered with mesh net (0.6cm for small, 1.9cm for large). Two 9.1m wings will extend from the opening of each fyke at an angle of approximately 45° when set (Figure 1) and may have a central lead of 9.1 to 18.2m (Figure 2). The wings and lead have a weighted footrope with floats on the head-rope and are the same height and comprised of the same net mesh as the fyke itself (either 0.91m or 1.83m high). Each fyke net has two throats tapering to a semi-rigid opening of 12.7cm for the small net and 45.7cm for the larger net. The fish pass through these throats before becoming trapped in the live car. For the large fyke (2m), the final compartment of the net is configured with a semi-rigid framed live car structure (2m x 1m x 1m). Access to the catch is through a large opening at the surface which allows for removal of catch directly from above the structure without having to haul the fyke net entirely. The small fyke has a sufficient volume (0.3m x 0.3m x 0.5m) to safely retain catch until the net is tended. An exclusion device is attached to the outer most throat of the larger 2m fyke net to stop marine mammals or larger fish from entering the net and becoming trapped. The configuration of the excluder consists of 1.27 cm (1/2 inch) aluminum bars oriented both vertically and horizontally as shown in Figure 3. This spacing between bars was decided based on similar exclusion devices placed in fishways on the Penobscot River at several hydroelectric facilities. The spacing of four to six inches prevents large animals from entering the facility, but allows for passage of numerous target species including river herring, eels, striped bass, and even multi sea-winter adult salmon. The 1m fyke has a relatively small, 12.7cm throat, thereby excluding mammals and large fish such as adult sturgeon.

The 2012-2016 study plan has proposed fyke netting to be conducted with both sized nets (1m and 2m) twice a week in the estuary from April to June and once a week from July to November (Table 2). Fyke nets will be set at low tide in various configurations and directions compared to river or tidal flow. Combinations of lead and wing lengths (multiples of 9.1m) will be used to establish the most effective method at each site. The nets will be secured at three points using 25lb mushroom type anchors at the end of each wing and at the cod end (Figure 1). Marker buoys will be attached to each of the three anchors to mark the location of the net for retrieval and as a notice to other boat traffic. The wings will be set first with the cod-end held in the boat until the net is stretched out fully and then released. The end anchors of the wings will be repositioned to configure an opening of approximately 30° relative to the net mouth. Deployments will be for two tidal cycles and nets will be checked at least daily. Crew will consist of a NOAA-certified boat operator and/or a Crew Leader plus two to three additional biologists.

Biological data will be obtained from all species captured in the fyke net gear. Hauling of the smaller fyke net after fishing should take approximately 30 minutes with processing time variable upon volume of catch. The larger 2m fyke net has a modified cod end/live car that serves as the temporary enclosure and sampling platform while working up the catch. The resultant fish catch will be sorted, identified to species, enumerated and total length measured. Where there are numerous (>30) individuals of one species, a subsample of 30 individuals' total length will be measured. When possible the subsample of 30 individuals will be weighed to determine an average weight to develop biomass estimates for the entire catch. All fish will be released immediately after biological work-up. Crustaceans will be enumerated to lowest possible taxon group, where possible. Large numbers of smaller pelagic crustaceans (e.g., pelagic shrimp) will be measured volumetrically and sample counts used to get an estimated count. All unknown species will be sacrificed and preserved in alcohol for identification in the lab. Additional selected species will be photographed, retained for voucher collections or other research. Additional selected species may be retained periodically for voucher collections or other research. All data will be recorded on the data sheet including: sample time start/end; date; GPS position; tide; depth; weather conditions; environmental parameters (temperature, salinity, dissolved oxygen (DO)); and crew. Resultant data will produce CPUE values in fish per hour per set for the various species intercepted. Crews will consist of a NOAA-certified boat operator and/or a crew leader plus two to three additional biologists.

Table 2: Proposed 2012-2016 Fyke/Trap netting sites and sampling effort (fyke set = 24 hours)

| | Site Name | Number of Sampling Events per Month | | | | | | | |
|------|--------------------------------|-------------------------------------|-----------|-----------|-----------|-----------|-----------|-----------|------------|
| | | April | May | June | July | Aug | Sept | Oct | Total |
| Fyke | Snub Point Fyke Index (2m) | 8 | 8 | 8 | 4 | 4 | 4 | 4 | 40 |
| | Bald Hill Cove Fyke Index (1m) | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 14 |
| | Chipmans Fyke Index (2m) | 8 | 8 | 8 | 4 | 4 | 4 | 4 | 40 |
| | Marsh Stream Fyke Index (1m) | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 14 |
| | South West Tip Verona (1m) | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 14 |
| | Orland Outlet (1m) | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 14 |
| | Total Sampling events | 24 | 24 | 24 | 16 | 16 | 16 | 16 | 136 |

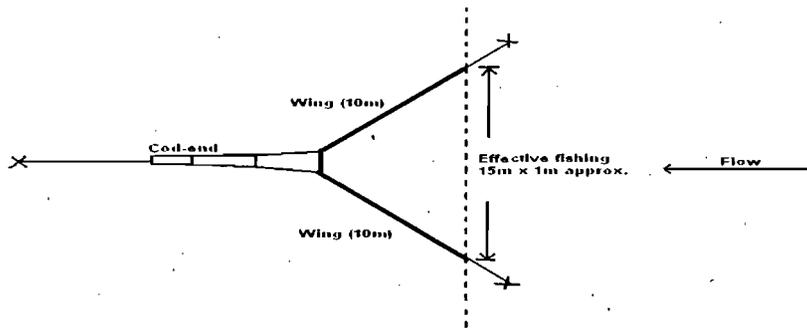


Figure 1: Sketch of 1m fyke net showing configuration for sampling a channel and effective fishing area.

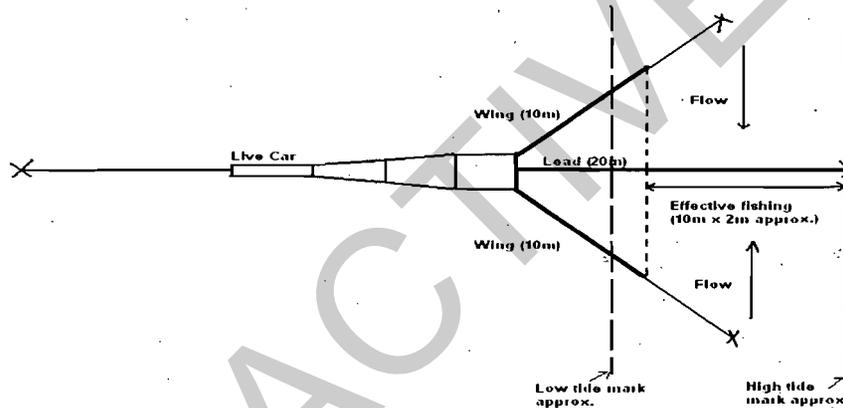


Figure 2: Sketch of 2m fyke net deployment. Orientation is perpendicular to flow with 20m central lead at approximately high tide mark. The net fishes both directions when there is sufficient water depth between the high tide mark and the ends of the wings. Wings are at 45° from the mouth of the net. The net is not fishing for an hour either side of low tide approximately, as there is insufficient water in the area between wings and lead. During 2 tidal cycles (24 hours), this is approximately 4 hours not effectively fishing.

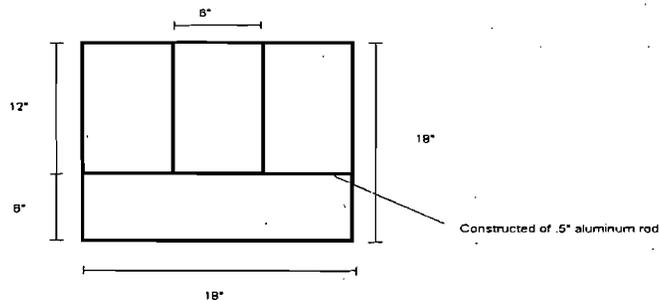


Figure 3: Excluder Device installed on entrance to 2m fyke net

2.1.3 Trawling Activities

NEFSC proposes to use trawl gear similar to the previous research survey conducted in 2011. A modified commercial fishing vessel will be contracted and chartered to conduct the trawling for the NEFSC ecosystem survey (2012-2016). Trawling will be conducted in those areas with sufficient depth and channel width to operate the gear safely and effectively. Trawling at various depths will be attempted to compare species assemblage at each stratum. Depths will mostly range from surface to mid-water; however, some trawls may be fishing in close proximity to the bottom, depending on overall depth of water column. Additionally, trawl gear can be used in conjunction with other less invasive survey methods such as hydro-acoustics and may be fished at greater depths to sample and identify organisms for validation of the different species detected by these gear types. As such, NEFSC proposes to trawl in areas sampled by other gear types used in this survey and other (e.g., post-smolt trawl) surveys to compare catch rates, species composition and size ranges with various gear types.

The ecosystem survey study area will encompass the estuary from Hampden seaward to the northern-most tip of Islesboro in areas 50-100m from shore and with depths from 10-100m (Figure 5 and 7). Specific locations for each trawl will be determined by a systematic sampling design whereby defined transects will be predetermined and repeated for each sampling event. However, the exact starting point for each tow may be altered to avoid the presence of natural obstructions, moored gear, and vessel traffic. Annual sampling efforts are anticipated to be approximately 16 days at sea and approximately 200 tows (~ 100 hrs actively fishing) from April through November. Sampling frequency will be every 7-10 days during the peak of diadromous activity (April – June) and then 7-20 days during the remainder of the season (Table 3). The trawl will be towed for approximately 20 minutes and any resulting catch will be worked up immediately. Depending on the catch rates and sea conditions for any given day, up to 12 sites can be sampled.

Biological data will be obtained from all species captured in the mid-water trawl gear. Each time the trawl net is hauled back, the resultant fish catch will be sorted, identified to species, enumerated and total length measured. Any ESA species, Atlantic salmon or sturgeon encountered will be handled first and if appropriate, placed in holding tank to recover before being released; otherwise, sturgeon will be released immediately. Where there are numerous (>30) individuals of one species, a subsample of 30 individual's total length will be measured. When possible the subsample of 30 individuals will be weighed to determine an average weight to develop biomass estimates for the entire catch. All fish will be released immediately after biological work-up. Crustaceans will be enumerated to lowest possible taxon group, where possible. Large numbers of smaller pelagic crustaceans (e.g., pelagic shrimp) will be measured volumetrically and sample counts used to get an estimated count. All unknown species will be sacrificed and preserved in alcohol for identification in the lab. Additional selected species may be photographed, retained for voucher collections or other research coordinated with additional researchers. All data will be recorded on the datasheet including: sample time; trawl position start/end; date; Universal Transverse Mercator (UTM) start/end; engine RPM; vessel speed; compass bearing of tow; tide; trawl depth; channel depth; weather conditions; environmental parameters (temperature, salinity, DO); and crew. Hauling of the net after fishing should take approximately 5 minutes with processing time variable upon volume of catch. Resultant data

will produce CPUE values in fish per hour per set for the various species intercepted.

The trawl net is constructed of High Density Polyethylene (HDPE) twine and measures 12m (head rope) by 6m (vertical). The body of the trawl net is comprised of various decreasing sized mesh from 19mm (0.75in), to 6.35mm (0.25 inches) at the cod end. The cod end has been modified to include an aluminum box “aquarium” or live car that reduces the velocity of the water passing through the net while retaining any catch in an oxygen rich environment. The aquarium interior dimensions are 0.3m (12 inches) high X 0.4m (16 inches) wide X 0.635 m (25 inches) long for a volume of approximately 76 L. There are 1066mm (42 inches) x 533mm (21 inches) doors and the net will be towed with 27m bridles approximately 110m from the vessel. This custom net was designed to allow for small boat operation (<500hp) and relatively quick sampling speeds (>3 knots). An example of the type of trawl net is shown in Figure 4 below.

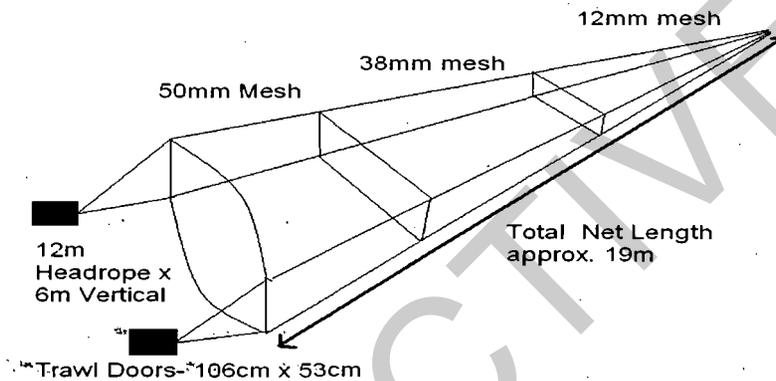


Figure 4: Example of the proposed type of trawl net to be used; the modified cod end is not shown.

Table 3: Proposed 2012-2016 trawl sampling effort (sample = @ 20 min tow)

| EcoZone | Number of Samples per Month | | | | | | | |
|--------------|-----------------------------|-----------|-----------|-----------|-----------|-----------|-----------|------------|
| | April | May | June | July | Aug | Sept | Oct | Total |
| 4 | 6 | 12 | 6 | 4 | 4 | 4 | 4 | 40 |
| 5 | 6 | 12 | 6 | 4 | 4 | 4 | 4 | 40 |
| 6 | 6 | 12 | 6 | 4 | 4 | 4 | 4 | 40 |
| 7 | 6 | 12 | 6 | 4 | 4 | 4 | 4 | 40 |
| 8 | 6 | 12 | 6 | 4 | 4 | 4 | 4 | 40 |
| Total | 30 | 60 | 30 | 20 | 20 | 20 | 20 | 200 |

Table 4: Water temperature thresholds identified for handling guidelines

| Water Temperature | Sampling and Handling |
|-------------------|-----------------------|
| < 20°C | All sampling allowed |
| 20°C - 25°C | *Minimal handling |
| >26°C | No sampling allowed |

*minimal handling requires releasing sturgeon immediately without weighing and measuring

2.1.4 Hydroacoustic Activities (mobile)

Hydroacoustic techniques will be used to survey fish biomass and distribution as part of the overall stock assessment in the estuary. Hydroacoustic equipment emits sound waves into the surrounding water and receives a reflected signal back from solid objects or fish encountered during the survey. A portable SIMRAD EK60 echosounder with 38- and 120 kHz split-beam transducers operating under SIMRAD controlling software will be used to produce echograms of mobile transects. The transducers will be pole-mounted from the side of the survey boat and the transducer face situated at 0.5 meter below the surface of the water.

There are 2 possible methods for setting up hydroacoustic transects as follows:

1. The echo-sounders will be deployed alongside the trawling gear. This will have the added benefit of directly sampling the catch while the echosounder is running and calibrating it at the same time. Transects will be decided on beforehand in discussion with the boat captain, but will generally be a few short tows (10-30 minutes) in each of the arbitrary eco-zones in relatively deep water (>10m).
2. From the smaller NOAA vessel, sets of 5 transects will be established within each of these eco-zones using hand held GPS devices. The 5 discrete systematic parallel transects will be set up approximately 0.5km apart in each eco-zone, perpendicular to the shore. Each transect length will vary depending on the site and width of the estuary at that site, but they are not expected to be more than 0.5km.

All data will be recorded on the datasheet including time, date, tide, depth, weather conditions, environmental parameters and crew. Some of these parameters will be recorded automatically on the sonar files, including; GPS data, time, depth, speed, water temperature, etc.

The project has established 5 arbitrary eco-zones within the estuary, which are based on previous work done by NMFS NEFSC staff; in particular, as a result of telemetry work done on Atlantic salmon in the estuary (Figure 5). The delineation of these arbitrary zones is in part geographic and in part the salinity regime expected at those sites. Transects will be set up in all zones. Sites range from near full freshwater (with tidal influence) at Hampden to near full salinity in the vicinity of Sandy Point/Fort Point. GPS positions will be taken to incorporate results into mapping software. Salinity and temperature in the estuary will drive distributions; therefore it is important to establish a systematic approach to sampling the entire gradient of environmental parameters in the estuary as much as feasibly possible.

The survey design for hydroacoustics sampling will be an adaptive systematic approach along pre-determined transects. Transects will be agreed upon beforehand and spread out evenly over the geographic range of the estuary, within each of the Ecozones (Figure 5). As knowledge on the distributions and timing of species in the estuary increases, it is envisaged that the sampling design can be adapted and targeted to effectively sample those distributions in future years. There will be an opportunity to conduct the complete survey of transects once in April, June and September 2011. Total annual effort will be approximately 36 sampling days and approximately 200 transects.

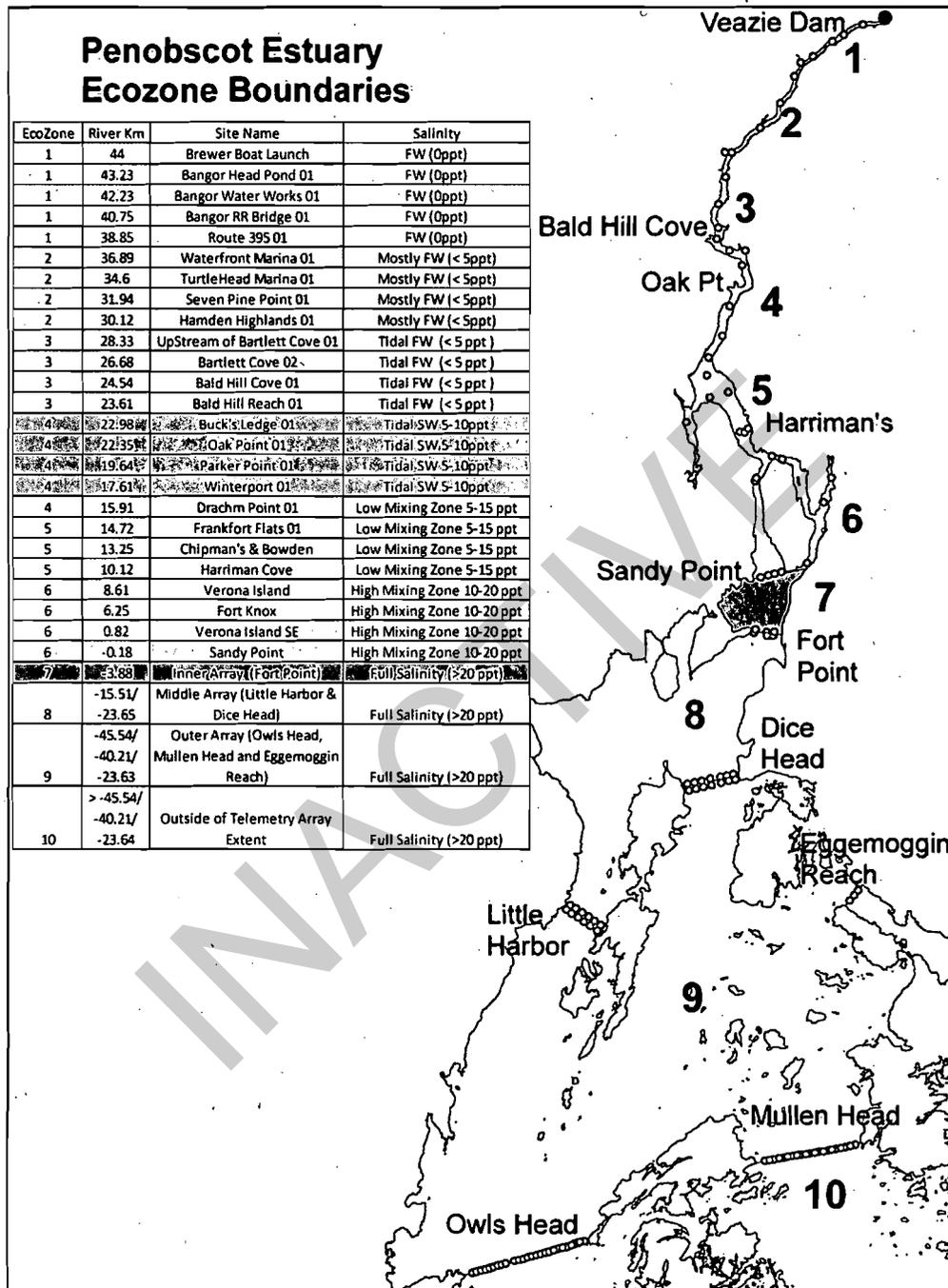


Figure 5: Eco-Zone areas as defined by NMFS biologists

Standard echo integration techniques will be used to estimate the numerical abundance and biomass density of fish. Visual scrutiny of echograms will be conducted in the field to estimate fish aggregations allowing for a certain degree of adaptive sampling to be conducted in subsequent surveys, particularly in 2012, for example. Full analyses of the hydroacoustic data

will be carried out later using Echoview software (Echoview, Hobart, Australia). The target threshold will be set to -70 dB and all other tracking parameters set to default values. The data will be analyzed from a range of 2 meters from the face of the transducer, to the seabed, outside the near-field where interference with bubbles would distort the data. The mean target strength of each fish track produced by Echoview could be converted to fish length using for example, the relationship described by Love (1971), $TS = (19.1 \log L) - (0.9 \log F) - 62.0$ where TS is target strength in dB, L is fish length in cm, and F is frequency in kHz, although there are other equations/relationships that will be considered. Mean target strengths of each fish echo will be categorized into length classes, the target strength distributions being used to assign species identity. Echograms from each transect will be categorized into 1m deep strata from a depth of 2m below the transducer surface down to the bottom. The bottom will be defined manually, if necessary. Horizontal strata will be in the region of 0.5km (transect length). Counts will be converted to fish densities expressed as individuals per volume of water.

2.1.5 Hydro-acoustic Activities (stationary)

Dual-frequency identification sonar (DIDSON, Sound Metrics) operates at high resolution and its rapid refresh rates allow it to perform better than optical systems in turbid water, making it ideal for use in estuaries. The DIDSON operates at two frequencies, 1.8 MHz or 1.0 MHz, and forms 96 beams spaced 0.3° apart or 48 beams spaced 0.6° apart, respectively. The unit being deployed can provide an image range out to 12 m at 1.8 MHz and 40 m at 1.0 MHz

The DIDSON will be mounted on a rigid structure, with the transducer pointing horizontally across the estuary to incorporate the entire water column. The DIDSON will be used to acquire visual acoustic images of fish from a stationary position as they pass the field of view. The efficiency is enhanced when the device is set up where the passing of fish is predicted. The concentration of fish can be artificially enhanced by configuring it with the fyke/trap net or some other herding device, like a fyke or curtain net. Otherwise it can be placed at a narrow point in the estuary or a channel between structures where fish numbers will be enhanced naturally. When used in conjunction with the fyke net, the net will be configured in a way that allows fish to pass through the net without being captured. The DIDSON will be set up to analyze fish as they escape the fyke net. It is envisaged that the larger 2m fyke will be used with the DIDSON.

A systematic approach to survey design will be undertaken when appropriate sites are selected. It is envisaged that less than five sites will be selected for ongoing systematic fyke net sampling with the attached DIDSON. Sampling will be conducted on a number of occasions in the estuary from April to November and the fyke/DIDSON configuration will be in the water and fishing for some of these events.

2.1.6 Pop Net Activities

The pop net proposed (Figure 6) will be a modified frame trawl with a rigid mouth of 3.05m x 3.05m square and an overall length of approximately 8 meters and constructed with a large, outer mesh with a gradient of mesh sizes (10.2, 7.6, 3.8, 1.9, and 1.3cm with 0.6cm cod-end). Fish will be trapped in a cod-end.

The pop net will be lowered until the body of the net collapses and the mouth rests on the bottom. After settling approximately 15 minutes (or longer) on the bottom, the net will be

manually retrieved vertically, sampling fish in the water column. Sonar techniques can guide when fish are in the sampling area, and night time sampling will be conducted with a high powered lamp above the surface of the water to attract fish to the area. This is a biased approach, but will give a useful index of the fish found in an area and will enhance the calibration technique for the sonar.

Pop nets will be used in conjunction with the hydroacoustic transects (for calibration) and also trialed as a method for random sampling throughout the estuary, especially in hard to reach areas. This provides a very versatile method of sampling. GPS positions will be taken to incorporate results into mapping software. It is envisaged that the pop net will be used throughout the estuary.

Survey design will be a random sampling approach. The study area from Islesboro to Hampden will be divided into 100m blocks and selected at random within each eco-zone proportional to each zone's area (Figure 5). Sites will then be selected at random within each block. Sites will also be non-randomly selected to overlap with other gear types to evaluate catch rates, species composition and size ranges compared to the other gear types. The pop net will be deployed weekly from April to November. Anticipated total effort will be approximately 30 sampling days and approximately 150 hauls.

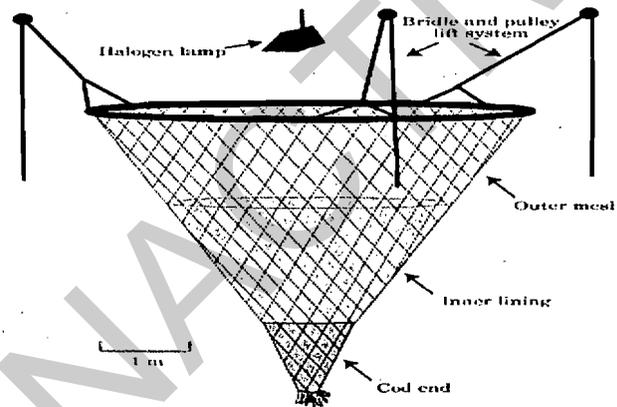


Figure 6: The design of the pop net will be similar to one used by Hagan and Able (2003), as shown

Biological data will be obtained from all species captured in the pop net gear. The resultant fish catch will be sorted, identified to species, enumerated and total length measured. Where there are numerous (>30) individuals of one species, a subsample of 30 individuals' total length will be measured. When possible the subsample of 30 individuals will be weighed to determine an average weight to develop biomass estimates for the entire catch. All fish will be released immediately after biological work-up. Crustaceans will be enumerated to lowest possible taxon group, where possible. Large numbers of smaller pelagic crustaceans (e.g., pelagic shrimp) will be measured volumetrically and sample counts used to get an estimated count. All unknown species will be sacrificed and preserved in alcohol for identification in the lab. Additional selected species will be photographed, retained for voucher collections or other research. All

data will be recorded on the datasheet including: sample time start/end; date; GPS position; tide; depth; weather conditions; environmental parameters (temperature, salinity, DO); and crew. Hauling of the net after fishing should take approximately 1 minute with processing time variable upon volume of catch. Additional selected species may be retained periodically for voucher collections or other research. Crews will consist of a NOAA-certified boat operator and/or a crew leader plus two to three additional biologists.

2.1.7 Plankton Survey Activities (zoo- and phyto-)

There are a number of methods that will be tested for sampling zooplankton, including volumetric integrated water column sampling (e.g., 30-50 liters), volumetric surface sampling (30-50 liters) and timed surface tow (e.g., 1-3 minute). Samples will be stored in alcohol (Lugol's solution) and individuals will be enumerated per volume and identified to species with a microscope in the laboratory afterwards. Phytoplankton will be sampled from either standard surface or integrated water samples or with a plankton net with $<50\mu\text{m}$ mesh. Standard nylon plankton nets (50cm mouth diameter opening, 150cm long and 120 μm mesh size for zooplankton ($<50\mu\text{m}$ for phytoplankton)) will be used to collect samples of phytoplankton.

The sample design will be systematic, with the emphasis on quantifying the presence of species. Samples will be taken once a week. Sampling stations will be set up beforehand to include upper, mid and lower estuary sites, most likely corresponding with the continuous monitoring sites set up for other environmental and biological monitoring. GPS positions will be taken to incorporate results into mapping software. Anticipated total effort will be approximately 30 sampling days and approximately 180 samples.

2.1.8 Environmental Monitoring Activities

A hand-held YSI probe (model 85 – 10FT) will be used to measure temperature, dissolved oxygen and salinity at each sampling event (e.g., seining, fyke-netting, trawling, pop-net and hydroacoustics). This method is adequate to give an accurate account of local surface conditions at the point of sampling. A standard secchi disk will be used to get a measurement of water clarity.

Monitoring buoys (YSI model 6920V2 or similar) will be used to continuously monitor environmental parameters (temperature, salinity, dissolved oxygen, turbidity and chlorophyll) at pre-determined stations in the estuary. The sensors will be copper-encased and have a copper guard to protect from bio-fouling. The sonde will have optical sensors for oxygen, turbidity and chlorophyll.

Salinity, temperature and dissolved oxygen will be measured locally at each sampling event using a hand-held YSI probe. The hand-held probe will be calibrated for 100% dissolved oxygen each sampling day. GPS coordinates at each event will be taken also. This will give an accurate indication of local conditions at the point of sampling. Care will be taken to select a sampling area that was representative of the site, and not affected for instance by disturbance created by the boat or other sampling activities. Parameters will be recorded on the datasheet.

Continuous monitoring stations will be set up in 3 locations, one in the upper estuary, one in the area around Bucksport and one in the vicinity of Sandy point. A hand-held probe with a long cable will be used to get depth profiles of environmental parameters at sampling sites. GPS

positions will be taken to incorporate results into mapping software.

The preferred approach will be to have a continuous monitoring station at selected points in the estuary, to pick up broader fluctuations, particularly salinity, temperature and turbidity. Ideally dissolved oxygen and chlorophyll should also be measured. There are areas in the estuary where mixing is likely to have a more localized affect and it may be useful to deploy a monitoring buoy in these regions. The continuous monitoring buoy will monitor environmental parameters from April to November at a frequency of every 15 minutes. There will be collaboration in the collection of environmental data, including with Maine Maritime Academy and Northeast Salmon team.

2.1.9 *Habitat Mapping Activities*

A visual shoreline habitat survey will be conducted to improve the maps currently available. This will be in addition to the sub-tidal survey. Both surveys will involve taking GPS positions to incorporate into mapping software.

A 6x6x6" Eckman grab sampler with a trigger mechanism will be used to sample the sub-tidal substrate. The shoreline survey will be visual, using best judgment from NOAA staff scientists. Data will be recorded on a data sheet.

The grab will be lowered by a line and the impact on the bottom will trigger the release mechanism, capturing a sample. After hauling to the surface, the substrate will be analyzed and assigned a category; for example; mud, sandy mud, muddy sand, sand, gravel, stones, rocks/hard. Plant material will also be identified.

The shoreline survey will involve conducting the habitat mapping from a boat. Initial effort will be focused on beach seine and fyke net sites. In the future, NEFSC plans to conduct a thorough estuarine-wide substrate survey; however, a timeframe for this study has not yet been identified.

The survey design will be systematic, along pre-determined transect lines from shore to shore across the estuary. All eco-zones will be covered to try and quantify the bottom habitat for a broad area of the estuary (Figure 5).

2.1.10 *Avian and Marine Mammal Monitoring Activities*

As part of the Penobscot survey, a systematic approach will be implemented to quantify avian and marine mammal presence in the estuary. As part of this a combination of transect and fixed video monitoring will be conducted. Data will consist of species abundance and behavioral characteristics to correspond with the fisheries and environmental monitoring. This data collection will be coordinated with the other sampling. These surveys will be visual with no attempt to interact with marine mammals or avian species.

Table 5 Proposed sampling effort by Eco-zone and gear type

| Eco zones (River Kilometer) | Sampling (days) | Total sampling effort (hrs) |
|---|-------------------|-----------------------------|
| 1 (Rkm 44-39) | NONE | 0 |
| 2 (Rkm 38-30) | Beach seines (42) | 10.5 |
| 3 (Rkm 29-24) | Fyke net 2m (40) | 800 |
| | Fyke net 1m (14) | 140 |
| | Beach seines (28) | 7 |
| 4 (Rkm 23-16) | Beach seines (42) | 10.5 |
| | Trawls (40) | 13 |
| 5 (Rkm 16-10) | Fyke net 2m (40) | 800 |
| | Fyke net 1m (14) | 168 |
| | Trawl (40) | 13 |
| 6 (Penobscot Bay 10-0) | Beach seines (56) | 14 |
| | Fyke net 2m (14) | 280 |
| | Fyke net 1m (14) | 168 |
| | Trawls (40) | 13 |
| <i>Below saltwater wedge (salinity > 20 ppt)</i> | | |
| 7 (Penobscot Bay) | Trawl (40) | 13 |
| 8 (Penobscot Bay) | Trawl (40) | 13 |
| Total | 504 events | 2463 hrs |

Source: NEFSC Biological Assessment

2.2 Action Area

The action area is defined in 50 CFR 402.02 as “all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action.” The action area for this consultation includes the area where the proposed sampling and monitoring activities will take place. As identified in the NEFSC 2012-2016 sampling plan within the BA (O’Malley *et al.*, 2012), this area consists of the Penobscot estuary from the tidal portion of river in Hampden through upper portions of Penobscot Bay near Islesboro (Figure 7).

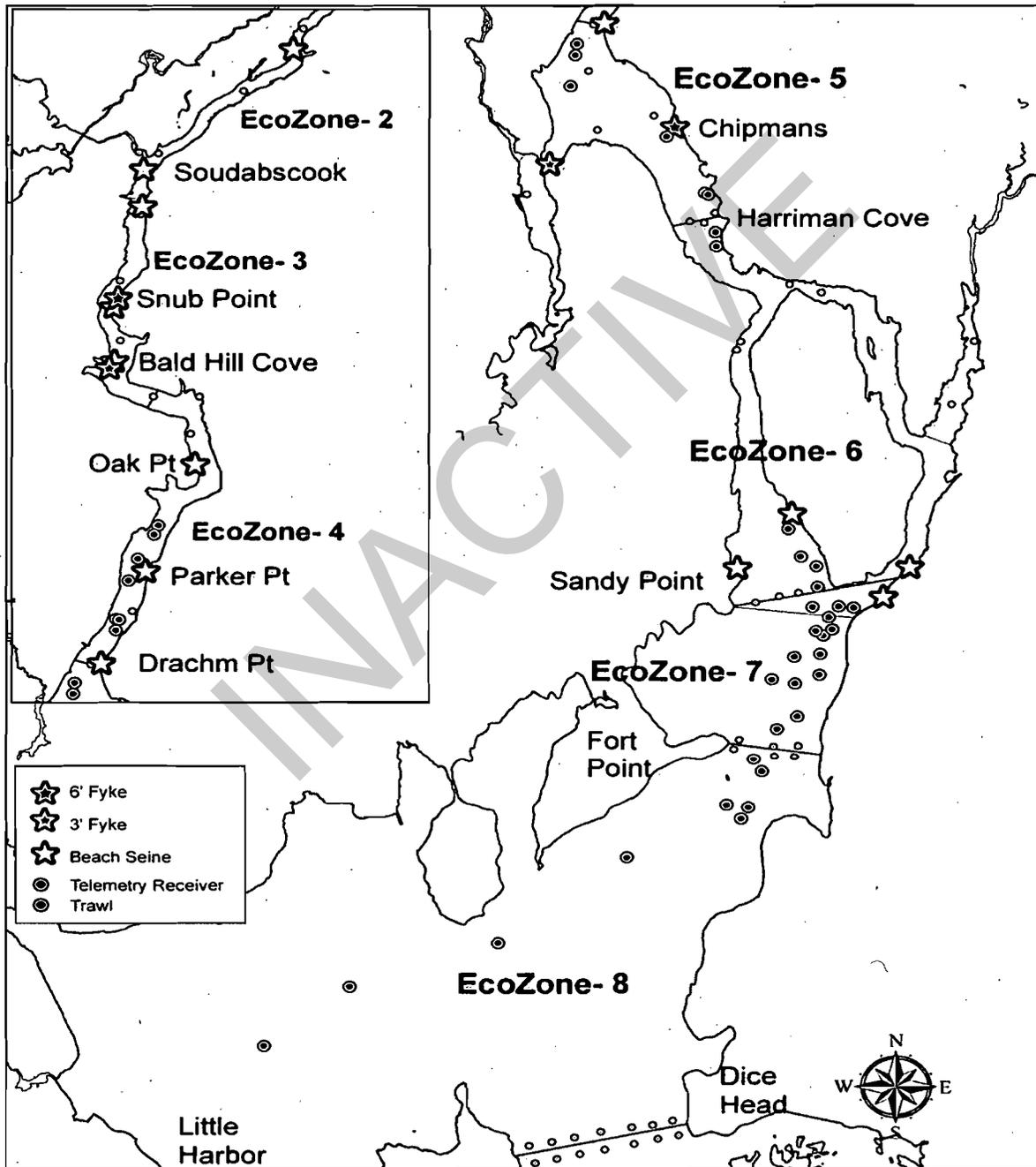


Figure 7: Map of Penobscot Bay EcoZones showing areas to be surveyed by each gear type.

3. RANGEWIDE STATUS OF AFFECTED SPECIES AND CRITICAL HABITAT

This section presents biological and ecological information relevant to formulating the Biological Opinion. Information on each species' life history, its habitat and distribution, and other factors necessary for its survival are included to provide background for analyses in later sections of this opinion. This section reviews the status of each of these species rangewide as well as within the Penobscot River.

Listed Species in the Action Area

Endangered shortnose sturgeon (*Acipenser brevirostrum*) occur in the action area. Additionally, New York Bight (NYB) and Gulf of Maine (GOM) Distinct Population Segments (DPSs) of Atlantic sturgeon occur in the action area. NMFS published a final listing rule on February 6, 2012 listing four DPSs as endangered (New York Bight, Chesapeake Bay, Carolina, and South Atlantic) and one DPS as threatened (Gulf of Maine). The effective date of the listing is April 6, 2012. NMFS has determined that the action being considered in this Opinion may affect the endangered shortnose sturgeon (*Acipenser brevirostrum*), endangered NYB and threatened GOM Atlantic sturgeon (*Acipenser oxyrinchus*). At this time, NMFS has not designated or proposed designating critical habitat for shortnose sturgeon or for any DPS of Atlantic sturgeon.

The GOM DPS of Atlantic salmon (*Salmo salar*) occurs in the action area. NMFS holds an ESA Section 10 (a)(1)(A) research permit (ESA permit 697823) from the U.S. Fish and Wildlife Service (USFWS). This Section 10 research permit allows NMFS and any designated subpermittee to engage in research, recovery, management, and assessment activities involving listed Atlantic salmon (*Salmo salar*) in Maine. As all effects to Atlantic salmon resulting from the proposed action will be considered and authorized under the Section 10 permit, any effects to Atlantic salmon will not be further considered in this Opinion.

3.1 Shortnose sturgeon

The section below describes the shortnose sturgeon life history and population trends; in addition, various factors affecting the survival of the species throughout their range are highlighted. Below, we also provide a description of the status of shortnose sturgeon in the action area and provide information on the use of the action area by shortnose sturgeon.

3.1.1 Species Description

Shortnose sturgeon are benthic fish that mainly occupy the deep channel sections of large rivers. They feed on a variety of benthic and epibenthic invertebrates including mollusks, crustaceans (amphipods, chironomids, isopods), and oligochaete worms (Vladykov and Greeley, 1963; Dadswell, 1979 in NMFS, 1998). Shortnose sturgeon have similar lengths at maturity (45-55 cm fork length) throughout their range, but, because sturgeon in southern rivers grow faster than those in northern rivers, southern sturgeon mature at younger ages (Dadswell *et al.*, 1984). Shortnose sturgeon are long-lived (30-40 years) and, particularly in the northern extent of their range, mature at late ages. In the north, males reach maturity at five to ten years, while females mature between seven and thirteen 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)¹ when the freshwater temperatures increase to 8-9°C. Several published reports have presented the problems facing long-lived species that delay sexual maturity (Crouse *et al.*, 1987; Crowder *et al.*, 1994; Crouse, 1999). In general, these reports concluded that animals that delay sexual maturity and reproduction must have high annual survival as juveniles through adults to ensure that enough juveniles survive to reproductive maturity and then reproduce enough times to maintain stable population sizes.

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

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

In populations that have free access to the total length of a river (e.g., no dams within the species' range in a river: Saint John, Kennebec, Altamaha, Savannah and Delaware Rivers), spawning areas are located at the farthest upstream reach of the river (NMFS, 1998). In the northern extent of their range, shortnose sturgeon exhibit three distinct movement patterns. These migratory movements are associated with spawning, feeding, and overwintering activities. In spring, as water temperatures rise above 8°C, 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

¹ For purposes of this consultation, Northern rivers are considered to include tributaries of the Chesapeake Bay northward to the St. John River in Canada. Southern rivers are those south of the Chesapeake Bay.

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 - 12°, and bottom water velocities of 0.4 to 0.7 m/sec (Dadswell *et al.*, 1984; NMFS, 1998). For northern shortnose sturgeon, the temperature range for spawning is 6.5-18.0°C (Kieffer and Kynard in press). Eggs are separate when spawned but become adhesive within approximately 20 minutes of fertilization (Dadswell *et al.*, 1984). Between 8° and 12°C, eggs generally hatch after approximately 13 days. The larvae are photonegative, remaining on the bottom for several days. Buckley and Kynard (1981) found week old larvae to be photonegative and form aggregations with other larvae in concealment.

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

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

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

Shortnose sturgeon are known to occur at a wide range of depths. A minimum depth of 0.6m is necessary for the unimpeded swimming by adults. Shortnose sturgeon are known to occur at depths of up to 30m but are generally found in waters less than 20m (Dadswell *et al.*, 1984; Dadswell, 1979). Shortnose sturgeon have also demonstrated tolerance to a wide range of salinities. Shortnose sturgeon have been documented in freshwater (Taubert, 1980; Taubert and Dadswell, 1980) and in waters with salinity of 30 parts-per-thousand (ppt) (Holland and Yeverton, 1973; Saunders and Smith, 1978). Mcleave *et al.* (1977) reported adults moving freely through a wide range of salinities, crossing waters with differences of up to 10ppt within a two hour period. The tolerance of shortnose sturgeon to increasing salinity is thought to increase with age (Kynard, 1996). Shortnose sturgeon typically occur in the deepest parts of rivers or estuaries where suitable oxygen and salinity values are present (Gilbert, 1989). 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 U.S. Department of the Interior, stated that shortnose sturgeon were “in peril...gone in most of the rivers of its former range [but] probably not as yet extinct” (USDOI, 1973). Pollution and overfishing, including bycatch in the shad fishery, were listed as principal reasons for the species’ decline. In the late nineteenth and early twentieth centuries, shortnose sturgeon commonly were taken in a commercial fishery for the closely related and commercially valuable Atlantic sturgeon (*Acipenser oxyrinchus*). More than a century of extensive fishing for sturgeon contributed to the decline of shortnose sturgeon along the east coast. Heavy industrial development during the twentieth century in rivers inhabited by sturgeon impaired water quality and impeded these species’ recovery; possibly resulting in substantially reduced abundance of shortnose sturgeon populations within portions of the species’ ranges (e.g., southernmost rivers of the species range: Santilla, St. Marys and St. Johns Rivers). A shortnose sturgeon recovery plan was published in December 1998 to promote the conservation and recovery of the species (see NMFS, 1998). Shortnose sturgeon are listed as “vulnerable” on the IUCN Red List.

Although shortnose sturgeon are listed as endangered range-wide, in the 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)² of shortnose sturgeon under the ESA. 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 comprised of breeding subpopulations (NMFS 1998).

Studies conducted since the issuance of the Recovery Plan have provided evidence that suggests

² The definition of species under the ESA includes any subspecies of fish, wildlife, or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature. To be considered a DPS, a population segment must meet two criteria under NMFS policy. First, it must be discrete, or separated, from other populations of its species or subspecies. Second, it must be significant, or essential, to the long-term conservation status of its species or subspecies. This formal legal procedure to designate DPSs for shortnose sturgeon has not been undertaken.

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

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

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

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

In 2007 NMFS initiated a five-year status review to assess the status of shortnose sturgeon rangewide. The status review team was specifically charged with analyzing new genetic data to inform the current understanding of shortnose sturgeon genetics rangewide. Although these

analyses are not yet available, 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 best available information demonstrates differences in life history and habitat preferences between northern and southern river systems and given the species' anadromous breeding habits, the rare occurrence of migration between river systems, and the documented genetic differences between river populations, it is unlikely that populations in adjacent river systems interbreed with any regularity. This behavior likely accounts for the failure of shortnose sturgeon to repopulate river systems from which they have been extirpated, despite the geographic closeness of persisting populations. This particular characteristic of shortnose sturgeon also complicates recovery and persistence of this species in the future because, if a river population is extirpated in the future, it is unlikely that this river will be recolonized. Consequently, this Opinion will treat the nineteen separate populations of shortnose sturgeon as subpopulations (one of which occurs in the action area) for the purposes of this analysis.

3.1.2 Status and Trends of shortnose sturgeon rangewide

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

3.1.3 Summary of factors affecting recovery of shortnose sturgeon

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 rangewide. Shortnose sturgeon continue to be taken incidentally in fisheries along the east coast and are probably targeted by poachers throughout their range (Dadswell, 1979; Dovel *et al.*, 1992; Collins *et al.*, 1996). Bridge construction and demolition projects may interfere with normal shortnose sturgeon migratory movements and disturb sturgeon concentration areas. Unless appropriate precautions are taken, internal damage and/or death may result from blasting projects with powerful explosives. Hydroelectric dams may affect shortnose sturgeon by restricting habitat, altering river flows or temperatures necessary for successful spawning and/or migration and causing mortalities to fish that become entrained in turbines. 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 dragarms 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. Shortnose sturgeon are susceptible to impingement on cooling water intake screens at power plants. Electric power and nuclear power generating plants can affect sturgeon by impinging larger fish on cooling water intake screens and entraining larval fish. The operation of power plants can have unforeseen and extremely detrimental impacts to water quality which can affect shortnose sturgeon. For example, the St. Stephen Power Plant near Lake Moultrie, South Carolina was shut down for several days in June 1991 when large mats of aquatic plants entered the plant's intake canal and clogged the cooling water intake gates. Decomposing plant material in the tailrace canal coupled with the turbine shut down (allowing no flow of water) triggered a low dissolved oxygen water condition downstream and a subsequent fish kill. The South Carolina Wildlife and Marine Resources Department reported that twenty shortnose sturgeon were killed during this low dissolved oxygen event.

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

Although there is little information available comparing the levels of contaminants in shortnose sturgeon tissues rangewide, some research on other related species indicates that concern about

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

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

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

Pulp mill, silvicultural, agricultural, and sewer discharges, as well as a combination of non-point source discharges, which contain elevated temperatures or high biological demand, can reduce dissolved oxygen levels. Shortnose sturgeon are known to be adversely affected by dissolved

oxygen levels below 5 mg/L. Shortnose sturgeon may be less tolerant of low dissolved oxygen levels in high ambient water temperatures and show signs of stress in water temperatures higher than 28°C (Flourney *et al.*, 1992). At these temperatures, concomitant low levels of dissolved oxygen may be lethal.

3.1.4 *Status of Shortnose Sturgeon in the Action area*

On June 30, 1978, one shortnose sturgeon was captured in Penobscot Bay during finfish sampling conducted by the MDMR (Squiers and Smith, 1979). As shortnose sturgeon were thought to rarely participate in coastal migrations and are known to complete their entire life history in their natal river, researchers concluded that this sturgeon was a member of a previously undocumented Penobscot River population of shortnose sturgeon. The river had long been suspected of supporting a shortnose sturgeon population based on anecdotal evidence of shortnose sturgeon capture and observation in combination with archeological data which suggested that sturgeon from the Penobscot River were used by native peoples (Knight, 1985 and Petersen and Sanger, 1986 in NMFS 1998; see also Fernandes *et al.*, 2010).

In 1994 and 1995, researchers attempted to document the use of the Penobscot River by shortnose sturgeon. Nets were set near the head of tide in both years with the goal of capturing spawning adults. This was the only area of the river targeted by the researchers. Researchers fished for approximately 409 net hours. No shortnose sturgeon were captured. However, even in rivers with relatively large populations with intense sampling programs (*i.e.*, the Connecticut River), it is not uncommon for there to be a year when no migration to the spawning grounds and subsequently no spawning occurs.

The 1978 capture, in conjunction with historical and anecdotal evidence and the habitat characteristics of the river, led NMFS to conclude that there was a small persistent population of shortnose sturgeon in the Penobscot River (NMFS, 1998).

In May 2006, the University of Maine (UM), in conjunction with NMFS and the U.S. Geological Survey (USGS), began a study of the distribution, abundance, and movements of adult and sub-adult Atlantic sturgeon in the Penobscot River. These research efforts confirmed the presence of shortnose sturgeon in the river. In 2006, 62 individual shortnose sturgeon were captured by UM in the Penobscot River from Frankfort upstream to Bangor. Between May 21, 2007, and September 10, 2007, an additional 99 individual shortnose sturgeon were captured and tagged in the river (Fernandes, 2008; Fernandes *et al.*, 2010). A total of 185 shortnose sturgeon were captured in the river in 2008 and 221 in 2009. To date, a total of 662 shortnose sturgeon have been captured in the Penobscot River (Dionne, 2010b in Maine DMR 2010). All sturgeon captured during the study were adults or large juveniles as the type of gear used for sampling (large mesh gill nets of 6 inch and 12 inch stretch) is not designed to capture sturgeon less than 2 feet in length.

Using the 2006 and 2007 mark-recapture data, UM researchers used two different calculation methods to obtain a preliminary population estimate for the Penobscot River (Fernandes *et al.*, 2008). Using a Lincoln/Peterson Index, an estimate of 1,049 fish was calculated (95% confidence interval of 673 and 6,939). A Schnabel estimate was also calculated yielding an

estimate of 1710 shortnose sturgeon. It must be noted that both models assume a closed population (no mortality, birth or migration takes place). Fernandes (2008) used capture data from 2006 and 2007 to calculate Peterson and Schnabel estimates of population size. The Peterson estimate of shortnose sturgeon abundance was 1,425 with a confidence interval of 203-2647. The Schnabel estimate was 1,531 with a confidence interval of 885-5681. As reported by Fernandes (2008), these two methods require a large number of recaptures for a precise estimate of abundance, and were likely affected by the low number of recaptures in this study. Additionally, several of the assumptions of these tests were violated, including the lack of a closed population and random sampling. A POPAN Jolly-Seber open population model completed in 2010 estimated approximately 1654 (95%CI: 1108-2200) adult shortnose sturgeon using the Penobscot River. Similarly, a more robust design analysis with closed periods in the summer and late fall, estimated seasonal adult abundance ranging from 636-1285 (weighted mean), with a low estimate of 602 (95%CI: 409.6-910.8) and a high of 1306 (95% CI: 795.6-2176.4).

As noted above, several population estimates have been made for the Penobscot River, ranging from 602-1654 adult shortnose sturgeon (Fernandes, 2008; Fernandes *et al.*, 2010, Zydlewski *et al.*, 2010 in Maine DMR 2010). It is currently unknown whether spawning is occurring in the Penobscot River or whether shortnose sturgeon present in the Penobscot River spawn in the Kennebec and/or Androscoggin River. Tracking data has shown that there is at least limited exchange between the Penobscot River and the Kennebec River. The most recent estimate of the number of shortnose sturgeon in the Kennebec complex is 9,488 and successful spawning has been confirmed in both the Kennebec and Androscoggin Rivers. The Maine Department of Marine Resources (MEDMR) 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 a population estimate of 9,488 (95% CI, 6,942 to 13,358) for the estuarine complex. Based on comparison to older population estimates, NMFS believes that the Kennebec River population is increasing slightly or is stable. Without historical data to compare to the current Penobscot River population estimate, it is not possible to assess the population trend.

Currently, shortnose sturgeon are limited to the area below Veazie Dam. Existing fish passage facilities at the Veazie Dam are not used by shortnose sturgeon and no shortnose sturgeon are known to occur upstream of the dam. Historically, the first natural obstacle to sturgeon migration on the Penobscot River may have been the falls at Milford, approximately rkm 70 (L. Flagg, MDMR, pers. comm 1998). If sturgeon were able to ascend the falls at Milford, they could have migrated without obstruction to Mattaseunk (rkm 171). The currently available information on the distribution of shortnose sturgeon in the Penobscot River is summarized below.

Recaptures of tagged fish and telemetry studies indicate that while shortnose sturgeon are present in the river and estuary throughout the year, their movements vary by season in response to water temperature and flow. From mid-October to mid-April most tagged shortnose sturgeon concentrate in a relatively small section of river in the Bangor area. Following this overwintering period they move downstream into the estuary, until returning upstream in summer during low flows. Tagged fish were observed to move as far upstream as 2 km (1.2 mi.)

below the Veazie Dam by August. At the end of summer, shortnose sturgeon moved downstream to the location of the overwintering site in the Bangor area (Fernandes 2008, Zydlewski, 2009b).

UM researchers captured 17 shortnose sturgeon in the reach of the Penobscot River between Sedgeunkedunk Stream (river kilometer 36.4) and an asphalt plant in Bangor (river kilometer 38.5) from September 28 to October 19, 2006. Additionally, in 2006, 12 of 14 (86%) shortnose sturgeon tagged with hydroacoustic transmitters were detected during the winter months in an approximately 7,500 foot section of the Penobscot River from the confluence of Sedgeunkedunk Stream upstream to the City of Bangor's waste water treatment facility. In 2011, sturgeon moved further upstream immediately above the old Bangor dam site into an area referred to as the Bangor headpond located in Ecozone 1 (river kilometer 43). Tracking data indicate that sturgeon begin moving into this reach of the Penobscot River in October and depart in April. Some adults start moving back into the vicinity of this area in June. This information indicates that the area around the Bangor water treatment facility and Sedgeunkedunk Stream is likely used as an overwintering area for shortnose sturgeon. These movements are consistent with movements of shortnose sturgeon in other river systems, including the Delaware and Kennebec Rivers. In these river systems, the majority of shortnose sturgeon have moved to the overwintering area by the time water temperatures reach 10°C in the fall, although some move to the overwintering area much sooner and others do not appear to move to the primary overwintering area at all.

The preliminary telemetry data collected by UM suggests that sub-adult and adult shortnose sturgeon move extensively within the river system during spring and early summer and often can be found over mudflats outside the main river channel (Fernandes *et al.*, 2006).

Based on life history information from other rivers, adult shortnose sturgeon in the Penobscot River would likely spawn downstream of the Veazie Dam when water temperatures are between 8 and 18°C. Based on studies of spawning shortnose sturgeon in other rivers, spawning areas likely have depths of 1-5m with water velocity between 50-125 cm/s and cobble/rubble substrate (101-300 mm diameter). In 2009, spawning mats and ichthyoplankton nets were used to detect potential spawning below Veazie Dam (Zydlewski, 2009a). While no actual spawning activity was detected, suitable spawning areas were described, using data on bathymetry, water temperature and velocity (Zydlewski, 2009a). Although spawning areas have not yet been identified, researchers suspect that based on the literature, spawning likely occurs as far upriver as sturgeon can migrate. This allows larvae and juveniles the most freshwater habitat downriver before they enter estuarine conditions. Accordingly, spawning habitat suitability (based on data on substrate and water velocity during predicted spawning periods) was much higher downstream in the vicinity of the former Bangor Dam, and essentially non-existent immediately below Veazie Dam (Zydlewski, 2009a).

Adults are known to rapidly leave the area after spawning and move to downstream foraging areas. Adults may also briefly visit more saline reaches of the estuary as is seen in the Connecticut and Merrimack Rivers. Typically, in the fall when water temperatures drop to 10°C, shortnose sturgeon move to upstream overwintering areas. In the Penobscot, water temperatures

of approximately 13°C seem to trigger movement to upstream concentration areas. In some river systems (Hudson, Connecticut), individual overwintering areas are segregated between spawners and non-spawners. In the Penobscot River, the distance to be traveled to the presumed spawning grounds is relatively short and in close proximity to overwintering areas as is seen in other rivers with small amounts of available habitat (e.g., the Merrimack River). Eggs and larvae are likely concentrated near the spawning area for up to 4 weeks post-spawning, after which larvae disperse into the tidal river. As juvenile sturgeon are believed to remain upstream of the salt wedge until they are about 45 cm long (Crance, 1986), it is likely that juvenile sturgeon would occur in the Penobscot River from the Veazie Dam downstream to the Town of Hampden, a stretch of river approximately 16 km long. This area is immediately above the proposed sampling for the Ecosystem survey.

Based upon data collected by UM, known life history characteristics of shortnose sturgeon, and habitat availability in the Penobscot River, juvenile and adult shortnose sturgeon have the potential to occur in the action area at various times of the year.

Outside of spawning, shortnose sturgeon typically occur over soft substrates consisting of mud, silt or sand, and commonly in deeper channels or over tidal mud flats (NMFS 1998). Such habitat is extensive in the Penobscot River from the estuary upstream to the area around Bangor and Brewer (Fernandes, 2008, Zydlewski, 2009a, Zydlewski, 2009b). Much of this soft sediment consists of bark, sawdust or wood chips, which were deposited as a result of log-driving and operation of saw mills and pulp and paper operations on the river. These soft sediment areas were found to be used by shortnose sturgeon throughout the year in recent University of Maine studies (Fernandes, 2008).

Recent data collected by UM and MEDMR indicate that migration between river systems is more extensive than was previously thought. As summarized by Dionne (2010a in Maine DMR 2010), between 2006 and 2009 a total of 68 shortnose sturgeon were implanted with coded acoustic transmitters. Of the 46 active acoustically tagged individuals, 13 remained within the Penobscot River system. These fish demonstrated an in-river migration pattern that involved downriver movement from the wintering area in the spring, followed by gradual upriver movement throughout the summer prior to returning to the wintering area in the fall (Fernandes *et al.*, 2010). Eleven individuals were characterized as “spring emigrants.” These fish followed a similar in-river movement pattern to resident fish but made a single migration out of the Penobscot River system in the spring (April 12 – May 11) while the resident fish remained in the estuary. These fish largely returned to the Penobscot River within two months (May 25 – July 7); with one fish remaining outside the Penobscot River for approximately 1 year. Fifteen tagged fish were determined to be “fall emigrants”. These fish followed the typical in-river migration pattern while in the river, with the exception of using the Kennebec River overwintering site. These fish utilized the Penobscot River from mid-spring through early fall (entering between April 19 and June 19 and leaving between September 9 and November 4). The remaining 7 tagged fish were classified as “summer emigrants”. The movements of these fish were not as well defined; these fish were observed leaving the Penobscot between June 1 and July 1 with some individuals overwintering in the Penobscot and some in the Kennebec. Returns to the Penobscot were made between April 26 and June 8. At least one of these fish spent over three

months in coastal river systems between the Penobscot and Kennebec Rivers.

Research has been conducted by the NYU School of Medicine involving mitochondrial DNA (mtDNA) analysis of shortnose sturgeon populations, including fish caught in the Penobscot River (Wirgin et al. in progress). Information available to date for the Penobscot samples indicates that haplotype frequencies in this population were almost identical to that in the Kennebec River system. Additionally, the Penobscot River samples did not exhibit any haplotypes that were not seen elsewhere. It is unknown at this time whether shortnose sturgeon in the Penobscot River are the descendants of recent migrants from the Kennebec River, migrants themselves or whether they represent a remnant naturally reproducing Penobscot River population. It is possible that the adults captured to date are representatives of all three scenarios. As the sample size is very small and as mtDNA represents only a fraction (less than 1%) of the genetic material and is maternally inherited, it is difficult to make conclusive statements regarding the potential for fish in the Penobscot River to be genetically distinct from other fish in the Kennebec complex. However, as there were no unique haplotypes in the Penobscot River fish and unique haplotypes are seen in almost every other population, the best available information suggests that fish occurring in the Penobscot River are not genetically unique and are not genetically distinct from other fish in the Kennebec River. Nuclear DNA analysis (King *et al.*, 2010) finds that the Kennebec, Androscoggin, and Penobscot Rivers form a metapopulation that are genetically indistinguishable from each other; reflecting a panmictic population.

3.1.5 Factors Affecting Shortnose Sturgeon in the action Area

3.1.5.1 Dams and Hydroelectric Facilities

As noted above, the range of shortnose sturgeon in the Penobscot River has been restricted by the Veazie Dam. This dam restricts the available habitat for shortnose sturgeon. In rivers where shortnose sturgeon have free access (*i.e.*, there are no dams), the species typically has a 100-200km range. In the Penobscot River, this range is restricted to only 25 miles of mainstem river, with an additional 20 miles of estuary available below the mouth of the river. The Veazie Dam and Great Works dam prevent shortnose sturgeon from accessing historically available habitat above the Dam, which is thought to have extended to at least Milford Falls (approximately rkm 70). These Dams have also likely prevented the species from spawning at their preferred spawning habitat, which is likely located upstream of the Veazie Dam. The lack of accessibility to this habitat has likely had a significant negative effect on shortnose sturgeon in this river system and will continue to delay recovery of this species in the Penobscot River. Because no shortnose sturgeon are known to occur upstream of any hydroelectric projects in the Penobscot River, passage over hydroelectric dams or through hydroelectric turbines is not a source of injury or mortality in the action area. The extent that shortnose sturgeon are affected by operations of hydroelectric facilities in the Penobscot River is currently unknown. Additionally, to the extent that upstream hydroelectric projects affect conditions below Veazie Dam, shortnose sturgeon are affected by the operation of these projects as well. The Veazie Dam is slated for removal within the timeframe of this action.

3.1.5.2 Contaminants and Water Quality

Shortnose are vulnerable to effects from contaminants and water quality over their entire life

history. In addition, their long life span increases the potential for environmental contaminants to build up in the tissue which may affect the development of the individual or its gametes. Point source discharges (*i.e.*, municipal wastewater, paper mill effluent, industrial or power plant cooling water or waste water) and compounds associated with discharges (*i.e.*, metals, dioxins, dissolved solids, phenols, and hydrocarbons) contribute to poor water quality that may also impact the health of individual sturgeon. The compounds associated with discharges can alter the chemistry and temperature of receiving waters, which may lead to mortality, changes in fish behavior, deformations, and reduced egg production and survival. Contaminants including heavy metals, polychlorinated aromatic hydrocarbons (PAHs), pesticides, and polychlorinated biphenyls (PCBs), can have serious, deleterious effects on aquatic life and are associated with the production of acute lesions, growth retardation, and reproductive impairment (Ruelle and Keenlyne, 1993). Contaminants introduced into the water column or through the food chain eventually become associated with the benthos where bottom dwelling species like shortnose sturgeon are particularly vulnerable. In 2000, the US Environmental Protection Agency (EPA) delegated authority for the National Pollutant Discharge Elimination System (NPDES) permit program to the State of Maine. Currently, NMFS reviews and comments on all NPDES issued for discharges to the Penobscot River occurring below the Veazie Dam. In general, water quality has improved in the Penobscot River and Gulf of Maine over the past decades (Lichter *et al.*, 2006; EPA, 2008). However, water quality issues that derive from wastewater treatment plants and power plants are still a concern for all life stages of shortnose sturgeon as effects may be long-lasting.

3.1.5.3 Conservation and Recovery Actions

Scientific Research Permits

Research activities for shortnose sturgeon conducted by University of Maine scientists are authorized through a scientific research permit (No. 1595) issued by NMFS in 2007. This permit allows the capture of up to 100 shortnose sturgeon annually in the Penobscot river from 2007-2012 using gill nets and trammels nets. This permit has been modified several times, most recently on January 13, 2011. The current permit allows the capture of up to 200 shortnose sturgeon annually. The permit also allows tagging, tissue sampling, and boroscopy of a subset of individuals. Permit No. 1595 also authorizes UM to collect and preserve thirty shortnose sturgeon eggs to verify spawning in the Penobscot River. Mortalities of two adult or juvenile shortnose sturgeon are authorized annually. A Biological Opinion on the effects of research authorized under this permit was issued on March 27, 2007. In this Opinion, NMFS concluded that the research to be authorized under Permit No. 1595 was not likely to jeopardize the continued existence of any ESA-listed species under NMFS jurisdiction. To date, approximately 893 individuals have been captured and only one mortality has been recorded. This research will continue through at least 2017.

3.2 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 likely to occur in the action area. 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.

3.2.1 Species Description

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 DPSs³ (77 FR 5880 and 77 FR 5914). These are: the Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs (Figure 2). 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 5 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 described below, individuals originating from 2 of the 5 listed DPSs are likely to occur in the action area. Information general to all Atlantic sturgeon as well as information specific to each of the relevant DPSs, is provided below.

Atlantic sturgeon life history

Atlantic sturgeon are long lived (approximately 60 years), late maturing, estuarine dependent, anadromous⁴ fish (Bigelow and Schroeder, 1953; Vladykov and Greeley 1963; Mangin, 1964; Pikitch *et al.*, 2005; Dadswell, 2006; ASSRT, 2007). They are a relatively large fish, even amongst sturgeon species (Pikitch *et al.*, 2005). Atlantic sturgeons 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). Juvenile 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

³ 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.”

⁴ 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 FAQ's, available at <http://www.nefsc.noaa.gov/faq/fishfaq1a.html>, modified June 16, 2011)

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 juvenile 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 Berggren, 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.

3.2.2 Status and Trends of Atlantic Sturgeon Rangewide

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 38 rivers prior to this period. Currently, only 20 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). 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 estimate of 863 mature adults per year (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).

It is possible, however, to estimate the total number of adults in some other rivers based on the number of mature adults in the Hudson River. We have calculated an estimate of total mature adults and a proportion of subadults for four of the five DPSs. The technique used to obtain these estimates is explained fully in Damon-Randall 2012(b) and is summarized briefly below. We used this method because for these four DPSs, there are: (1) no total population estimates available; (2) with the exception of the Hudson River, no estimates of the number of mature adults; and, (3) no information from directed population surveys which could be used to generate an estimate of the number of spawning adults, total adult population or total DPS population.

Kahnle *et al.* (2007) estimated the number of total mature adults per year in the Hudson River

using data from surveys in the 1980s to mid-1990s and based on mean harvest by sex divided by sex specific exploitation rate. While this data is over 20 years old, it is currently the best available data on the abundance of Hudson River origin Atlantic sturgeon. The sex ratio of spawners is estimated to be approximately 70% males and 30% females. As noted above, Kahnle et al. (2007) estimated a mean annual number of mature adults at 596 males and 267 females.

We were able to use this estimate of the adult population in the Hudson River and the rate at which Atlantic sturgeon from the Hudson River are intercepted in certain Northeast commercial fisheries⁵ to estimate the number of adults in other spawning rivers. As noted above, the method used is summarized below and explained fully in Damon-Randall 2012(b). Given the geographic scope of commercial fisheries as well as the extensive marine migrations of Atlantic sturgeon, fish originating from nearly all spawning rivers are believed to be intercepted by commercial fisheries. An estimate of the number of Atlantic sturgeon captured in certain fisheries authorized by NMFS under Federal FMPs in the Northeast is available (NEFSC, 2011). This report indicates that based on observed interactions with Atlantic sturgeon in sink gillnet and otter trawl fisheries from 2006-2010, on average 3,118 Atlantic sturgeon are captured in these fisheries each year. Information in the Northeast Fisheries Observer Program (NEFOP) database, indicates that 25% of captured Atlantic sturgeon are adults (determined as length greater than 150 cm) and 75% are subadults (determined as length less than 150cm). By applying the mixed stock genetic analysis of individuals⁶ sampled by the NEFOP and At Sea Monitoring Program (see Damon-Randall *et al.*, 2012a) to the bycatch estimate, we can determine an estimate of the number of Hudson River Atlantic sturgeon that are intercepted by these fisheries on an annual basis.

Given the number of observed Hudson River origin Atlantic sturgeon adults taken as bycatch, we can calculate what percentage of Hudson River origin Atlantic sturgeon mature adults these represent. This provides an interception rate. We assume that fish originating in any river in any DPS are equally likely to be intercepted by the observed commercial fisheries; therefore, we can use this interception rate to estimate the number of Atlantic sturgeon in the other rivers of origin. This type of back calculation allows us to use the information we have for the Hudson River and fill in significant data gaps present for the other rivers. Using this method, we have estimated the total adult populations for the Gulf of Maine DPS.

5 Bycatch information was obtained from a report prepared by NMFS' Northeast Fisheries Science Center (NEFSC 2012).

6 Based on the best available information, we expect that 46% of Atlantic sturgeon captured in Northeast commercial fisheries originate from the New York Bight DPS and that 91% of those individuals originate from the Hudson River (see Damon-Randall *et al.* 2012a and Wirgin and King 2011).

Table 2: Summary of Calculated Population Estimates from NER Fisheries Dependent Data

| DPS | Estimated Adult Population | Estimated Subadults of Size vulnerable to capture in commercial fisheries |
|---------------------------------------|----------------------------|---|
| GOM | 166 | 498 |
| NYB (Hudson River and Delaware River) | 950 | 2,850 |

3.2.3 Summary of Factors Affecting Recovery of Atlantic Sturgeon

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.

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. The analysis conducted 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%, with the exception of monkfish gear which has a higher mortality rate of approximately 27%. Mortality rates in otter trawl gear are believed to be lower at approximately 5%. Comparing the estimated annual average mortalities to the adult population estimates for each of the four DPSs encountered in Northeast fisheries, we estimate that at least 4% of adults from each DPS are being killed as a result of interactions with fisheries authorized by Northeast FMPs each year. We 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.

3.2.4 Determination of DPS Composition in the Action Area

As explained above, the range of all 5 DPSs overlaps and extends from Canada through Cape Canaveral, Florida. We have considered the best available information to determine from which DPSs individuals in the action area are likely to have originated. We have determined that Atlantic sturgeon in the action area likely to originate from two of the five ESA listed DPSs as well as from the St. John River in Canada. Fish originating from the St. John River are not listed under the ESA. The only way to tell the river (or DPS) of origin for a particular individual is by genetic sampling. 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 you are. Areas that are geographically close are expected to have a similar composition of individuals. The nearest areas to the action area for which mixed stock analysis is available is the Bay of Fundy, Canada. In this area, 63% of individuals are Canadian (St. John River) origin, 36% are GOM DPS origin and 1% are NYB origin. We do not currently have a mixed stock analysis for the action area. In the Penobscot River we expect the composition to be similar; however we expect that GOM DPS individuals will be more frequent than Canadian origin individuals. Therefore, in the action area we expect Atlantic sturgeon to occur at the following frequencies: St. John River (Canada) 36%; Gulf of Maine 63% and, NYB 1%. This assumption

is supported by some preliminary genetic analyses of fish caught in rivers within the GOM; showing that the fish are predominantly of GOM origin with some St. John River and Hudson River fish present. 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 in Damon-Randall (2012).

3.2.5 Status of Atlantic Sturgeon in the Action Area

Gulf of Maine DPS

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 also possible that it still occurs in the Androscoggin and Penobscot Rivers 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. 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 Merymeeting 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 Merymeeting 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 in all states has been prohibited since 1998, and retention of Atlantic sturgeon by catch in and from the Exclusive Economic Zone (EEZ) has been prohibited since 1999. 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 DPS have navigation channels that are maintained by dredging. Dredging outside of Federal channels and in-water construction occurs throughout the Gulf of Maine DPS. 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 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. The extent that Atlantic sturgeon are affected by operations of dams in the Gulf of Maine region is currently unknown; however, 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. As explained above, we have estimated that there is an annual mean of 166 mature adult Atlantic sturgeon in the GOM DPS.

Summary of the Gulf of Maine DPS

Spawning for the Gulf of Maine DPS is known to occur in two rivers (Kennebec and Androscoggin) and possibly in a third. 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.

New York Bight DPS

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 Hudson River and Estuary extend 504 kilometers from the Atlantic Ocean to Lake Tear of-the-Clouds in the Adirondack Mountains (Dovel and Berggren, 1983). The estuary is 246 km long, beginning at the southern tip of Manhattan Island (rkm 0) and running north to the Troy Dam (rkm 246) near Albany (Sweka *et al.*, 2007). All Atlantic sturgeon habitats are believed to occur below the dam. Therefore, presence of the dam on the river does not restrict access of Atlantic sturgeon to necessary habitats (e.g., for spawning, rearing, foraging, over wintering) (NMFS and USFWS, 1998; ASSRT, 2007).

Use of the river by Atlantic sturgeon has been described by several authors. Briefly, spawning likely occurs in multiple sites within the river from approximately rkm 56 to rkm 182 (Dovel and Berggren, 1983; Van Eenennaam *et al.*, 1996; Kahnle *et al.*, 1998; Bain *et al.*, 2000). Selection

of sites in a given year may be influenced by the position of the salt wedge (Dovel and Berggren, 1983; Van Eenennaam *et al.*, 1996; Kahnle *et al.*, 1998). The area around Hyde Park (approximately rkm 134) has consistently been identified as a spawning area through scientific studies and historical records of the Hudson River sturgeon fishery (Dovel and Berggren, 1983; Van Eenennaam *et al.*, 1996; Kahnle *et al.*, 1998; Bain *et al.*, 2000). Habitat conditions at the Hyde Park site are described as freshwater year round with bedrock, silt and clay substrates and waters depths of 12-24 m (Bain *et al.*, 2000). Bain *et al.* (2000) also identified a spawning site at rkm 112 based on tracking data. The rkm 112 site, located to one side of the river, has clay, silt and sand substrates, and is approximately 21-27 m deep (Bain *et al.*, 2000).

Young-of-year (YOY) have been recorded in the Hudson River between rkm 60 and rkm 148, which includes some brackish waters; however, larvae must remain upstream of the salt wedge because of their low salinity tolerance (Dovel and Berggren, 1983; Kahnle *et al.*, 1998; Bain *et al.*, 2000). Catches of immature sturgeon (age 1 and older) suggest that juveniles utilize the estuary from the Tappan Zee Bridge through Kingston (rkm 43- rkm 148) (Dovel and Berggren, 1983; Bain *et al.*, 2000). Seasonal movements are apparent with juveniles occupying waters from rkm 60 to rkm 107 during summer months and then moving downstream as water temperatures decline in the fall, primarily occupying waters from rkm 19 to rkm 74 (Dovel and Berggren, 1983; Bain *et al.*, 2000). Based on river-bottom sediment maps (Coch, 1986) most juvenile sturgeon habitats in the Hudson River have clay, sand, and silt substrates (Bain *et al.*, 2000). Newburgh and Haverstraw Bays in the Hudson River are areas of known juvenile sturgeon concentrations (Sweka *et al.*, 2007). Sampling in spring and fall revealed that highest catches of juvenile Atlantic sturgeon occurred during spring in soft-deep areas of Haverstraw Bay even though this habitat type comprised only 25% of the available habitat in the Bay (Sweka *et al.*, 2007). Overall, 90% of the total 562 individual juvenile Atlantic sturgeon captured during the course of this study (14 were captured more than once) came from Haverstraw Bay (Sweka *et al.*, 2007). At around 3 years of age, Hudson River juveniles exceeding 70 cm total length begin to migrate to marine waters (Bain *et al.*, 2000).

In general, Hudson River Atlantic sturgeons mature at approximately 11 to 21 years of age (Dovel and Berggren, 1983; ASMFC, 1998; Young *et al.*, 1998). A sample of 94 pre-spawning adult Atlantic sturgeon from the Hudson River was comprised of males 12 to 19 years old, and females that were 14 to 36 years old (Van Eenennaam *et al.*, 1996). The majority of males were 13 to 16 years old while the majority of females were 16 to 20 years old (Van Eenennaam *et al.*, 1996). These data are consistent with the findings of Stevenson and Secor (1999) who noted that, amongst a sample of Atlantic sturgeon collected from the Hudson River fishery from 1992-1995, growth patterns indicated males grew faster and, thus, matured earlier than females. The spawning season for Hudson River Atlantic sturgeon extends from late spring to early summer (Dovel and Berggren, 1983; Van Eenennaam *et al.*, 1996).

The abundance of the Hudson River Atlantic sturgeon riverine population prior to the onset of expanded exploitation in the 1800's 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. All available data on abundance of juvenile Atlantic sturgeon in the Hudson River Estuary indicate a substantial drop in production of young since the mid 1970's (Kahnle *et al.*, 1998). A decline appeared to occur in the mid to late 1970's followed by a secondary drop in the late 1980's (Kahnle *et al.*, 1998; Sweka *et al.*, 2007; ASMFC, 2010). Catch-per-unit-effort data suggests that recruitment has remained depressed relative to catches of juvenile Atlantic sturgeon in the estuary during the mid-late 1980's (Sweka *et al.*, 2007; ASMFC, 2010). In examining the CPUE data from 1985-2007, there are significant fluctuations during this time. There appears to be a decline in the number of juveniles between the late 1980s and early 1990s and while the CPUE is generally higher in the 2000s as compared to the 1990s, given the significant annual fluctuation it is difficult to discern any trend. Despite the CPUEs from 2000-2007 being generally higher than those from 1990-1999, they are low compared to the late 1980s. There is currently not enough information regarding any life stage to establish a trend for the Hudson River population.

In the Delaware River and Estuary, Atlantic sturgeon occur from the mouth of the Delaware Bay to the fall line near Trenton, NJ, a distance of 220 km (NMFS and USFWS, 1998; Simpson, 2008). As is the case in the Hudson River, all historical Atlantic sturgeon habitats appear to be accessible in the Delaware (NMFS and USFWS, 1998; ASSRT, 2007). Recent multi-year studies have provided new information on the use of habitats by Atlantic sturgeon within the Delaware River and Estuary (Brundage, 2007; Simpson, 2008; Brundage and O'Herron, 2009; Fisher, 2009; Calvo *et al.*, 2010; Fox and Breece, 2010).

Historical records from the 1830's indicate Atlantic sturgeon may have spawned as far north as Bordentown, just below Trenton, NJ (Pennsylvania Commission of Fisheries, 1897). Cobb (1899) and Borden (1925) reported spawning occurring between rkm 77 and 130 (Delaware City, DE to Chester City, PA). Based on recent tagging and tracking studies carried out from 2009-2011, Breece (2011) reports likely spawning locations at rkm 120-150 and rkm 170-190. Mature adults have been tracked in these areas at the time of year when spawning is expected to occur and movements have been consistent with what would be expected from spawning adults. Based on tagging and tracking studies, Simpson (2008) suggested that spawning habitat also exists from Tinicum Island (rkm 136) to the fall line in Trenton, NJ (rkm 211). To date, eggs and larvae have not been documented to confirm that actual spawning is occurring in these areas. However, as noted below, the presence of young of the year in the Delaware River provides confirmation that spawning is still occurring in this river.

Sampling in 2009 that targeted YOY resulted in the capture of more than 60 YOY in the Marcus Hook anchorage (rkm 127) area during late October-late November 2009 (Fisher, 2009; Calvo *et al.*, 2010). Twenty of the YOY from one study and six from the second study received acoustic tags that provided information on habitat use by this early life stage (Calvo *et al.*, 2010; Fisher, 2011). YOY used several areas from Deepwater (rkm 105) to Roebing (rkm 199) during late fall to early spring. Some remained in the Marcus Hook area while others moved upstream,

exhibiting migrations in and out of the area during winter months (Calvo *et al.*, 2010; Fisher, 2011). At least one YOY spent some time downstream of Marcus Hook (Calvo *et al.*, 2010; Fisher, 2011). Downstream detections from May to August between Philadelphia (rkm 150) and New Castle (rkm 100) suggest non-use of the upriver locations during the summer months (Fisher, 2011). By September 2010, only 3 of 20 individuals tagged by DE DNREC persisted with active tags (Fisher, 2011). One of these migrated upstream to the Newbold Island and Roebing area (rkm 195), but was back down in the lower tidal area within 3 weeks and was last detected at Tinicum Island (rkm 141) when the transmitter expired in October (Fisher, 2011). The other two remained in the Cherry Island Flats (rkm 113) and Marcus Hook Anchorage area (rkm 130) until their tags transmissions also ended in October (Fisher, 2011).

The Delaware Estuary is known to be a congregation area for sturgeon from multiple DPSs. Generally, non-natal late stage juveniles (sometimes also referred to as subadults) immigrate into the estuary in spring, establish home range in the summer months in the river, and emigrate from the estuary in the fall (Fisher, 2011). Subadults tagged and tracked by Simpson (2008) entered the lower Delaware Estuary as early as mid-March but, more typically, from mid-April through May. Tracked sturgeon remained in the Delaware Estuary through the late fall departing in November (Simpson, 2008). Previous studies have found a similar movement pattern of upstream movement in the spring-summer and downstream movement to overwintering areas in the lower estuary or nearshore ocean in the fall-winter (Brundage and Meadows, 1982; Lazzari *et al.*, 1986; Shirey *et al.*, 1997; 1999; Brundage and O'Herron, 2009; Brundage and O'Herron in Calvo *et al.*, 2010).

Brundage and O'Herron (in Calvo *et al.*, 2010) tagged 26 juvenile Atlantic sturgeon, including 6 young of the year. For non YOY fish, most detections occurred in the lower tidal Delaware River from the middle Liston Range (rkm 70) to Tinicum Island (rkm 141). For non YOY fish, these researchers also detected a relationship between the size of individuals and the movement pattern of the fish in the fall. The fork length of fish that made defined movements to the lower bay and ocean averaged 815 mm (range 651-970 mm) while those that moved towards the bay but were not detected below Liston Range averaged 716 mm (range 505-947 mm), and those that appear to have remained in the tidal river into the winter averaged 524 mm (range 485-566 mm) (Calvo *et al.*, 2010). During the summer months, concentrations of Atlantic sturgeon have been located in the Marcus Hook (rkm 123-129) and Cherry Island Flats (rkm 112-118) regions of the river (Simpson, 2008; Calvo *et al.*, 2010) as well as near Artificial Island (Simpson, 2008). Sturgeon have also been detected using the Chesapeake and Delaware Canal (Brundage, 2007; Simpson, 2008).

Adult Atlantic sturgeon captured in marine waters off of Delaware Bay in the spring were tracked in an attempt to locate spawning areas in the Delaware River, (Fox and Breece, 2010). Over the period of two sampling seasons (2009-2010) four of the tagged sturgeon were detected in the Delaware River. The earliest detection was in mid-April while the latest departure occurred in mid-June (Fox and Breece, 2010). The sturgeon spent relatively little time in the river each year, generally about 4 weeks, and used the area from New Castle, DE (rkm 100) to Marcus Hook (rkm 130) (Fox and Breece, 2010). A fifth sturgeon tagged in a separate study was also tracked and followed a similar timing pattern but traveled farther upstream (to rkm 165)

before exiting the river in early June (Fox and Breece, 2010).

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 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 NYB DPS. As explained above, we have estimated that there are an annual mean total of 950 mature adult Atlantic sturgeon in the NYB DPS. NMFS has determined that the NYB 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.

3.2.6 *Factors Affecting Atlantic Sturgeon in Action Area*

3.2.6.1 *Dams and Hydroelectric facilities*

Connectivity is disrupted by the presence of dams on several rivers in the Gulf of Maine region, including the Penobscot River. 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. Because no Atlantic sturgeon occur upstream of any hydroelectric projects in the Penobscot River, passage over hydroelectric dams or through hydroelectric turbines is not a source of injury or mortality in the action area. The extent that Atlantic sturgeon are affected by operations of hydroelectric facilities in the Penobscot River is currently unknown.

3.2.6.2 *Contaminants and Water Quality*

Atlantic sturgeon are vulnerable to effects from contaminants and water quality over their entire life history. In addition, their long life span increases the potential for environmental contaminants to build up in the tissue which may affect the development of the individual or its gametes. Point source discharges (i.e., municipal wastewater, paper mill effluent, industrial or power plant cooling water or waste water) and compounds associated with discharges (i.e., metals, dioxins, dissolved solids, phenols, and hydrocarbons) contribute to poor water quality that may also impact the health of individual sturgeon. The compounds associated with discharges can alter the chemistry and temperature of receiving waters, which may lead to mortality, changes in fish behavior, deformations, and reduced egg production and survival. Contaminants including heavy metals, polychlorinated aromatic hydrocarbons (PAHs), pesticides, and polychlorinated biphenyls (PCBs), can have serious, deleterious effects on aquatic life and are associated with the production of acute lesions, growth retardation, and reproductive impairment (Ruelle and Keenlyne, 1993). Contaminants introduced into the water column or through the food chain eventually become associated with the benthos where bottom dwelling species like Atlantic sturgeon are particularly vulnerable.

3.2.6.3 *Conservation and Recovery Actions*

Scientific Research Permits

The Maine Department of Marine Resources, in collaboration with scientists at the University of Maine and others, proposes to conduct studies on the Atlantic sturgeon population in the GOM DPS. The research proposed to be conducted through a scientific research permit (NMFS No.

16526; in review) would include determining movement patterns and rate of exchange between coastal river systems, characterizing the population structure (i.e., sex ratios, aging), generating estimates of population abundance. The proposed action would involve several major river systems in Maine, including the Penobscot, Kennebec, Androscoggin and Sheepscot rivers. Smaller coastal rivers throughout Maine would also be targeted. The applicant would use gill nets to capture up to 975 juvenile and adult Atlantic sturgeon, and D-nets to sample 200 early life stage (ELS) annually. Atlantic sturgeon captured by gill nets, trammel nets, trawls, and beach seines would be measured, weighed, photographed, PIT tagged, Floy/T-bar tagged, tissue sampled, boroscoped, apical spine sampled, blood sampled, anesthetized, fin ray sectioned, and be implanted with an acoustic telemetry tag. The applicant would use MS-222 as an anesthetic or on occasion, electronarcosis; see the application for further details. Not all Atlantic sturgeon would undergo all procedures. In total, up to 200 ELS, plus two annual incidental mortalities of juvenile Atlantic sturgeon and up to one adult Atlantic sturgeon over the life of the permit would be anticipated as the result of research. Research conducted prior to issuance of this permit has demonstrated a low mortality rate using similar gear types; approximately 120 Atlantic sturgeon were captured over a five year study with four incidental mortalities occurring to juvenile fish. This research would take place concurrently with authorized shortnose sturgeon research conducted in the Penobscot river under current Permit No. 1595.

4.0 ENVIRONMENTAL BASELINE

Environmental baselines for biological opinions include the past and present impacts of all state, federal or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early Section 7 consultation, and the impact of state or private actions that are contemporaneous with the consultation in process (50 CFR 402.02). The environmental baseline for this biological opinion includes the effects of several activities that occur in the Penobscot River that may affect the survival and recovery of the endangered species in the action area. Therefore, it is important to consider these activities when assessing the impacts of the survey on individual Atlantic and shortnose sturgeon. 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.

4.1 Formal or Early Section 7 Consultation

NMFS has undertaken several ESA Section 7 consultations to address the effects of various federal actions on threatened and endangered species in the upper Penobscot River. However, NMFS has not completed any formal or early section 7 consultations for actions taking place in the action area e.g., lower Penobscot river and estuary.

4.2 Other Federal Actions in the Action Area

In 2000, the US Environmental Protection Agency (EPA) delegated authority for the National Pollutant Discharge Elimination System (NPDES) permit program to the State of Maine. Currently, NMFS reviews and comments on all NPDES issued for discharges to the Penobscot River occurring below the Veazie Dam. In general, water quality has improved in the Gulf of

Maine over the past decades (Lichter *et al.*, 2006; EPA, 2008). However, water quality issues that derive from wastewater treatment plants and power plants are still a concern for all life stages of Atlantic and shortnose sturgeon as effects may be long-lasting.

4.3 Non-Federally Regulated Actions

Fisheries

Unauthorized take of Atlantic and shortnose sturgeon is prohibited by the ESA. However, Atlantic and shortnose sturgeon are taken incidentally in various fisheries along the East Coast and may be targeted by poachers (NMFS 1998). The Penobscot River is an important corridor for migratory movements of various species including alewife (*Alosa pseudohernegus*), American eel (*Anguilla rostrata*), blueback herring (*Alosa aestivalis*), American shad (*Alosa sapidissima*), rainbow smelt (*Osmerus mordax*), and striped bass (*Morone saxatilis*). It has been estimated that approximately 20 shortnose sturgeon were killed each year when commercial shad fisheries were operating in several rivers in the Northeast. There are no longer commercial shad fisheries in operation in the Penobscot River. However, in general there is still the potential for Atlantic and shortnose sturgeon to be taken in recreational fisheries. The incidental take of Atlantic and shortnose sturgeon in the Penobscot River has not been 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 Atlantic and shortnose sturgeon caught and released or killed in commercial or recreational fisheries on the Penobscot River is available.

4.4 Global Climate Change

There is a large and growing body of literature on past, present, and future impacts of global climate change induced by human activities - frequently referred to in layman's terms as "global warming." Some of the likely effects commonly mentioned are sea level rise, increased frequency of severe weather events, and change in air and water temperatures. The EPA's climate change webpage provides basic background information on these and other measured or anticipated effects (see www.epa.gov/climatechange/index.html). Activities in the action area that may have contributed to global warming include the combustion of fossil fuels by vessels. The impact of climate change on Atlantic and shortnose sturgeon in the action area is likely to be related to changes in water temperatures, potential changes to pH and salinity in rivers and oceans, and the potential decline of forage species abundance and distribution. These changes may affect the fitness of individuals and populations of both these species due to the potential loss of foraging opportunities, displacement from ideal habitats and potential increase in susceptibility to disease (Elliot and Simmonds, 2007). Further, a decline in reproductive fitness as a result of global climate change could have profound effects on the abundance and distribution of Atlantic and shortnose sturgeon in the action area, and throughout their range.

Climate change and other forces are predicted to cause a pole-ward shift in the distribution of species and to disrupt the evolved phenology of community organization. This may lead to a change in the species richness, their distribution among watersheds and migration timing in Maine's rivers and estuaries. This will have repercussions for the ecology of the area, including all of the diadromous species utilizing this river system for survival. For example, median capture date for adult Atlantic salmon in the Penobscot and Connecticut rivers has advanced by

more than one day per two years from early 1980s to 2000s (Juanes *et al.*, 2004). New England streams have warmed to 13°C about 12 days earlier compared to the 1970s and evidence suggests alewife runs also occur earlier based on historic run data (Ellis and Vokoun, 2009). Rainbow smelt were extirpated from the Hudson River in the 1990s and are becoming scarce south of Maine (Murawski and Cole, 1978; Waldman 2006). There is also a high economic interest in Maine, as many commercially harvested marine and diadromous species have life stages which exploit estuaries at some point in their life cycle.

As described above, over the long term, global climate change may affect Atlantic and shortnose sturgeon by affecting the distribution of prey, water temperature and water quality. Any activities occurring within and outside the action area that contribute to global climate change are also expected to affect Atlantic and shortnose sturgeon in the action area. However, given the short-term duration of the proposed action (i.e., 2012-2016) both Atlantic and shortnose sturgeon in the action area are unlikely to experience new climate change related effects not already captured in the “Status of the Species” section above concurrent with the proposed action.

4.5 Cumulative threats to Atlantic and shortnose sturgeon from other sources in the action area

The Penobscot River and estuary have suffered greatly in the past from human and industrial pollution. The lumber boom of the mid-1800s and subsequent development of the pulp and paper industry resulted in the construction of numerous dams and the subsequent employment caused a population boom in the river catchment area. Pollution became a problem and the impacts from such industries have had long lasting effects in the river and estuary. Johnson and Larsen (1985) for example, reported that total polycyclic aromatic hydrocarbons (PAHs) concentrations ranged from 286 to 8794 ppb (dry weight) in the Penobscot and that concentrations formed a distinct gradient decreasing seaward from the head. These levels are very high and more like levels found in more impacted systems. Johnson and Larsen (1985) reported that the levels of PAHs in Penobscot Bay would fall within the range found in more industrialized regions. They suggested that most of the pollution in the bay came from upstream sources and that concentrations were highest at the entrance to Belfast Harbor, at Searsport, and at the mouth of the river.

Several characteristics of sturgeon life history including long life span, extended residence in estuarine habitats, and being a benthic omnivore, predispose these species to long term, repeated exposure to environmental contaminants and bioaccumulation of toxicants (Dadswell, 1979). For example, contaminant analysis of tissues from a shortnose sturgeon from the Kennebec River (which supports similar industries, such as paper mills, as the Penobscot River) revealed the presence of fourteen metals, one semivolatile compound, one PCB Aroclor, Polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) in one or more of the tissue samples. Of these, cadmium and zinc were detected at concentrations above an adverse effect concentration reported for fish in the literature (ERC 2003). Thomas and Khan (1997) demonstrated that exposure to cadmium at concentrations well below the concentration detected in the shortnose sturgeon significantly increased ovarian production of estradiol and testosterone which can adversely affect reproductive function. The concentration of zinc detected in the shortnose sturgeon liver tissue was slightly less than the effect concentration for reduced egg hatchability reported by Holcombe *et al.* (1979) and exceeded the effect concentration for reduced survival cited in Flos *et al.* (1979).

Ruelle and Henry (1994) determined that heavy metals and organochlorine compounds (*i.e.*, PCBs) accumulate in fat tissues. Although the long term effects of the accumulation of contaminants in fat tissues are not yet known, some speculate that lipophilic toxins could be transferred to eggs and potentially inhibit egg viability. PCBs may also contribute to a decreased immunity to fin rot. In other fish species, reproductive impairment, reduced egg viability, and reduced survival of larval fish are associated with elevated levels of environmental contaminants including chlorinated hydrocarbons. A strong correlation that has been made between fish weight, fish fork length, and DDE (dichlorodiphenyldichloroethylene) concentration in pallid sturgeon livers indicates that DDE increase proportionally with fish size (NMFS, 1998).

Despite improvements to water quality in the Penobscot River, discharges to this system contribute various chemical contaminants as well as heated effluent to the river. As noted above, the watershed is considered impaired for fish consumption and recreational uses. The cumulative effects of discharges into the river is unknown and may be negatively impacting or delaying the potential for shortnose sturgeon to recover in this system.

While no studies of contaminant levels of Atlantic or shortnose sturgeon in the action area have been conducted, sturgeon found in other large industrial river systems (*e.g.*, Hudson, Delaware and Kennebec) have shown significant contaminant loads. More recently (2010), contaminant analysis conducted on nine shortnose and two Atlantic sturgeon from the Kennebec and Penobscot rivers have indicated an increase in the levels of certain chemical compounds as compared to previous findings (Mierzykowski, 2012). Therefore, it is reasonable to assume Atlantic and shortnose sturgeon occurring in the action area that are exposed to high contaminant loads may be affected by this exposure. It is also possible that the presence of contaminants in the action area may have adversely affected shortnose sturgeon abundance, reproductive success and survival.

In the marine range, threats to Gulf of Maine DPS Atlantic sturgeon from incidental capture in federal and state managed fisheries continue to affect survivorship of subadult and adult Atlantic sturgeon (Stein *et al.*, 2004; ASMFC 2007). There are strict regulations on the use of fishing gear in Maine State waters that minimize incidental catch of 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 commercial 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 originating from the Gulf of Maine DPS are not commonly taken as bycatch in areas south of Chatham, MA. For example, only 8 percent (*e.g.*, 7 of the 84 fish) of interactions observed in the Mid Atlantic/Carolina region have been assigned back 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, sturgeon captured in Canadian fisheries in the Bay of Fundy indicated that approximately 35 percent were from the Gulf of Maine DPS (Wirgin *et al.*, in draft). 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.

4.6 Summary and Synthesis of the Status of the Species and Environmental Baseline

Impacts from actions occurring in the Environmental Baseline for the action area have the potential to impact Atlantic and shortnose sturgeon. Despite regulations on fisheries actions and improvements in water quality, both Atlantic and shortnose sturgeon continue to encounter numerous threats in this area, primarily from poor water quality and habitat alteration. Without more information on the status of Atlantic and shortnose sturgeon in the Penobscot River and the relationship between populations in the Penobscot River, the Kennebec River and other Gulf of Maine rivers, including reliable population estimates and the population dynamics within and between these systems, it is difficult to draw conclusions about the status of these populations with a high level of certainty and accuracy. However, recent investigations are continually providing the most up to date and best available information which NMFS has drawn from in this Opinion; some of these are summarized for each species below.

4.6.1 Summary of Information on shortnose sturgeon in the action area

Shortnose sturgeon adults and subadults are likely to migrate into the action area in the spring as they move from overwintering sites to downstream foraging and resting sites. During other times of the year, individuals are likely migrating within the marine environment or transitioning from and to overwintering and foraging areas within larger rivers along the coast (e.g., Kennebec and Androscoggin). This seasonal change in distribution may be associated with seasonal movements of the saltwedge and differential seasonal use of habitats. The preliminary telemetry data collected by UM suggests that subadult and adult shortnose sturgeon move extensively within the river system during spring and early summer and can be found over mudflats outside the main river channel (Fernandes *et al.*, 2006). As such, shortnose sturgeon overwinter in the upper river and migrate downstream in the spring (mid-April) and are present in the lower river and estuary through the early summer. By July, most shortnose sturgeon begin migrating back upstream to the overwintering area, with all shortnose sturgeon present at the overwintering site by mid to late October. Tracking data from tagged shortnose sturgeon indicates that during the spring and summer, individuals are most likely to occur within rkm 21-24.5 (Fernandes *et al.*, 2010). During the winter months, adult shortnose sturgeon are most likely to occur over a 2 km stretch around rkm 36.5 (Fernandes *et al.*, 2010). However, in 2011 the overwintering site moved further upstream into the Bangor headpond area within Ecozone 1 at approximately rkm 43.

Migration in and out of the Penobscot estuary has been documented, with the majority of movements taking place in the late spring to early summer and few occurring in late summer or early fall. Recent data collected by UMaine and Maine DMR indicate that migration between river systems is more extensive than was previously thought. As summarized by Dionne (2010a in Maine DMR 2010), between 2006 and 2009 a total of 68 shortnose sturgeon were implanted with coded acoustic transmitters. Of the 46 active acoustically tagged individuals, 13 remained within the Penobscot River system. These fish demonstrated an in-river migration pattern that involved downriver movement from the wintering area in the spring, followed by gradual upriver movement throughout the summer prior to returning to the wintering area in the fall (Fernandes *et al.*, 2010). Eleven individuals were characterized as “spring emigrants.” These fish followed

a similar in-river movement pattern to resident fish, but made a single migration out of the Penobscot River system in the spring (April 12 – May 11) while the resident fish remained in the estuary. These fish largely returned to the Penobscot River within two months (May 25 – July 7); with one fish remaining outside the Penobscot River for approximately 1 year. Fifteen tagged fish were determined to be “fall emigrants.” These fish followed the typical in-river migration pattern while in the river, with the exception of using the Kennebec River overwintering site. These fish utilized the Penobscot River from mid-spring through early fall (entering between April 19 and June 19 and leaving between September 9 and November 4). The remaining 7 tagged fish were classified as “summer emigrants.” The movements of these fish were not as well defined; these fish were observed leaving the Penobscot between June 1 and July 1 with some individuals overwintering in the Penobscot and some in the Kennebec. Returns to the Penobscot were made between April 26 and June 8. At least one of these fish spent over three months in coastal river systems between the Penobscot and Kennebec Rivers.

As discussed in the life history sections above, spawning sites for shortnose sturgeon within the Penobscot River have not been identified. However, UM researchers are working to model the preferred spawning habitat within the river in order to understand the essential abiotic components which create the ideal conditions that may promote spawning. Recent efforts conducted by the UM to investigate likely sturgeon spawning sites have been unsuccessful in recovering any eggs or larvae from shortnose sturgeon. Although no spawning has been previously documented in the Penobscot River for this species, there may be other locations within the river that have yet to be discovered. While we do not know if shortnose sturgeon spawning is occurring in the Penobscot River, we do not expect that the gear types used in the study will have any effects to early life stages of either sturgeon species if they are present.

A POPAN Jolly-Seber open population model completed in 2010 estimated approximately 1654 (95%CI: 1108-2200) adult shortnose sturgeon using the Penobscot River. Robust design analysis with closed periods in the summer and late fall estimated seasonal adult abundance ranging from 636-1285 (weighted mean), with a low estimate of 602 (95%CI: 409.6-910.8) and a high of 1306 (95% CI: 795.6-2176.4). The particulars of population dynamics and habitat use of the Penobscot River population are currently being studied. Any estimate of abundance is complicated by information regarding the interchange of individuals between the Kennebec River and Penobscot River. Without information on historical abundance, it is difficult to make determinations regarding the stability of the population or about the long term survival and recovery of this population.

4.6.2 Summary of information on Atlantic sturgeon in the Action Area

Atlantic sturgeon adults and subadults are likely to be present in the action area in the spring as they move from oceanic overwintering sites to upstream foraging and resting sites and then migrate back out of the area as they move to lower reaches of the estuary or oceanic areas in the late summer. During other times of the year, individuals are likely migrating within the marine environment or transitioning from and to overwintering and foraging areas within larger rivers along the coast (e.g., Kennebec and Androscoggin). Tracking data from tagged Atlantic sturgeon indicates that during the spring and summer, individuals are most likely to occur within rkm 21-24.5 (Fernandes *et al.*, 2010). During this time, most Atlantic sturgeon are located between a 1.5 km stretch from rkm 23 to rkm 24.5. During the winter months, subadult Atlantic

sturgeon are most likely to occur over a two km stretch around rkm 36.5 (Fernandes *et al.*, 2010). However, in 2011 the overwintering site moved further upstream into the Bangor headpond area within Ecozone one at approximately rkm 43. As explained above, Atlantic sturgeon in the action area are likely to have originated from the Gulf of Maine DPS and New York Bight DPS with the majority of individuals originating from the Gulf of Maine DPS, and all of those individuals originating from the Kennebec River.

As explained in the status of the species section above, Atlantic sturgeon from the New York Bight and Gulf of Maine DPSs are expected to occur in Penobscot River and estuary. As discussed in the life history sections above, recent spawning of Atlantic sturgeon in the Penobscot River has not been documented. Further, spawning for the Gulf of Maine DPS is known to occur in the Kennebec River. Spawning may be occurring in other rivers, such as the Penobscot and Androscoggin, but has not been confirmed. However, UM researchers are working to model the preferred spawning habitat within the river in order to understand the essential abiotic components which create the ideal conditions that may promote spawning. Recent efforts conducted by the UM to investigate likely sturgeon spawning sites have been unsuccessful in recovering any eggs or larvae from Atlantic sturgeon. Although no spawning has been previously documented in the Penobscot River for this species, there may be other locations within the river that have yet to be discovered. While we do not know if Atlantic sturgeon spawning is occurring in the Penobscot River, we do not expect that the gear types used in the study will have any effects to early life stages of either sturgeon species if they are present.

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 River and the Presumpscot River). 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.

Some of the impacts from the threats that facilitated 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). As noted previously, studies have shown that Atlantic sturgeon can only sustain low levels of bycatch and other anthropogenic mortality (e.g., vessel strikes) (Boreman, 1997; ASMFC, 2007; Kahnle *et al.*, 2007; Brown and Murphy, 2010). 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) the persistence of some degree of threat from bycatch and habitat impacts from continued degraded water quality and dredging in some areas; (2) the likelihood of increased impact from existing threats; and, (3) the lack of measures to address these threats.

5. EFFECTS OF THE ACTION

This section of an Opinion assesses the direct and indirect effects of the proposed action on threatened and endangered species or critical habitat, together with the effects of other activities that are interrelated or interdependent (50 CFR 402.02). Indirect effects are those that are caused

later in time, but are still reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend upon the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration (50 CFR 402.02). This Opinion examines the likely effects (direct and indirect) of the proposed action on Atlantic and shortnose sturgeon in the Penobscot River and their habitat within the context of the species current status, the environmental baseline and cumulative effects.

The biology of Atlantic and shortnose sturgeon complicates the assessment of sturgeon movement and impacts to the species as a whole, as these fish have a long life span, delayed sexual maturity and non-annual spawning behavior (Buckley and Kynard, 1985). For instance, migration patterns that are observed during one year are not always seen in consecutive years because mature adults do not return to the spawning site each year. Further, in many river systems, sturgeon are very particular in regards to habitat use and during certain times of the year are typically only found in discrete regions of the river system. Within river migrations are common for both these species, these include movements from overwintering areas to spawning sites in the early spring, followed by movements to preferred foraging sites in the lower estuary with some individuals choosing to migrate into adjacent river systems. The complex life history, coupled with the scarcity of population dynamics data existing for these species, makes it extremely difficult to fully assess the effects of the proposed research at the population level.

5.1 Effects to Shortnose Sturgeon From Research Activities

In the analysis below, NMFS considers the effects of each of the fish sampling techniques (beach seines, fyke nets, midwater trawls, pop net and plankton sampling) on shortnose sturgeon. In order to determine whether the proposed action affects the abundance, reproduction, or distribution of the species, we first estimate the number of individuals that would likely interact with each gear type (exposure) then we describe the level of effects (response) to each individual. The effects analysis is broken into several components where impacts are most likely to occur: 1) physiological stress associated with handling, capture and entanglement; and 2) migrational delays. While all individuals will be released alive, each of the research activities actively capturing and handling fish will have some human interaction with individual animals resulting in non-lethal effects such as increased physiological stress. Appropriate protocols for sampling and handling during the survey at varying water temperatures (Table 4) will be utilized to minimize effects from sampling and decrease the likelihood of long term effects or mortality to individuals. The other research activities that are proposed as part of this action (hydroacoustic surveys, visual avian and mammal monitoring, habitat mapping/shoreline surveys, and water quality monitoring) will not affect forage species or interact with shortnose sturgeon in any way. As such, the effects of those activities will be insignificant and discountable and not considered further in this analysis.

5.1.1 Effects to shortnose sturgeon from beach seining activities

The best available information, corroborated by past experience in the action area, indicates that shortnose sturgeon are unlikely to be captured in a beach seine. The feasibility work in 2010 and 2011 allowed NEFSC scientists to fish several gear configurations and better understand the incidental catch rates that could be anticipated when sampling approximately 12 selected sites within the Penobscot River and estuary. Sample sites and gear types that have been selected for

2012-2016 are shown in Figure 7 and Table 1. Sites in close proximity to known sturgeon congregating areas including Bald Hill Cove and Oak Point represent important ecological areas in the salinity transition zone and therefore are necessary sampling locations for the estuarine survey.

Anticipated capture rates

The type of habitat where beach seining occurs overlaps with some of the preferred shortnose sturgeon habitat. Shortnose sturgeon forage on tidal mud flats where an abundance of preferred prey items are found. Typically, beach seines will be set in shallow sub-tidal waters near the shore on sandy, gravel or mud substrates. Given the area to be sampled, the short duration of the net sets (15 minutes) and the limited amount of spatial area covered, it is unlikely that any shortnose sturgeon will be captured by the beach seine. This conclusion is supported by data from the MDMR which conducts bi-monthly beach seines in the Kennebec estuary as part of a biological assessment for American shad restoration efforts. From 1982-2009, over 2,703 beach seine hauls were conducted in the Kennebec River and only six shortnose sturgeon were captured. All six were captured in one location on one day in 2007 (Gail Whipplehauser, pers. comm.) and these captures were considered unusual. No mortalities were experienced during this research.

In 2010, 148 beach seines were conducted between August and November 2010 by NEFSC in the action area, and no shortnose sturgeon were captured. In 2011, 146 beach seine hauls were made between April and October (Table 8) by NEFSC in the action area, and no shortnose sturgeon were captured.

Based on the information summarized above, while it is unlikely that any shortnose sturgeon will be encountered during beach seining, it is reasonable to believe that on occasion a shortnose sturgeon could be encountered. This assumption is based mainly on the number of sampling events, coupled with the 12 selected sites specifically chosen to reduce likely interactions with shortnose sturgeon. As described above, while shortnose sturgeon are typically found in deep river channels near the bottom, on rare occasions sturgeon have previously been captured in beach seines being conducted in other river systems in Maine. Based on the information described above, NMFS anticipates capturing up to two shortnose sturgeon during the term of the survey (2012-2016), with no lethal injuries or mortalities expected.

Entrapment and Handling

Direct effects from handling and capture in the seine net will result in some physical damage and physiological stress; which may extend post-capture. Captured shortnose sturgeon will be minimally handled and released immediately; however, released fish may experience minor abrasions due to chafing on the net. These injuries are expected to be minor and full recovery is expected to be rapid and complete. No lethal injuries or mortality are anticipated.

Migrational Delays

Beach seine net sampling involves sets of up to 15 minutes. This may cause shortnose sturgeon to be temporarily withheld from normal behaviors. However, based on results of gill net studies in other river systems where the same fish have been repeatedly captured, the stress related to

this capture is likely to be temporary, and shortnose sturgeon are expected to be able to rapidly recover and resume their normal behaviors. Accordingly, if captured fish are handled correctly, NMFS expects the level of stress to be low enough to result in no long term physiological effects, behavioral change or changes to normal migratory behaviors.

5.1.2 Effects to shortnose sturgeon from fyke netting activities

Fyke nets are considered to be an effective means of sampling in areas where beach seining cannot be accomplished due to substrate, water depth or physical obstacles. The feasibility work in 2010 and 2011 allowed NEFSC scientists to fish several gear configurations and better understand the incidental catch rates that could be anticipated when sampling within the Penobscot River and estuary. In 2011, sampling was expanded to include additional sites over a broader time period than was conducted in 2010. Data collected from previous telemetry work involving sturgeon conducted by researchers from the UM and others, in addition to data collected by MEDMR and NOAA during the 2010 and 2011 field seasons, were considered to select appropriate sites for sampling in 2012-2016. For example, Ecozones 2 and 4 were excluded from sampling with fyke nets due to areas of increased densities and activity of shortnose sturgeon. These data were also used to provide an estimate for interactions and capture rates with each of the gear types proposed. Data collected in 2011 confirm the conservation measures to be effective in reducing sturgeon and marine mammal interactions with these gear types; both fyke nets fished over 650 hours from April through November with no captures of sturgeon.

The NEFSC proposes to fish the fyke net gear through two complete tide cycles, covering a 24 hour period. The fyke nets will be deployed in the water and fishing for no longer than 24 hours at a time. The total anticipated annual effort for fyke netting will be approximately 136 sampling days and approximately 3,200 hours. This sampling frequency is proposed to address study objectives and is consistent with other protocols involving live capture of ESA species; such as rotary screw traps which are used to capture Atlantic salmon smolts and adult salmon traps that are in most cases tended at 24 hour intervals. Although the number of interactions may increase due to an increase in number of hours fishing, the capture rate should not increase. The incidental capture of shortnose sturgeon with this gear type is anticipated to be extremely low; however, the gear fishes on the river bottom where shortnose sturgeon are known to occur and will be placed in habitats where shortnose sturgeon may be present. As such, it is reasonable to assume that shortnose sturgeon could interact with and be captured by this sampling gear. This assumption is supported by the documented capture of shortnose sturgeon by fyke nets fishing in Maryland waters of the Chesapeake Bay, as described below.

Anticipated capture rate

Data for estimating the efficiency of fyke nets to capture sturgeon is limited. Benson et al., (2005) concluded fyke nets to be an ineffective capture technique in a study looking at lake sturgeon in a Lake Michigan tributary. They caught no lake sturgeon in 67 days when examining various gear types targeting sturgeon. Seesholtz (2005) used fyke nets to target and assess local populations of sturgeon in the Feather River in California and did not capture any sturgeon. Additionally, Shuman (2009) did not capture any pallid or shovelnose sturgeon in six years of large river sampling with fyke nets. Information from the USFWS Atlantic Sturgeon

Reward Program, carried out in Maryland waters of the Chesapeake Bay, indicates that both shortnose and Atlantic sturgeon are occasionally caught as bycatch in commercial fyke/hoop net gear (Eyler, unpublished data 2011). Of 75 reported incidental captures of shortnose sturgeon in commercial fishing gear between 1996 and 2006, 12 were in fyke nets, with the size of the fish ranging from 38.4-94cm TL. Without information on the level of fishing effort and the geographic and temporal scope over which these captures have occurred, it is difficult to analyze these data in a meaningful way. Any analysis is further complicated by significant uncertainty surrounding the rate of reporting. Thus, while the data indicates that shortnose sturgeon can be captured in fyke nets, it is not possible to use these data to estimate the likelihood of capture in the deployment of fyke nets being carried out as part of the Penobscot estuary study.

Catch-per-unit-effort (CPUE) data for shortnose sturgeon and fyke nets deployed in the Penobscot River is limited to previous research conducted by NEFSC in 2010 and 2011. Data from 2010 and 2011 (700 hrs approximate soak time) showed no interaction with sturgeon for both years. Other than the fyke nets that NEFSC deployed in 2010 and 2011, no Penobscot-specific data exist for incidental catch of shortnose sturgeon in this gear type. However, CPUE data for research currently being conducted on shortnose sturgeon is available. This effort is focused on capturing shortnose sturgeon using a different type of stationary gear (e.g., gill net) which is being deployed in a similar geographic region of the Penobscot River. In 2006, UM began directed research to document the presence of Atlantic sturgeon in the Penobscot River. During the first summer of sampling, 46 shortnose sturgeon were captured in gill nets set throughout the Penobscot River estuary. Gill nets are commonly used for research on sturgeon and are an efficient means to capture shortnose sturgeon. It is difficult to estimate incidental capture rates for fyke nets from these gill net studies because the nets were specifically deployed in areas of known sturgeon congregations and is the preferred method of catching this species. Further, gill nets have been shown to be more effective at catching various fish species than fyke nets. However, incidental capture rates derived from the NEFSC research conducted in 2010 and 2011 and the direct capture rates for the 2006 study represent the best available information to estimate incidental catch rates for the proposed fyke net sampling⁷. It is important to note that the directed capture estimates obtained from the 2006 research reflect a much higher rate of capture that could be anticipated for the fyke net gear due to gill nets being more efficient at capturing sturgeon in combination with the gear being fished in areas of known sturgeon congregations. The CPUEs of zero derived from the NEFSC pilot study in 2010-2011 are the most relevant and may better represent an incidental catch rate for the gear and locations selected for the proposed study. Therefore, considering this information, the estimates calculated below likely overestimate the potential for interactions and incidental capture rate of shortnose sturgeon in fyke nets. However, merging these CPUEs are thought to provide a reasonable estimate of potential interactions with fyke net gear because: (1) fishing occurred in a similar temporal and spatial scope as the proposed study; (2) both fyke nets and gill nets were set at the bottom of the river, where sturgeon reside; and (3) shortnose sturgeon are known to be vulnerable to capture in

⁷ While CPUE data can also be calculated for gill net fishing effort from 2007-2010, these nets were set in areas where shortnose sturgeon were known to occur and/or were determined to be present based on the detection of tagged individuals; thus, the 2007-2010 CPUE data are likely to grossly overestimate the likely CPUE for fyke nets set for this study, as researchers in this study will be specifically avoiding sturgeon concentration areas.

both gear types (e.g., gill and fyke nets).

Based on the number of fish caught per hour of fishing with 6 inch and 12 inch mesh gill nets in the Penobscot River in 2006, UM calculated a capture rate of 0.079 fish/net hour using a standardized net length. Since the effective fishing area for the gill nets used in the study were significantly larger than the effective fishing area of the fyke nets, it is reasonable to decrease the capture rate for the fyke net accordingly. To figure the effective fishing area for the fyke net gear, we assumed the overall length of the exposed lead for the 2m and the opening from wing tip to wing tip for the 1m (Figures 1 and 2) would comprise the effective fishing area for this gear. Accordingly, the estimated effective fishing area for the fyke nets is 10 times smaller for the 2m and 20 times smaller for the 1m, than the gill nets used in the 2006 study. Based on the effective fishing area, the estimated capture rate for 2m fyke nets would be approximately 0.0079 fish/net hour and for the 1m fyke would be approximately 0.0039 fish/net hour.

The NEFSC is proposing to fish two nets, twice weekly for a period of 24 hours, from April through November. To determine the total amount of fishing effort that can be applied to the incidental capture rate, an estimation of the exposure time individuals would likely encounter the fyke net gear in areas inhabited by sturgeon is considered below. We also accounted for how the gear fished through each of the tidal cycles by making an allowance for the orientation of the gear to the flow of the river and the height of each tidal cycle. This allowed us to determine the appropriate amount of time the gear will be effectively fishing during these times. For example, the 1m fyke net is fished parallel to the flow and the 2m fyke is fished perpendicular, which affects how the gear fishes during different times of each tidal cycle. Therefore, the effective fishing time for each fyke net can be reduced over a 24 hour tidal cycle, mainly during periods of low tide. This reduction amounts to a 4 hour decrease for the 2m fyke and a 12 hour decrease for the 1m fyke, over a 24 hour period.

To calculate fishing effort for each gear type, the action area is divided into separate geographic areas or Ecozones (See Figure 5) with the respective gear types and effort specified for each of these areas in Table 5. As explained above, adult shortnose sturgeon are likely to be present in the action area from mid-April through July, a period of approximately 12 weeks (higher capture rate), with only occasional shortnose sturgeon present in the action area from late summer to early fall (lower capture rate), with only occasional adult shortnose sturgeon present in other Ecozones during this period (Fernandes *et al.*, 2010). All shortnose sturgeon are likely to be in the overwintering area from mid-October to mid-April located immediately above the action area (Ecozone 1). As such, there are likely to be 68 sampling events when more than occasional shortnose sturgeon are likely to be present in the action area⁸ (2m and 1m fyke nets, twice per week for 12 weeks), for a total of 880 and 432 fishing hours, respectively for the 2m and 1m fyke nets. Using the capture rate of 0.0079 fish/hour and 0.0039 for the 2m and 1m fyke nets calculated above, up to eight shortnose sturgeon are likely to encounter the fyke nets during this period. Sampling that occurs between July through October could encounter shortnose sturgeon transiting from one transition area to another (i.e., leaving overwintering or foraging areas) but at

⁸ Based on the best available information, shortnose sturgeon are more likely to occur in the action area between mid-April and early July, with a few shortnose sturgeon also transiting through the action area in the fall when moving back into the river from the Kennebec River.

a lower incidence and capture rate. NEFSC proposes to fish the 2m and 1m fyke nets twice per week for 16 weeks, each fished for up to 24 hours, for a total of 720 and 288 fishing hours respectively for the 2m and 1m fyke nets. Using a reduced capture rate of 0.002 fish/hour for the 2m fyke and .001 fish/hour for the 1m fyke, up to two shortnose sturgeon are likely to encounter the fyke nets during this period. Therefore, the total anticipated interactions with fyke net gear is up to 10 shortnose sturgeon annually (e.g., 8 during mid-April-July and 2 from July –4 October).

To estimate the number of shortnose sturgeon that could be trapped in the sampling gear; take the total number of individual shortnose sturgeon that may encounter this gear ((10) see above) and reduce this number due to restricted access to the trap from an excluder device on the opening of the 2m fyke (Figure 3) and only a four inch opening in the throat of the 1M fyke net (Figure 1). These measures should eliminate capture of larger adult sturgeon by effectively screening for only smaller individuals which could pass through the entrance into the trap. Based on length frequencies and body size of individual shortnose sturgeon captured in gill nets, it is reasonable to anticipate a lower number of fish may actually enter the fyke net and become trapped or entangled in the entrance to the net. Accordingly, shortnose sturgeon larger than 90 cm (2m fyke) and 85 cm (1m fyke) would be excluded from capture in fyke net gear. The frequency of fish captured in 6 inch and 12 inch gill nets deployed in the Penobscot river (2006-2010) in this size range was less than 35% of the total fish sampled. However, this data represents the size distribution of fish captured in a specific gear (6 inch or 12 inch mesh) which was selective for fish large enough to be caught in the gill net. Based on this information, NMFS estimates the number of individuals captured by this gear would only be a third of the total calculated above or approximately three subadult or juvenile fish could be captured in fyke net gear annually.

Anticipated interaction with juvenile shortnose sturgeon

As no juvenile shortnose sturgeon data have been collected in the Penobscot River, it is difficult to estimate the number of juvenile sturgeon that could be in the sampling areas. The CPUE data collected by UM using gill net gear are biased to larger fish and may not have captured any juveniles as a result. Furthermore, it is not reasonable to assume that juveniles would be distributed throughout the river in the same way that adults are. Given that shortnose sturgeon juveniles concentrate above the freshwater/saltwater interface, juveniles are expected to be distributed over at least an approximately 4km stretch of river (Ecozone 1 & 2) from the Veazie Dam to Hampden, Maine (Figure 5). As explained above, the fyke nets will be set downstream of this area (Table 2). Thus, based on the best available information regarding the presence of shortnose sturgeon juveniles above the saltwater/freshwater interface and the location of the fyke net sets, very few juvenile shortnose sturgeon are likely to be present in the targeted areas and very few juvenile shortnose sturgeon are likely to be encountered during the fyke net sampling. However, the fyke net gear is selective for smaller fish and would not likely exclude juvenile sturgeon. Therefore, NMFS anticipates that the capture of juvenile fish in the fyke net gear is possible and thus estimates that a portion of the 3 fish captured (from above) would be subadult. Based on this, NMFS has increased the previous estimate by one; therefore, up to four shortnose sturgeon could be captured in fyke nets annually or up to 20 subadult or adult fish captured over the term of the survey (2012-2016).

Entrapment and Handling

Fyke netting is considered a non-lethal sampling method. However, there is always the potential for a fish to become entangled in the sampling gear; entanglement in nets can result in injury and mortality, reduced fecundity, and delayed or aborted spawning migrations of sturgeon (Moser and Ross, 1995; Collins *et al.*, 2000; Moser *et al.*, 2000 and Kahn and Mohead, 2010). In some cases, if pre-spawning adults are captured and handled, it is possible that they could interrupt or abandon their spawning migrations after being handled (Moser and Ross, 1995). Generally, most of the reported mortalities from similar gear types are due to other extraneous circumstances including environmental conditions (e.g., water temperature and dissolved oxygen), net configuration, soak times and minimal experience handling captured fish. Data reported on mortality rates for shortnose sturgeon captured in gill nets fished in northern river systems range from less than 1% to approximately 4% (Zydlewski *et al.*, 2010 in Maine DMR 2010; Hastings, 1983; Kieffer and Kynard, 1993; Kynard *et al.*, 1999). In the Penobscot River, mortality rates for shortnose sturgeon have been less than 1% (4 mortalities/662 captures; UM unpublished data). The low mortality rates of more recent research efforts are due to mitigation measures implemented by researchers in NMFS permits (Kahn and Mohead, 2010), such as reduced soak times at warmer temperatures or lower dissolved oxygen concentrations and minimal holding or handling time. Similar restrictions for handling shortnose sturgeon during certain water temperatures will be required (Table 4). Based on the recent mitigation measures implemented by researchers, the number of mortalities and effects from capture and handling on shortnose sturgeon has been reduced. The fyke nets used in this study are constructed with 0.6cm (1m fyke) and 1.9cm (2m fyke) coated mesh which will reduce abrasion of adult or juvenile sturgeon. Captured shortnose sturgeon may experience minor abrasions due to chafing on the net. These injuries are expected to be minor and recovery is expected to be rapid and complete. No other injuries are anticipated. Since fish are trapped in fyke nets, not hooked or gilled, NMFS believes that captured sturgeon are less likely to be injured or stressed by this gear.

Migrational Delays

Indirect effects of capture in the net may include post-capture stress and delayed access to foraging or overwintering grounds. Fyke net sampling may involve sets of up to 24 hours. This may cause shortnose sturgeon to be temporarily withheld from normal behaviors. However, based on results of gill net studies in other river systems where the same fish have been repeatedly captured, the stress related to this capture is likely to be temporary and shortnose sturgeon are expected to be able to rapidly recover and resume their normal behaviors. Accordingly, if captured fish are handled correctly, NMFS expects the level of stress to be low enough to result in no long-term behavioral change or long term disruptions to normal migratory behaviors. Further, the capture of migrating sturgeon is not expected to result in excessive stress that would result in pre-spawning adults abandoning their spawning runs.

5.1.3 Effects to Shortnose Sturgeon from Trawling Activities

A midwater/pelagic trawl is proposed for this study; sampling using smaller epibenthic, otter trawls would take place in tidally influenced estuaries and up-river locations identified in Figure 8 and Table 3. Dovel and Berggren (1983) found such trawling was effective for collecting shortnose sturgeon with minimal impact to bottom substrate. Damon-Randall *et al.* (2010) described the effective use of trawl gear in the directed and undirected capture of sturgeon. Trawling studies that are known to result in bycatch of shortnose sturgeon (e.g., Hudson River

Long River Survey and Striped Bass Mark-Recapture Study) employ beam or otter trawls that fish on the bottom.

Anticipated Capture Rates

Data for estimating the efficiency of trawl gear in capturing shortnose sturgeon is limited, however, the information indicates shortnose sturgeon can be captured in trawl gear. The 2007 NMFS status review of Atlantic sturgeon reported many examples of incidental interactions with commercial and research trawl gear. For example, Peterson (2000) reported a CPUE of 0.2 fish per hour in an area of the Hudson River where the population of juvenile Atlantic sturgeon is estimated to be 9,243 in the 225km study area. Wanner et al. (2007) reported a juvenile pallid sturgeon (*Scaphirhynchus albus*) CPUE of 0.012 fish per 100m in their 111km reach. Since they trawled for 300m in 2-3 minutes, this extrapolates to result in a CPUE of 0.72 fish per hour. Additionally, Hastings et al. (1987) reported conducting 720 minutes (12hours) of trawling which yielded two shortnose sturgeon for a CPUE of 0.17 fish/hour. These trawls were all directed bottom trawls with different CPUEs.

Indirect captures of sturgeon have been documented in near shore trawling activities conducted for several monitoring programs in the Gulf of Maine. In 1997, a biweekly trawl survey conducted from April to November by Normandeau Associates in the lower Kennebec River captured 31 subadult and one adult Atlantic sturgeon. Sampling efforts supporting the MEDMR inshore ground fish trawl survey (2000-2003) collected 13 subadult Atlantic sturgeon at the mouth of the Kennebec River (Atlantic Sturgeon Status Review Team, 2007). More recently, in 2009, the MEDMR inshore groundfish trawl survey sampled 44 different stations in the Gulf of Maine and captured no shortnose or Atlantic sturgeon (CPUE of zero). The level of interaction with sturgeon during the aforementioned undirected sampling is a more appropriate CPUE to base an estimate of the catch rate for the ecosystem survey. Based on these surveys, in combination with fishing in areas that overlap with shortnose sturgeon habitat in the Penobscot River, NMFS anticipates the proposed trawling activities conducted for the Ecosystem survey has the potential of incidentally capturing shortnose sturgeon.

Given the CPUE estimates from directed trawling conducted in the GOM, NMFS decreased this catch rate significantly to estimate interactions and captures for the trawl being used by NEFSC in this survey. Additionally, the chance of encounter is further reduced by the short duration of each tow (20 minutes) and efforts to avoid known sturgeon congregation areas. By implementing these conservation measures, the potential for interactions should be minimized. This assumption is supported by data collected by NEFSC in 2011, where they capture no shortnose sturgeon (CPUE of zero). Therefore, based on incidental and directed capture rates described above, NMFS has estimated a conservative CPUE of 0.03 fish/hr during sampling with the trawl gear proposed in the Ecosystem survey. The NEFSC proposes to deploy trawl gear for up to 70 hours annually (approximately 200 tows lasting 20 min. each) in locations that overlap with shortnose sturgeon habitat (Figure 7). Using the CPUE of .03 fish/hr from above, NMFS anticipates that up to 10 shortnose sturgeon would be incidentally captured in trawl gear during the term of the survey (2012-2016).

Anticipated interaction with juvenile shortnose sturgeon

As no juvenile shortnose sturgeon data has been collected in the Penobscot River, it is difficult to estimate the number of juvenile sturgeon that could be in the sampling areas. The data collected by UM using gill net gear is bias to larger fish and may have not captured any juveniles as a result. Furthermore, it is not reasonable to assume that juveniles would be distributed throughout the river in the same way that adults are. Given that shortnose sturgeon juveniles concentrate above the freshwater/saltwater interface, juveniles are expected to be distributed over at least an approximately 4km stretch of river (Ecozone 1 & 2) from the Veazie Dam to Hampden, Maine (Figure 5). As explained above, trawling will be conducted downstream of this area (Table 3). Thus, based on the best available information regarding the presence of shortnose sturgeon juveniles above the saltwater/freshwater interface and the location of the trawling activities, no juvenile shortnose sturgeon are likely to be present in the targeted areas and no juvenile shortnose sturgeon are likely to be encountered from sampling with the trawl gear.

Entrapment and handling

Direct effects from handling and capture in the trawl gear will result in some physical damage and physiological stress; which may extend post-capture. Captured shortnose sturgeon will be minimally handled and released immediately; however, released fish may experience minor abrasions due to chafing on the net. These injuries are expected to be minor and full recovery is expected to be rapid and complete. Very few lethal injuries or mortality are anticipated. Further, data from directed trawling efforts indicates this gear type causes minimal damage or mortality to sturgeon and NMFS believes this gear will be similar in terms of minimal injury and mortality associated with capture. To minimize impacts from handling stress, NEFSC will have a flow through holding tank and will process the fish immediately after gear is hauled back. Based on directed research, the mortality rate for this gear type is anticipated to be low (< 4%); NMFS expects no more than 1 individual would experience lethal injuries or mortality as a result of interactions with trawling gear over the duration of the survey (2012-2016).

Migrational Delays

Indirect effects of capture in the trawl gear may include post-capture stress and delayed access to foraging grounds. Trawl net sampling may involve tows of up to 20 minutes, with some additional time for processing the catch. This may cause shortnose sturgeon to be temporarily withheld from normal behaviors. The stress related to this capture is likely to be temporary and shortnose sturgeon are expected to be able to rapidly recover and resume their normal behaviors. Accordingly, if captured fish are handled correctly, NMFS expects the level of stress to be low enough to result in no long-term behavioral change or long term disruptions to normal migratory behaviors. Further, the capture of migrating sturgeon is not expected to result in excessive stress that would result in pre-spawning adults abandoning their spawning runs.

Anticipated incidental mortality from sampling with Fyke nets and Trawl gear

Given the above information, and assuming the worst case; that capture in a fyke net has comparable mortality rates to capture in a gill net (4% or less) it is reasonable to expect up to one mortality. Additionally, based on directed research, the mortality rate for otter trawl gear is anticipated to be low (< 4%) it is reasonable to expect up to one mortality. However, by following proper handling protocols and carefully releasing the captured fish the majority of

effects that could lead to lethal mortalities can be avoided. Therefore, NMFS expects no more than 1 individual would experience lethal injuries or mortality as a result of interactions with fyke nets or trawling gear over the duration of the survey (2012-2016).

5.1.4 Effects to Shortnose Sturgeon from Other Research Activities

Plankton sampling

A variety of zoo- and phytoplankton sampling techniques will be tested in 2011. The only life stage of shortnose sturgeon that could be vulnerable to capture in these surveys are mobile shortnose sturgeon larvae. Shortnose sturgeon spawning has not been documented to date in the Penobscot River; however, suitable spawning habitat has been identified between the Veazie Dam and the former Bangor Dam. If eggs were present in the river, they are likely to be limited to this stretch of the river and would not be susceptible to capture in the plankton sampling as they are demersal and adhesive and would not be vulnerable to capture in water column sampling. Similarly, larvae are typically found near the bottom and limited to the area above the freshwater/saltwater interface, which is outside of the action area. As no plankton sampling will occur in the area where shortnose sturgeon eggs and larvae are likely to occur, no early life stages of shortnose sturgeon would be vulnerable to capture in the plankton sampling proposed. As such, the effects of this sampling on shortnose sturgeon will be insignificant and discountable.

Pop net

As explained above, the pop net proposed will be a modified frame trawl with a rigid mouth of 3.05m x 3.05m square and an overall length of approximately 8 meters and constructed with a large, outer mesh with a gradient of mesh sizes. The pop net will be lowered until the body of the net collapses and the mouth rests on the bottom. After settling approximately 15 min on the bottom, the net will be manually retrieved vertically, sampling fish in the water column. The pop net fishes a very small volume of water relative to other gears. Any capture of either adult or juvenile shortnose sturgeon is unlikely given: (1) the extremely small area sampled by the pop net; (2) the short duration of the set; and (3) the ability of shortnose sturgeon to swim away and escape as the net is raised off the bottom. Given this analysis, no shortnose sturgeon are likely to be captured in the pop net and all effects of deployment of this gear type will be insignificant and discountable.

5.2 Effects of Research Activities to Atlantic Sturgeon

In the analysis below, NMFS considers the effects of each of the fish sampling techniques (beach seines, fyke nets, midwater trawls, pop net and plankton sampling) on Atlantic sturgeon. Due to the similarity of the species, NMFS expects the impacts of research activities on Atlantic sturgeon would be similar to the effects from capture and handling experienced by shortnose sturgeon as described above. However, the presence of individual Atlantic sturgeon in the Penobscot River and estuary may be different than shortnose sturgeon. For example, telemetry data has shown Atlantic sturgeon subadults to be concentrated in a small area within Ecozone 4 (rkm 21-24) in close proximity to the freshwater/saltwater interface. Further, capture data from Fernandez et al. 2010 suggests the majority of subadult Atlantic sturgeon inhabiting the Penobscot River are encountered between rkm 21.0 and rkm 24.5 (Ecozone 4 as shown in Figure 5) as early as late May until the end of October. However, as explained above, the fyke nets will be set outside of this area. Additionally, during the period from early May through July the

distribution of tagged individual Atlantic sturgeon in the Penobscot River estuary overlapped with other tagged shortnose sturgeon (Fernandez *et al.*, 2010). As such, very few Atlantic sturgeon are likely to be in the action area from mid-October to mid-May. Thus, based on the best available information regarding the presence of Atlantic sturgeon subadults entering the Penobscot river as early as May and residing in the system through October, it is reasonable to believe subadult Atlantic sturgeon will encounter sampling gear and may become captured.

In order to determine whether the proposed action affects the abundance, reproduction, or distribution of the species, we first estimate the number of individuals that would likely interact with each gear type (exposure) then we describe the level of effects (response) to each individual. The effects analysis is broken into several components where impacts are likely to occur: 1) physiological stress associated with handling, capture and entanglement; and 2) migrational delays. While all individuals will be released alive, each of the research activities actively capturing and handling fish will have some human interaction with individual animals resulting in non-lethal physiological stress. Appropriate precautions and handling protocols will be utilized to minimize effects from sampling, which should also decrease the likelihood of long term physiological effects or mortalities. The other research activities that are proposed as part of this action (hydroacoustic surveys, visual avian and mammal monitoring, habitat mapping/shoreline surveys, and water quality monitoring) will not affect forage species or interact with Atlantic sturgeon in any way. As such, the effects of those activities will be insignificant and discountable and not considered further in this analysis.

5.2.1 Effects to Atlantic Sturgeon from Beach Seining Activities

The best available information, corroborated by past experience in the action area, indicates that Atlantic sturgeon are unlikely to be captured in a beach seine. The feasibility work in 2010-2011 allowed NEFSC scientists to fish several gear configurations and better determine the logistics required to sample approximately 12 selected sites within the Penobscot River and estuary. It is important to choose the correct sampling locations in order to maximize gear effectiveness and increase spatial and temporal distribution. Sample sites and gear types that have been selected for 2012-2016 are shown in Figure 7 and Table 1. Sites in close proximity to known sturgeon congregating areas including Bald Hill Cove and Oak Point represent important ecological areas in the salinity transition zone and therefore are necessary sampling locations for the estuarine survey.

Anticipated Capture Rates

The type of habitat where beach seining is proposed mostly overlaps with juvenile or sub-adult Atlantic sturgeon habitat, but some lower river estuary sites will also be sampled. However, since no data are available to support spawning of Atlantic sturgeon in the Penobscot river, NMFS believes very few if any juveniles reside in this system. Since Atlantic sturgeon spend the majority of their adult life in the marine environment where they are typically found in coastal waters, adult sturgeon would not likely be in lower salinity riverine environments as found throughout Ecozones 1-3 as shown in Figure 5.

Typically, beach seines will be set in shallow sub-tidal waters near the shore on sandy, gravel or mud substrates. Given the area to be sampled, the short duration of the net sets (10 minutes) and

the limited amount of spatial area covered, it is extremely unlikely that any juvenile or adult Atlantic sturgeon will be captured by the beach seine. This conclusion is supported by data from the MDMR which conducts bi-monthly beach seines in the Kennebec estuary as part of a biological assessment for American shad restoration efforts. From 1982-2009, over 2,703 beach seine hauls were conducted in the Kennebec River and no Atlantic sturgeon were captured.

In 2010, 148 beach seines were conducted between August and November 2010 by NEFSC in the action area, and no Atlantic sturgeon were captured. In 2011, 146 beach seine hauls were made between April and October by NEFSC in the action area, and no Atlantic sturgeon were captured. Based on this information, NMFS has determined no Atlantic sturgeon will be captured in beach seine gear.

Entrapment and Handling

Based on the information summarized above, it is extremely unlikely that any Atlantic sturgeon will be encountered during beach seining.

Migrational Delays

Based on the information summarized above, it is extremely unlikely that any Atlantic sturgeon will be encountered during beach seining.

5.2.2 Effects to Atlantic Sturgeon from Fyke Netting Activities

Fyke nets are considered to be an effective means of sampling in areas where beach seining cannot be accomplished due to substrate, water depth or physical obstacles. The feasibility work in 2010 and 2011 allowed NEFSC scientists to fish several gear configurations and better understand the incidental catch rates that could be anticipated when sampling within the Penobscot River and estuary. Previous efforts in 2010 and 2011 did not result in capture of any Atlantic sturgeon; however, sites were specifically chosen to reduce the likelihood of capture of Atlantic sturgeon. In 2011, sampling was expanded to include additional sites over a broader time period than was conducted in 2010.

The NEFSC proposes to fish the fyke net gear through two complete tide cycles, covering a 24 hr period. This sampling frequency is proposed to address study objectives and is consistent with other protocols involving live capture of ESA species, such as rotary screw traps which are used to capture Atlantic salmon smolts and adult salmon traps that are in most cases tended at 24 hour intervals. Although the number of interactions may increase due to an increase in number of hours fishing, the interaction rate should not increase. In 2011, modifications to the 2m fyke net included adding excluder bars (which are designed to exclude large fish and marine mammals) and a live car for holding captured fish to minimize handling stress. The 1m fyke has a relatively small 12.7cm throat, thereby excluding marine mammals and large fish. The incidental capture of adult Atlantic sturgeon with this gear type is anticipated to be extremely low; however, the gear fishes on the river bottom where Atlantic sturgeon are known to occur and will be placed in habitats where Atlantic sturgeon may be present. As such, it is reasonable to assume that Atlantic sturgeon could interact with and may become captured in the fyke net gear. This assumption is supported by the documented capture of Atlantic sturgeon by fyke nets fishing in Maryland waters of the Chesapeake Bay, as described below.

5.2.3 Anticipated capture rate

Data for estimating the efficiency of fyke nets to capture sturgeon is limited. Benson et al. (2005) concluded fyke nets to be an ineffective capture technique in a study looking at lake sturgeon in a Lake Michigan tributary. They caught no lake sturgeon in 67 days when examining various gear types targeting sturgeon. Seesholtz (2005) used fyke nets to target and assess local populations of sturgeon in the Feather River in California and did not capture any sturgeon. Additionally, Shuman (2009) did not capture any pallid or shovelnose sturgeon in six years of large river sampling with fyke nets. Information from the USFWS Atlantic Sturgeon Reward Program, carried out in Maryland waters of the Chesapeake Bay indicates that both shortnose and Atlantic sturgeon are occasionally caught as bycatch in commercial fyke/hoop net gear (Eyler, unpublished data 2011). Of 75 reported incidental captures of shortnose sturgeon in commercial fishing gear between 1996 and 2006, 12 were in fyke nets, with the size of the fish ranging from 38.4-94cm TL. Without information on the level of fishing effort and the geographic and temporal scope over which these captures have occurred, it is difficult to analyze this data in a meaningful way. Any analysis is further complicated by significant uncertainty surrounding the rate of reporting. Thus, while the data indicates that Atlantic sturgeon can be captured in fyke nets, it is not possible to use this data to estimate the likelihood of capture in the deployment of fyke nets being carried out as part of the Penobscot estuary study.

Catch per unit effort (CPUE) data for Atlantic sturgeon and fyke nets deployed in the Penobscot River is limited to previous research conducted by NEFSC in 2010 and 2011. Data from 2010 and 2011 (700 hours approximate soak time) showed no interaction with Atlantic sturgeon for both years. Other than the fyke nets that NEFSC deployed in 2010 and 2011, no Penobscot-specific data exist for interaction with Atlantic sturgeon and this gear type. However, CPUE data for research currently being conducted on shortnose sturgeon is available. This effort is focused on capturing shortnose sturgeon using a different type of stationary gear (e.g., gill net) which is being deployed in a similar geographic region of the Penobscot River. In 2006, UM began a study to document the presence of shortnose sturgeon in the Penobscot River. During the first summer of sampling, 35 subadult Atlantic sturgeon were captured in gill nets set throughout the Penobscot River estuary. Gill nets are an efficient means to capture Atlantic and shortnose sturgeon and are more effective at catching these species than fyke nets and were deployed in similar habitat types. Interaction estimates and capture rates derived from the NEFSC research conducted in 2010 and 2011 in addition to the 2006 study represent the best available information on encounter rates for the proposed fyke net sampling⁹. It is important to note that the capture estimates for 2006 reflect an upper limit or “worst case scenario”, as gill nets are expected to be more efficient at capturing sturgeon and were fished in areas of known sturgeon congregations. The CPUEs from the NEFSC pilot study in 2010-2011 (CPUE of zero) are the most relevant and may better represent the gear and locations selected for the proposed study. Therefore, using this information, the estimates calculated below likely overestimate the potential capture rate of Atlantic sturgeon in fyke nets. However, these CPUEs are thought to be

⁹ While CPU data can also be calculated for gill net fishing effort from 2007-2010, these nets were set in areas where shortnose sturgeon were known to occur and/or were determined to be present based on the detection of tagged individuals; thus, the 2007-2010 CPU data are likely to grossly overestimate the likely CPU for fyke nets set for this study, as researchers will be specifically avoiding sturgeon concentration areas.

a reasonable estimate of interactions with fyke nets because: (1) fishing occurred in a similar temporal and spatial scope as the proposed study; (2) both fyke nets and gill nets were set at the bottom of the river, where sturgeon reside; and (3) Atlantic sturgeon are known to be vulnerable to capture in both gear types (e.g., gill and fyke nets).

Based on the number of fish caught per hour of fishing with 6 inch and 12 inch mesh gill nets in the Penobscot River in 2006, UM calculated a capture rate of 0.009 fish/net hour using a standardized net length. Since the effective fishing area for the gill nets used in the study were significantly larger than the effective fishing area of the fyke nets, it is reasonable to decrease the capture rate for the fyke net accordingly. To figure the effective fishing area for the fyke net gear, we assumed the overall length of the exposed lead for the 2m and the opening from wing tip to wing tip for the 1m (Figures 1 and 2) comprised the effective fishing area for this gear. Accordingly, the estimated effective fishing area for the fyke nets is 10 times smaller for the 2m and 20 times smaller for the 1m, than the gill nets used in the 2006 study. Based on the effective fishing area, the estimated capture rate for 2m fyke nets would be approximately 0.0009 fish/net hour and for the 1m fyke would be .0005 fish/net hour.

The NEFSC is proposing to fish two nets, twice weekly for a period of 24 hours, from April through November. To calculate fishing effort for each gear type, the action area is divided into separate geographic areas or Ecozones (See Figure 5) with the respective gear types and effort specified for each of these areas in Table 5. As explained above, sub-adult Atlantic sturgeon are likely to be present in Ecozone 4 from mid-May through October, with only occasional subadult Atlantic sturgeon present in other Ecozones during this period (Fernandes *et al.*, 2010). Additionally, very few Atlantic sturgeon are likely to be in the action area from mid-October to mid-May and there are no sampling events proposed where more than occasional subadult Atlantic sturgeon are likely to be present in the immediate area¹⁰. Sampling is proposed for areas outside of Ecozone 4 that could encounter subadult Atlantic sturgeon transiting from one transition area to another (i.e., leaving Ecozone 4 area). To determine the total amount of fishing effort that can be applied to the incidental capture rate, an estimation of the exposure time individuals would likely encounter the fyke net gear in areas inhabited by sturgeon is considered below. We also considered how the gear fished through each of the tide cycles which accounted for the orientation of the gear to the flow of the river and the height of each tide cycle. This allowed us to determine the appropriate amount of time the gear will be effectively fishing during these times. For example, the 1m fyke net is fished parallel to the flow and the 2m fyke is fished perpendicular, which affects how the gear fishes during different tide cycles. Therefore, the effective fishing time for each fyke net can be reduced over a 24 hour tide cycle, mainly during periods of low tide. This reduction amounts to a four hour decrease for the 2m fyke and a 12 hour decrease for the 1m fyke, over a 24 hour period. As such, 2m and 1m fyke nets fished twice per week for 28 weeks, each fished for up to 24 hours, for a total of 1600 and 720 fishing hours respectively for the 2m and 1m fyke nets. Using the capture rate of 0.0009 fish/hour for the 2m fyke and .0005 fish/hour for the 1m fyke, no more than two Atlantic sturgeon are likely to encounter the fyke nets annually.

¹⁰ Based on the best available information, sub-adult Atlantic sturgeon are likely to occur within Eco zone 4 of the identified action area between mid-May and early October, with few Atlantic sturgeon also transiting through the action area during migrations from various transition zones or when moving back into the Kennebec River.

The total number of individual Atlantic sturgeon that may encounter this gear and become trapped (2 from above) can be further reduced because fyke nets will have restricted access to the trap due to an excluder device on the opening of the 2m fyke (Figure 3) and only a 4 inch opening in the throat of the 1m fyke net (Figure 1). These measures should eliminate the capture of larger sturgeon by effectively screening for only smaller individuals to pass through into the trap. Based on length frequencies and body size of captured individuals (UM data sent to NMFS), it is reasonable to anticipate a lower number of fish may enter the fyke net and actually become trapped or entangled in the entrance to the net. Accordingly, Atlantic sturgeon over 110 cm would be excluded from entering the entrance to the fyke net. Data collected from the UM gill netting efforts between 2006-2010, showed a length frequency distribution for individuals smaller than 110 cm would be approximately 30%. Based on this information, it would be reasonable to estimate the number of individuals captured by this gear would only be a third of the total calculated above. However, considering the limitations of the data (size selective for larger fish) and to account for the potential presence of juveniles in the system, the number of individuals anticipated to be encountered annually (two from above) has been decreased by only one. Therefore, NMFS estimates up to five individual Atlantic sturgeon (3 GOM, 1 St. John River and 1 NYB) will be captured over the term of the survey (2012-2016).

Entrapment and Handling

Fyke netting is considered a non-lethal sampling method. However, there is always the potential for a fish to become entangled in the sampling gear; entanglement in nets can result in injury and mortality, reduced fecundity, and delayed or aborted spawning migrations of sturgeon (Moser and Ross, 1995; Collins *et al.*, 2000; Moser *et al.*, 2000 and Kahn and Mohead, 2010). In some cases, if pre-spawning adults are captured and handled, it is possible that they could interrupt or abandon their spawning migrations after being handled (Moser and Ross, 1995). Generally, most of the reported mortalities from similar gear types are due to other extraneous circumstances including environmental conditions (e.g., water temperature and dissolved oxygen), net configuration, soak times and experience handling captured fish. Data reported for shortnose sturgeon mortality rates for fish captured in gill nets fishing in northern river systems range from less than 1% to approximately 4% (Zydlowski *et al.*, 2010 in Maine DMR 2010; Hastings, 1983; Kieffer and Kynard, 1993; Kynard *et al.*, 1999). In the Penobscot River, mortality rates have been less than 1% (4 mortalities/662 captures; UM unpublished data). The low mortality rates of more recent research are due to mitigation measures implemented in permits by NMFS and researchers following accepted sturgeon protocols (Kahn and Mohead, 2010), such as reduced soak times at warmer temperatures or lower dissolved oxygen concentrations and minimal holding or handling time. Similar restrictions for handling Atlantic sturgeon during certain water temperatures will be required (Table 4). Based on the recent mitigation measures implemented by researchers, the number of mortalities and effects from capture and handling on shortnose sturgeon has been reduced. Since fish enter the fyke net and are trapped, not hooked or gilled, NMFS believes that captured sturgeon are less likely to be injured or stressed by this gear type. In addition, the fyke nets used in this study are constructed with 0.6cm (1m fyke) and 1.9cm (2m fyke) coated mesh which will reduce abrasion of adult or juvenile sturgeon. Captured Atlantic sturgeon may experience minor abrasions due to chafing on the net. These injuries are expected to be minor and recovery is expected to be rapid and

complete. No other injuries are anticipated.

Migrational Delays

Because Atlantic sturgeon would be passively trapped and not gilled in fyke nets, the capture of migrating sturgeon is not expected to result in excessive stress that would result in pre-spawning adults abandoning their spawning runs. If captured, and fish are handled correctly, NMFS expects the level of stress would be low enough to result in no long-term behavioral change.

Indirect effects of capture in the net may include post-capture stress and delayed access to foraging or overwintering grounds. Fyke net sampling may involve sets of up to 24 hours. This may cause Atlantic sturgeon to be temporarily withheld from normal behaviors. However, based on results of gill net studies in other river systems where the same fish have been repeatedly captured, the stress related to this capture is likely to be temporary and Atlantic sturgeon are expected to be able to rapidly recover and resume their normal behaviors. As such, long term disruptions to normal migratory behaviors are not likely.

5.2.4 Effects to Atlantic Sturgeon from Trawling Activities

A midwater/pelagic trawl is proposed for this study. Trawling studies that are known to result in bycatch of shortnose sturgeon (e.g., Hudson River Long River Survey and Striped Bass Mark-Recapture Study) employ beam or otter trawls that fish on the bottom. As Atlantic sturgeon are not typically found in the mid and upper water column where the trawl will be fished, they are less likely to encounter the gear. However, on occasion they are observed at the surface or leaping from the water. While these events occur infrequently, it is reasonable to anticipate encountering a few individuals during the term of the survey.

Anticipated capture rates

The 2007 NMFS status review of Atlantic sturgeon reported many examples of incidental interactions with commercial and research trawl gear. For example, Peterson (2000) reported a CPUE of 0.2 fish per hour in an area of the Hudson River where the population of juvenile Atlantic sturgeon is estimated to be 9,243 in the 225km study area. Wanner et al. (2007) reported a juvenile pallid sturgeon (*Scaphirhynchus albus*) CPUE of 0.012 fish per 100m in their 111km reach. Since they trawled for 300m in 2-3 minutes, this extrapolates to result in a CPUE of 0.72 fish per hour. Additionally, Hastings et al. (1987) reported conducting 720 minutes (12hrs) of trawling which yielded two shortnose sturgeon for a CPUE of 0.17 fish/hour. These trawls were all directed bottom trawls with different CPUEs.

Indirect captures of sturgeon have been documented in near shore trawling activities conducted for several monitoring programs in the Gulf of Maine. In 1997, a biweekly trawl survey conducted from April to November by Normandeau Associates in the lower Kennebec River captured 31 subadult and one adult Atlantic sturgeon. Sampling efforts supporting the MEDMR inshore ground fish trawl survey (2000-2003) collected 13 subadult Atlantic sturgeon at the mouth of the Kennebec River (Atlantic Sturgeon Status Review Team, 2007). More recently, in 2009, the MEDMR inshore groundfish trawl survey sampled 44 different stations in the Gulf of Maine and didn't capture any shortnose or Atlantic sturgeon (CPUE of zero). The level of interaction with sturgeon during the aforementioned undirected sampling is a more appropriate CPUE to base an estimate of the catch rate for the ecosystem survey. Based on these surveys, in

combination with fishing in areas that overlap with Atlantic sturgeon habitat in the Penobscot River, NMFS anticipates the proposed trawling activities conducted for the Ecosystem survey has the potential of incidentally capturing Atlantic sturgeon.

Given the CPUE estimates from directed trawling conducted in the GOM, NMFS decreased this catch rate significantly to estimate interactions and captures for the trawl being used by NEFSC in this survey. This is primarily due to two reasons: 1) the chance of encountering individual sturgeon is further reduced by the short duration of each tow (20 minutes); and 2) efforts to avoid known sturgeon congregation areas reduces the potential for interactions. This reduction in CPUE is supported by data collected by NEFSC in 2011 and the MEDMR inshore survey; where they captured no Atlantic sturgeon. Therefore, based on incidental and directed capture rates described above, NMFS has estimated a conservative CPUE of 0.03 fish/hr during sampling with the trawl gear proposed in the Ecosystem survey. The NEFSC proposes to deploy trawl gear for up to 70 hours annually (approximately 200 tows lasting 20 min. each) in locations that overlap with Atlantic sturgeon habitat (Figure 7). Using the CPUE of .03 fish/hr from above, NMFS anticipates that up to 10 Atlantic sturgeon (6 GOM, 3 St. John and 1 NYB) would be incidentally captured in trawl gear during the term of the survey (2012-2016).

Entrapment and Handling

Direct effects from handling and capture in the trawl gear will result in some physical damage and physiological stress, which may extend post-capture. Captured Atlantic sturgeon will be minimally handled and released immediately; however released fish may experience minor abrasions due to chafing on the net. These injuries are expected to be minor and full recovery is expected to be rapid and complete. Very few lethal injuries or mortality are anticipated. Further, data from directed trawling efforts indicates this gear type causes minimal damage or mortality to sturgeon and NMFS believes this gear will be similar in terms of minimal injury and mortality associated with capture. In addition, to minimize impacts from handling stress, NEFSC will have a flow through holding tank and will process the fish immediately after gear is hauled back.

Migrational Delays

Indirect effects of capture in the trawl gear may include post-capture stress and delayed access to foraging grounds. Trawl net sampling may involve tows of up to 20 minutes, with some additional time for processing the catch. This may cause Atlantic sturgeon to be temporarily withheld from normal behaviors. The stress related to this capture is likely to be temporary and Atlantic sturgeon are expected to be able to rapidly recover and resume their normal behaviors. Accordingly, if captured fish are handled correctly, NMFS expects the level of stress to be low enough to result in no long-term behavioral change or long term disruptions to normal migratory behaviors. Further, the capture of migrating sturgeon is not expected to result in excessive stress that would result in pre-spawning adults abandoning their spawning runs.

Anticipated incidental mortality from sampling with Fyke nets and Trawl gear

Given the above information, and assuming the worst case, that capture in a fyke net has comparable mortality rates to capture in a gill net (4% or less) it is reasonable to expect up to one mortality. Additionally, based on directed research, the mortality rate for otter trawl gear is

anticipated to be low (< 4%) it is reasonable to expect up to one mortality. However, by following proper handling protocols and carefully releasing the captured fish the majority of effects that could lead to lethal mortalities can be avoided. Therefore, NMFS expects no more than one subadult Atlantic sturgeon would experience lethal injuries or mortality as a result of interactions with fyke nets or trawling gear over the duration of the survey (2012-2016).

5.2.5 Effects to Atlantic Sturgeon from Other Research Activities

Plankton sampling

A variety of zoo- and phytoplankton sampling techniques will be tested in 2011. The only life stage of Atlantic sturgeon that could be vulnerable to capture in these surveys are mobile Atlantic sturgeon larvae. Atlantic sturgeon spawning has not been documented to date in the Penobscot River; however, suitable spawning habitat has been documented between the Veazie Dam and the former Bangor Dam. If eggs were present in the river, they are likely to be limited to this stretch of the river and would not be susceptible to capture in the plankton sampling as they are demersal and adhesive and would not be vulnerable to capture in water column sampling. Similarly, larvae are typically found near the bottom and limited to the area above the freshwater/saltwater interface, which is outside of the action area. As no plankton sampling will occur in the area where Atlantic sturgeon eggs and larvae are likely to occur, no early life stages of Atlantic sturgeon would be vulnerable to capture in the plankton sampling proposed. As such, the effects of this sampling on Atlantic sturgeon will be insignificant and discountable.

Pop net

As explained above, the pop net proposed will be a modified frame trawl with a rigid mouth of 3.05m x 3.05m square and an overall length of approximately 8 meters and constructed with a large, outer mesh with a gradient of mesh sizes. The pop net will be lowered until the body of the net collapses and the mouth rests on the bottom. After settling approximately 15 min on the bottom, the net will be manually retrieved vertically, sampling fish in the water column. The pop net fishes a very small volume of water relative to other gears. Any capture of either adult or juvenile Atlantic sturgeon is unlikely given: (1) the extremely small area sampled by the pop net; (2) the short duration of the set; and (3) the ability of Atlantic sturgeon to swim away and escape as the net is raised off the bottom. Given this analysis, no Atlantic sturgeon are likely to be captured in the pop net and all effects of deployment of this gear type will be insignificant and discountable.

6. CUMULATIVE EFFECTS

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

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

Impacts to individual Atlantic and shortnose sturgeon from non-Federal activities are largely unknown in this large river system. It is possible that recreational and commercial fishing for anadromous fish species may result in incidental takes of Atlantic or shortnose sturgeon.

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, power plants and other industrial facilities. Contaminants introduced into the water column or through the food chain eventually become associated with the benthos where bottom dwelling species like Atlantic and shortnose sturgeon are particularly vulnerable.

Industrialized waterfront development will continue to impact the water quality in and around the action area. Sewage treatment, industrial, and electric generating facilities present in the action area are likely to continue to operate. Excessive water turbidity, water temperature variations and increased shipping traffic are likely with continued future operation of these facilities. As described in more detail above, as a result of these activities, Atlantic and shortnose sturgeon behavior, spawning success and/or distribution in the action area may be adversely affected.

7. INTEGRATION AND SYNTHESIS OF EFFECTS

In the discussion below, NMFS considers 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 shortnose sturgeon and the New York Bight and Gulf of Maine 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 shortnose sturgeon and the New York Bight and Gulf of Maine DPSs of Atlantic sturgeon.

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 shortnose sturgeon and the New York Bight and Gulf of Maine DPSs of Atlantic sturgeon, the listed species that may be affected by the proposed action, NMFS summarizes the status of the species and considers 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.

NMFS has estimated that the proposed NEFSC Ecosystem survey, to be carried out between 2012-2016, will result in the capture of up to 32 shortnose sturgeon and up to 15 Atlantic sturgeon in sampling gear that may result in both non-lethal and lethal effects (Table 7). While lethal injuries and/or mortalities are being reduced by adhering to specific handling protocols; nonetheless, increased handling stress and gear related injuries could still result in the death of up to one shortnose sturgeon and up to one individual Gulf of Maine or one individual New York Bight Atlantic sturgeon. Any interactions between the sampling gear and sturgeon are expected to have minor behavioral, physiological and physical effects; however, NMFS anticipates these fish to fully recover from any handling stress or physical injuries without any reduction in fitness and only a minimal impact on survival (< 4%).

7.1. *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 shortnose sturgeon residing in the Penobscot River come from one of these nineteen populations. 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.

NMFS has estimated that the proposed NEFSC Ecosystem survey will result in non-lethal physiological and behavioral impacts to no more than 32 shortnose sturgeon. One mortality is anticipated. As explained in the "Effects of the Action" section, the deployment of certain gear types (e.g., beach seine, trawl gear and fyke nets) is likely to result in interactions with a limited number of shortnose sturgeon. Further, no interactions with shortnose sturgeon are likely to result from any of the other gear types identified in the proposed study plan. The potential for effects are possible when fish encounter or are trapped by the sampling gear. These effects could include range from altering normal behavior such as a temporary startle or avoidance of the sampling area or result in minor physiological stress and minor physical injury from abrasion associated with physically interacting with the trap, main lead or wings. Non-lethal behavioral responses are expected to be temporary and spatially limited to the area and time fish interact with or are restricted by sampling gear. Capture in sampling gear is anticipated to increase physiological effects associated with handling stress and result in minor injuries that for the majority (> 96%) will not impair the fitness of any individuals or affect survival; however, a small percentage (<4%) could suffer lethal injuries or death. We have determined that any behavioral responses from fish passively interacting with the sampling gear, including in the worst case, an increase in physiological stress associated with physically interacting with the leads, would have insignificant and discountable effects to individuals. We have further

determined the behavior and physiological responses as a result of sturgeon becoming captured would increase physiological stress (i.e., associated with physically removing the animal from the trap) and cause physical injury, which could result in mortality (up to 4%). Therefore, the survival of up to one individual shortnose sturgeon will be affected by the proposed sampling during the term of the survey. As such, there will be a slight reduction in the numbers of shortnose sturgeon and no change in the status of this species or its trend.

Interactions between shortnose sturgeon and beach seines are anticipated to be very brief in duration (< 20 minutes) and limited to the immediate area of the net set. Because shortnose sturgeon could become captured in this gear, protocols will be in place to expedite release and reduce stress from handling. As outlined above, no more than two shortnose sturgeon are likely to become captured in a beach seine over the course of the sampling efforts (2012-2016). All fish are anticipated to be released alive with minimal injury.

Adverse effects may result from interactions with the fyke nets. Specifically, shortnose sturgeon encountering the fyke nets may become trapped within the fyke net until the net is tended and the catch is processed and released. This will result in the disruption of normal behaviors for a maximum of 24 hours. As outlined above, no more than 20 shortnose sturgeon are likely to become entangled or trapped in a fyke net over the course of the sampling efforts (2012-2016). While fyke net sampling is generally considered to be non-lethal, there is the potential for sturgeon to become trapped or entangled in the gear or otherwise suffer lethal injury or mortality. However, the mortality rate is expected to be very low and less than the mortality rate estimated for gill nets (less than 4%).

Shortnose sturgeon captured in trawl gear will experience a disruption in normal behavior for up to 30 minutes and may result in physical injury that may lead to death. As outlined above, no more than 10 shortnose sturgeon are likely to become captured in a trawl net over the course of the sampling efforts (2012-2016). While precautions will be taken to minimize handling stress, physical injuries due to being captured by trawl gear could result in lethal injury or mortality. Data from commercial trawling indicates a low mortality rate of sturgeon incidentally caught in otter trawl gear.

While the proposed sampling may result in the mortality of one shortnose sturgeon, this number represents a very small percentage of shortnose sturgeon in the Penobscot River, and an even smaller percentage of the total population of shortnose sturgeon rangewide. It is also important to note that this mortality estimate is considered to be a worst case scenario and is based on conservative assumptions outlined in the "Effects of the Action" section above. As described in the "Status of the Species in the Action Area" section above, the best available adult abundance estimates indicate that there are approximately 1,654 adult shortnose sturgeon in the Penobscot River and an unknown number of juveniles. While the death of one adult shortnose sturgeon will reduce the number of shortnose sturgeon in the Penobscot River compared to the number that would have been present absent the proposed action, it is not likely that this reduction in numbers will change the status of this population as this loss represents only 0.06% of fish residing in the Penobscot River.

This action is expected to have an undetectable reduction in reproduction of shortnose sturgeon in the Gulf of Maine for the following reasons: (1) the fyke net sampling is not likely to intercept any pre-spawning shortnose sturgeon; thus, there will be no delay in migration to the spawning grounds; and (2) at worst, the action will result in the mortality of one adult shortnose sturgeon; as there are many thousands of available spawners in the Kennebec River, the reduction in available spawners by no more than one is expected to result in an undetectable reduction in the number of eggs laid or larvae produced and similarly, an undetectable effect on the strength of subsequent year classes. Additionally, as no spawning has been documented in the Penobscot River, the proposed action will not affect spawning habitat in any way and will not create any barrier to pre-spawning sturgeon accessing the spawning grounds in the Kennebec River. 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 and Penobscot Rivers. Further, the action is not expected to reduce the river by river distribution of shortnose sturgeon or the ability of shortnose sturgeon to migrate between the Penobscot and Kennebec Rivers or any other coastal rivers. Additionally, as the number of shortnose sturgeon likely to be killed as a result of the proposed action is less than 0.06% of the Penobscot River inhabitants, there is not likely to be a loss of any unique genetic haplotypes and therefore, it is unlikely to result in the loss of genetic diversity. While, generally speaking, the loss of a small number of individuals from a subpopulation or species may have an appreciable effect on the numbers, reproduction and distribution of the species, this is likely to occur only when there are very few individuals in a population, the individuals occur in a very limited geographic range or the species has extremely low levels of genetic diversity. This situation is not likely in the case of shortnose sturgeon because: (1) the species is widely geographically distributed; (2) it is not known to have low levels of genetic diversity (see status of the species section above); and (3) there are thousands of shortnose sturgeon expected to spawn each year.

Based on the information provided above, the death of no more than one shortnose sturgeon as a result of the proposed project will not appreciably reduce the likelihood of survival (i.e., it will not increase the risk of extinction faced by this species) for this species given that: (1) the population trend of shortnose sturgeon in the Gulf of Maine is stable or increasing; (2) the death of one shortnose sturgeon represents an extremely small percentage of the number of shortnose sturgeon in the Penobscot River and an even smaller percentage of the species as a whole; (3) the loss of one shortnose sturgeon will not change the status or trends of the species as a whole; (4) the loss of one shortnose sturgeon is likely to have an undetectable effect on reproductive output of shortnose sturgeon throughout its' range or the species as a whole; and (5) the action will have no effect on the distribution of shortnose sturgeon in the action area or 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 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 ESA 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, and (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 a slight reduction in the number of shortnose sturgeon and since it will not affect the overall distribution of shortnose sturgeon other than to cause minor temporary adjustments in movements within the action area. The proposed action will not utilize shortnose sturgeon for recreational or commercial purposes or affect the adequacy of existing regulatory mechanisms to protect this species. The proposed action is likely to result in up to one mortality, a slight reduction in future reproductive output; therefore, the NEFSC Ecosystem survey is not expected to affect the persistence of shortnose sturgeon rangewide. There will be no change in the status or trend of shortnose sturgeon. As there will be only a slight reduction in numbers or future reproduction, the action would not cause any reduction in the likelihood of improvement in the status of shortnose sturgeon. The effects of the proposed action will not hasten the extinction timeline or otherwise increase the danger of extinction since the action will not cause any significant 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 shortnose sturgeon can be brought to the point at which they are no longer listed as endangered. Based on the analysis presented herein, the proposed action is not likely to appreciably reduce the survival and recovery of this species.

7.2. *Atlantic sturgeon*

NMFS has estimated that the proposed estuarine sampling study may interact with New York Bight and GOM DPSs of Atlantic sturgeon. As explained in the “Effects of the Action” section, the deployment of certain gear types (e.g., trawl gear and fyke nets) is expected to directly affect up to 15 or fewer Atlantic sturgeon subadults (4 St. John River (Canada), 9 GOM DPS and 2 NYB DPS). Because these gear types are not selective for which populations may be captured, NMFS anticipates that the effects from this Ecosystem survey could impact both the New York Bight and Gulf of Maine DPSs of Atlantic sturgeon. Further, the one mortality authorized in the ITS is allocated to either the GOM DPS or NYB DPS. Therefore, impacts from the anticipated interaction and capture of up to 15 individual Atlantic sturgeon which could originate from either the GOM DPS or NYB DPS are described below. Further, no interactions with Atlantic sturgeon are likely to result from any of the other gear types identified in the study plan.

7.2.1 *Gulf of Maine DPS of Atlantic sturgeon*

While Atlantic sturgeon occur in several rivers in the Gulf of Maine, recent spawning has only been documented in the Kennebec and Androscoggin rivers. The available information indicates that the size of the adult population is approximately 166 adults with approximately 1/3 of adults spawning each year. There are approximately 498 subadults estimated from captures of fish in commercial fisheries in the Gulf of Maine.

NMFS has estimated that the proposed NEFSC Ecosystem survey will result in non-lethal physiological and behavioral impacts to no more than 9 GOM DPS Atlantic sturgeon; one mortality is anticipated. As explained in the "Effects of the Action" section, the deployment of certain gear types (e.g., trawl gear and fyke nets) is likely to result in interactions with a limited number of Atlantic sturgeon. Further, no interactions with Atlantic sturgeon are likely to result from any of the other gear types identified in the proposed study plan. The potential for effects are possible when fish encounter or are trapped by the sampling gear. These effects could range from altering normal behavior such as a temporary startle or avoidance of the sampling area or result in minor physiological stress and minor physical injury from abrasion associated with physically interacting with the trap, main lead or wings. Non-lethal behavioral responses are expected to be temporary and spatially limited to the area and time fish interact with or are restricted by sampling gear. Capture in sampling gear is anticipated to increase physiological effects associated with handling stress and result in minor injuries that for the majority (> 96%) will not impair the fitness of any individuals or affect survival; however, a small percentage (<4%) could suffer lethal injuries or death. We have determined that any behavioral responses from fish passively interacting with the sampling gear, including in the worst case, an increase in physiological stress associated with physically interacting with the leads, would have insignificant and discountable effects to individuals. We have further determined the behavior and physiological responses as a result of sturgeon becoming captured would increase physiological stress (i.e., associated with physically removing the animal from the trap) and cause physical injury, which could result in mortality (up to 4%). Therefore, the survival of up to one individual GOM DPS Atlantic sturgeon will be affected by the proposed sampling during the term of the survey. As such, there will be a slight reduction in the numbers of GOM DPS Atlantic sturgeon and no change in the status of this species or its trend.

Adverse effects may result from interactions with the fyke nets. Specifically, Atlantic sturgeon encountering the fyke nets may become trapped within the fyke net until the net is tended and the catch is processed and released. This will result in the disruption of normal behaviors for a maximum of 24 hours. As outlined above, no more than three GOM DPS Atlantic sturgeon are likely to become captured or entangled in a fyke net over the course of the sampling efforts (2012-2016). While fyke net sampling is generally considered to be non-lethal, there is the potential for sturgeon to become entangled in the gear or otherwise suffer injury or mortality. However, the mortality rate is expected to be very low and less than the mortality rate estimated for gill nets (less than 4%).

Atlantic sturgeon captured in trawl gear will experience a disruption in normal behavior for up to 30 minutes and may result in physical injury that may lead to death. As outlined above, no more than six GOM DPS Atlantic sturgeon are likely to become captured in a trawl net over the course of the sampling efforts (2012-2016). While precautions will be taken to minimize handling stress, increased physiological stress and physical injuries due to being captured by trawl gear could result in lethal injury or mortality. Data from commercial trawling indicates a low mortality rate of sturgeon incidentally caught in otter trawl gear.

While the proposed sampling may result in the mortality of up to one subadult Atlantic sturgeon,

this number represents a very small percentage of the Gulf of Maine distinct population segment of Atlantic sturgeon. 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. The best available population estimates indicate that there are approximately 166 adult Atlantic sturgeon and an estimated 498 subadults and an unknown number of juveniles in the Gulf of Maine. While the death of one subadult Atlantic sturgeon will reduce the number of Atlantic sturgeon in the Gulf of Maine population compared to the number that would have been present absent the proposed action, it is not likely that this reduction will change the status of this population as this loss represents only 0.2% of subadults.

This action is expected to have an undetectable reduction in reproduction of Gulf of Maine Atlantic sturgeon in the Penobscot River for the following reasons: (1) the exclusion of larger presumably mature fish means no spawning or adult fish will be captured or killed; (2) there will be no delay in migration to the spawning grounds; and (3) at worst, the action will result in the mortality of one subadult Atlantic sturgeon, which means that any effects to reproduction are limited to the future reproductive contributions of those individuals to the Gulf of Maine DPS. NMFS has estimated the adult equivalent of one subadult is approximately 0.48 adults; this makes the loss of 1 subadult under the proposed action approximately equal to the loss of one adult. Therefore, the reduction in available adults by no more than one is expected to result in an undetectable reduction in the number of eggs laid or larvae produced and similarly, an undetectable effect on the strength of subsequent year classes. Additionally, the proposed action will not affect spawning habitat in any way and will 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 Atlantic sturgeon from accessing any seasonal concentration areas, including foraging, spawning or overwintering grounds in the Penobscot River. Further, the action is not expected to reduce the river by river distribution of Atlantic sturgeon or the ability of Atlantic sturgeon to migrate between the Penobscot and Kennebec Rivers or any other coastal rivers. Additionally as the number of Atlantic sturgeon likely to be killed as a result of the proposed action is less than 0.2% of the adult Gulf of Maine population, there is not likely to be a loss of any unique genetic haplotypes and therefore, it is unlikely to result in the loss of genetic diversity.

While generally speaking, the loss of a small number of individuals from a subpopulation or species may have an appreciable effect on the numbers, reproduction and distribution of the species, this is likely to occur only when there are very few individuals in a population, the individuals occur in a very limited geographic range or the species has extremely low levels of genetic diversity. This situation is not likely in the case of Atlantic sturgeon because: (1) the species is widely geographically distributed; (2) it is not known to have low levels of genetic diversity (see status of the species section above); and (3) hundreds of Atlantic sturgeon are expected to spawn each year.

Based on the information provided above, the death of no more than one subadult Atlantic sturgeon as a result of the proposed project will not appreciably reduce the likelihood of survival (i.e., it will not increase the risk of extinction faced by this species) for this species given that: (1) the population trend of Atlantic sturgeon in the Gulf of Maine is tending toward positive; (2) the death of one subadult Atlantic sturgeon represents an extremely small percentage of the

number of subadult Atlantic sturgeon in the Gulf of Maine; (3) the loss of one subadult Atlantic sturgeon is not expected to change the status or trends of the GOM DPS as a whole; (4) the loss of one subadult Atlantic sturgeon is likely to have an undetectable effect on reproductive output of the Gulf of Maine DPS of Atlantic sturgeon; and (5) the action will have no effect on the distribution of Atlantic sturgeon in the action area or 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 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 ESA 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, and (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 a slight 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 within the action area. The proposed action will not utilize GOM DPS Atlantic sturgeon for recreational or commercial purposes or affect the adequacy of existing regulatory mechanisms to protect this species. The proposed action is likely to result in up to one mortality, a slight reduction in future reproductive output; therefore, the NEFSC Ecosystem survey is not expected to affect the persistence of the GOM DPS of Atlantic sturgeon. There will be no change in the status or trend of the GOM DPS of Atlantic sturgeon. As there will be only a slight 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 hasten the extinction timeline or otherwise increase the danger of extinction since the action will not cause any significant 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 endangered. Based on the analysis presented herein, the proposed action is not likely to appreciably reduce the survival and recovery of this species.

7.2.2 New York Bight DPS of Atlantic sturgeon

New York Bight DPS

Individuals originating from the New York Bight (NYB) DPS are reasonably likely to occur in the action area. The NYB DPS has been listed as endangered. There are approximately 950 adults and 2,850 subadults estimated from captures in commercial fisheries.

NMFS has estimated that the proposed NEFSC Ecosystem survey will result in non-lethal physiological and behavioral impacts to no more than two NYB DPS Atlantic sturgeon; one mortality is anticipated. As explained in the “Effects of the Action” section, the deployment of certain gear types (e.g., trawl gear and fyke nets) is likely to result in interactions with a limited number of NYB DPS Atlantic sturgeon. Further, no interactions with NYB DPS Atlantic sturgeon are likely to result from any of the other gear types identified in the proposed study plan. The potential for effects are possible when fish encounter or are trapped by the sampling gear. These effects could include altering normal behavior such as a temporary startle or avoidance of the sampling area or result in minor physiological stress and minor physical injury from abrasion associated with physically interacting with the trap, main lead or wings. Non-lethal behavioral responses are expected to be temporary and spatially limited to the area and time fish interact with or are restricted by sampling gear. Capture in sampling gear is anticipated to increase physiological effects associated with handling stress and result in minor injuries that for the majority (> 96%) will not impair the fitness of any individuals or affect survival; however, a small percentage (<4%) could suffer lethal injuries or death. We have determined that any behavioral responses from fish passively interacting with the sampling gear, including in the worst case, an increase in physiological stress associated with physically interacting with the leads, would have insignificant and discountable effects to individuals. We have further determined the behavior and physiological responses as a result of sturgeon becoming captured would increase physiological stress (i.e., associated with physically removing the animal from the trap) and cause physical injury, which could result in mortality (up to 4%). Therefore, the survival of up to one individual NYB DPS Atlantic sturgeon will be affected by the proposed sampling during the term of the survey. As such, there will be a slight reduction in the numbers of NYB DPS Atlantic sturgeon and no change in the status of this species or its trend.

Adverse effects may result from interactions with the fyke nets. Specifically, Atlantic sturgeon encountering the fyke nets may become trapped within the fyke net until the net is tended and the catch is processed and released. This will result in the disruption of normal behaviors for a maximum of 24 hours. As outlined above, no more than one NYB DPS Atlantic sturgeon is likely to become captured or entangled in a fyke net over the course of the sampling efforts (2012-2016). While fyke net sampling is generally considered to be non-lethal, there is the potential for sturgeon to become entangled in the gear or otherwise suffer injury or mortality. However, the mortality rate is expected to be very low and less than the mortality rate estimated for gill nets (less than 4%).

Atlantic sturgeon captured in trawl gear will experience a disruption in normal behavior for up to 30 minutes and may result in physical injury that may lead to death. As outlined above, no more than one NYB DPS Atlantic sturgeon is likely to become captured in a trawl net over the course of the sampling efforts (2012-2016). While precautions will be taken to minimize handling stress, increased physiological stress and physical injuries due to being captured by trawl gear could result in lethal injury or mortality. Data from commercial trawling indicates a low mortality rate of sturgeon incidentally caught in otter trawl gear.

This action is expected to have an undetectable reduction in reproduction of NYB DPS Atlantic sturgeon in the Penobscot River for the following reasons: (1) the fyke net sampling is not likely to intercept any pre-spawning adult Atlantic sturgeon; thus, there will be no delay in migration to the spawning grounds; (2) the exclusion of larger presumably mature fish means no spawning or adult fish will be captured or killed; and (3) at worst, the action will result in the mortality of 1 subadult Atlantic sturgeon, which means that any effects to reproduction are limited to the future reproductive contributions of those individuals to the NYB DPS. NMFS has estimated the adult equivalent of 1 subadult is approximately 0.48 adults; this makes the loss of 1 subadult under the proposed action equal to the loss of approximately one adult. Therefore, the reduction in available adults by no more than 1 is expected to result in an undetectable reduction in the number of eggs laid or larvae produced and similarly, an undetectable effect on the strength of subsequent year classes. Additionally, since the proposed action will occur outside of the rivers where NYB DPS fish are expected to spawn (i.e., the Hudson and Delaware Rivers), the proposed action will not affect their spawning habitat in any way and will 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 Hudson River or elsewhere. Any effects to distribution will be minor and temporary and limited to the temporal and geographic scale of the area being sampled.

Based on the information provided above, the exposure of NYB DPS Atlantic sturgeon to the effects of the NEFSC Ecosystem survey 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 a slight reduction in the numbers of NYB DPS Atlantic sturgeon; (2) there will be minor effects to the fitness of individuals and an extremely small effect on reproductive output of the NYB DPS of Atlantic sturgeon; and (3) the action will have only a minor and temporary effect on the distribution of NYB DPS Atlantic sturgeon in the action area (related to capture in the sampling gear) 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 ESA 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, and (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 a slight 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 within the action area. The proposed action will not utilize NYB DPS Atlantic sturgeon for recreational or commercial purposes or affect the adequacy of existing regulatory mechanisms to protect this species. The proposed action is likely to result in up to one mortality, a slight reduction in future reproductive output, therefore, the NEFSC Ecosystem survey is not expected to affect the persistence of the NYB DPS of Atlantic sturgeon. There will be no change in the status or trend of the NYB DPS of Atlantic sturgeon. As there will be only a slight 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 hasten the extinction timeline or otherwise increase the danger of extinction since the action is not expected to cause any significant 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 endangered. Based on the analysis presented herein, the proposed action is not likely to appreciably reduce the survival and recovery of this species.

8. CONCLUSION

After reviewing the current status of the species discussed herein, the environmental baseline for the action area, the effects of the proposed action, the funding and carrying out of the Penobscot Estuarine Fish Community and Ecosystem Survey from 2012-2016 by the NEFSC, it is NMFS' biological opinion that the proposed action may adversely affect, but is not likely to jeopardize the continued existence of shortnose sturgeon and the New York Bight and Gulf of Maine DPSs of Atlantic sturgeon. Because no critical habitat has been designated for these species at this time, none will be affected.

9. INCIDENTAL TAKE STATEMENT

Section 9 of the ESA prohibits the take of endangered species of fish and wildlife. "Fish and wildlife" is defined in the ESA "as any member of the animal kingdom, including without limitation any mammal, fish, bird (including any migratory, non-migratory, or endangered bird for which protection is also afforded by treaty or other international agreement), amphibian, reptile, mollusk, crustacean, arthropod or other invertebrate, and includes any part, product, egg, or offspring thereof, or the dead body or parts thereof." 16 U.S.C. 1532(8). "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by NMFS to include any act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns including breeding, spawning, rearing, migrating, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. "Otherwise lawful activities" are those actions that meet all State and Federal legal requirements except for the prohibition against taking in ESA Section 9 (51 FR 19936, June

3, 1986), which would include any state endangered species laws or regulations. Section 9(g) makes it unlawful for any person “to attempt to commit, solicit another to commit, or cause to be committed, any offense defined [in the ESA.]” 16 U.S.C. 1538(g). See also 16 U.S.C. 1532(13)(definition of “person”). Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement. The prohibitions against take for shortnose sturgeon are in effect now. The listing of Atlantic sturgeon is effective on April 6, 2012; therefore, the prohibitions on take are effective on this date and so are the exemptions provided by this ITS pertaining to Atlantic sturgeon.

The measures described below are non-discretionary, and must be undertaken by NEFSC so that they become binding conditions for the exemption in section 7(o)(2) to apply. NEFSC has a continuing duty to regulate the activity covered by this Incidental Take Statement. If NEFSC fails to assume and implement the terms and conditions, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, NEFSC must report the progress of the action and its impact on the species to the NMFS as specified in the Incidental Take Statement [50 CFR §402.14(i)(3)] (See U.S. Fish and Wildlife Service and National Marine Fisheries Service’s Joint Endangered Species Act Section 7 Consultation Handbook (1998) at 4-49).

9.1 Amount or Extent of Incidental Take

The proposed action, the funding and carrying out of the proposed Penobscot Estuarine Fish Community and Ecosystem Survey in 2012-2016, is expected to directly affect up to 15 or fewer Atlantic sturgeon juveniles and/or subadults (4 St. John River (Canada), 9 GOM DPS and 2 NYB DPS) and up to 32 or fewer shortnose sturgeon juveniles and/or adults. The anticipated interaction and capture of 47 Atlantic and shortnose sturgeon with sampling gear would be considered take under Section 9 of the ESA. All anticipated lethal take or non-lethal harm and harassment is a result of the interaction, capture or entrapment of sturgeon in the sampling gear (beach seine, fyke and trawl nets). We have determined that all behavioral effects from interacting with the gear and not being captured will be insignificant and discountable. The majority of effects from being captured and handled are anticipated to be minor and individuals are expected to make a full recovery with no impact to future survival or fitness. While all sturgeon captured in the sampling gear are largely assumed to be released alive and uninjured, a small portion may experience lethal injuries or death. As explained in the “effects of the action” section above, some interactions have the potential to result in the lethal injury or death; therefore, we anticipate up to one or fewer subadult Atlantic sturgeon and up to one or fewer shortnose sturgeon may die as a result of interactions with the sampling gear. This ITS exempts the following take (Table 7): A total of no more than 32 adult or juvenile shortnose sturgeon harassed or injured during sampling; and a total of no more than 15 subadult or juvenile Atlantic sturgeon harassed or injured during the sampling with the survey gear. Based on a mixed stock analyses, we anticipate that no more than nine of the Atlantic sturgeon will be GOM DPS origin and no more than two will be NYB DPS origin. The remaining four Atlantic sturgeon will originate from St. John River Canada and are not protected under the US ESA.

Table 7. Anticipated Incidental Take of Sturgeon in Research Gear (2012-2016)

| Gear type | Anticipated non-lethal captures | Anticipated lethal take |
|---|--|--------------------------------|
| <i>Shortnose sturgeon</i> | | |
| Beach seine | 2 | 0 |
| Fyke net | 20 | 1 |
| Trawl gear | 10 | 1 |
| Total | 32 | 1* |
| <i>Atlantic sturgeon (NYB and GOM combined)</i> | | |
| Beach Seine | None | 0 |
| Fyke net | 5 | 1 |
| Trawl Gear | 10 | 1 |
| Total | 15 | 1* |

*total mortality for all sampling is up to one fish for either gear type combined

For this proposed action, reporting all sturgeon captured in research gear will enable NMFS to track take estimates and will provide a basis to determine whether the anticipated number of individual mortalities is consistent with this Opinion. Because the capture of individual fish may increase the likelihood of experiencing lethal injuries or physiological effects from handling, it is reasonable to use the number of fish being captured annually to determine if the lethal take estimate will be exceeded before the term of the survey. As explained in the “Effects of the Action” section of the Opinion, the mortality rate is expected to be very low for these gear types and no more than one subadult Atlantic sturgeon from either the GOM DPS or NYB DPS and one juvenile or adult shortnose sturgeon are likely to experience lethal injuries or die as a result of capture or entanglement in sampling gear.

NMFS believes this level of incidental take is reasonable given the likely seasonal distribution and abundance of Atlantic and shortnose sturgeon in the action area and the encounter rates for fishing gear types assessed above. In the accompanying biological opinion, NMFS determined that this level of anticipated take is not likely to result in jeopardy to the species.

9.2 Reasonable and prudent measures

Reasonable and prudent measures (RPMs) are those measures necessary and appropriate to minimize incidental take of a listed species. In order to effectively monitor the effects of this action, it is necessary to document the amount of incidental take (i.e., the number of Atlantic and shortnose sturgeon captured, collected, injured or killed) and to examine any sturgeon that are captured during the Ecosystem survey. Research monitoring provides information on the

characteristics of the sturgeon encountered and may provide data which will help develop more effective measures to avoid future interactions with listed species. We do not anticipate any additional injury or mortality to be caused by removing the fish from the water and examining them as required in the RPMs. Any live sturgeon are to be released alive back into the river, away from the research activities. All of the conservation measures utilized in this research survey have been adopted from previous consultations with the NEFSC in coordination with the MEDMR and UM. These measures have been included in the Biological Assessment (BA) and have been considered in the effects of the action. In addition to adhering to the conditions relevant to Atlantic and shortnose sturgeon outlined in this Opinion, sampling protocols and the BA, NMFS believes the following reasonable and prudent measures are necessary and appropriate to monitor for any incidental captures of listed sturgeon:

1. The NEFSC must contact the Protected Resources Division before sampling commences and again upon completion of the sampling activity.
2. The NEFSC must promptly report all captures of Atlantic or shortnose sturgeon to the Protected Resources Division.
3. The NEFSC must promptly report any mortalities of Atlantic or shortnose sturgeon to the Protected Resources Division.
4. The NEFSC must sample any Atlantic or shortnose sturgeon captured; sampling must include visually inspecting the animal for any external tags, scanned for PIT tags, photographed and measured.

9.3 Terms and conditions

In order to be exempt from prohibitions of section 9 of the ESA, NEFSC must comply with the following terms and conditions of the Incidental Take Statement, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary. Any taking that is in compliance with the terms and conditions specified in this Incidental Take Statement shall not be considered a prohibited taking of the species concerned (ESA Section 7(o)(2)).

1. To implement RPM #1, the NEFSC must contact the Protected Resources Division Secretary by phone (978-281-9328) or fax (978-281-9394).
2. To implement RPM #2 and #3, the NEFSC must contact the Northeast Region Protected Resources Division secretary by phone (978-281-9328) or fax (978-281-9394) within 24 hours of any captures of Atlantic or shortnose sturgeon, including non-lethal and lethal takes.
3. To implement RPM # 4 any Atlantic or shortnose sturgeon captured during sampling must be visually assessed for any external tags, scanned for PIT tags, photographed and measured following proper protocols. The corresponding incident report form (Appendix A) must be completed and submitted to NMFS **within 24 hours** by fax (978-281-9394) of any captures of sturgeon (juvenile or adult).

4. To implement RPM #3, the NEFSC in the event of any lethal takes, any dead specimens or body parts must be photographed, measured, and preserved (freeze) until disposal procedures are discussed with NMFS's NER. The Sturgeon Salvage form included as Appendix B must be completed and submitted to NMFS's NER as noted above.
5. To implement RPM #2 and #3, the NEFSC must take fin clips if any captures occur (according to the procedure outlined in Appendix C) the clips are to be returned to NMFS's NER for ongoing analysis of the genetic composition.
6. To implement RPM #1 through #4, the NEFSC must submit a final report at the end of each calendar year summarizing the results of sampling activities and any takes of listed species to NMFS by mail (to the attention of the Section 7 Coordinator, NMFS Protected Resources Division, 55 Great Republic Drive, 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. Specifically, these RPMs and Terms and Conditions will keep NMFS informed of when sampling activities are taking place and will require NEFSC to report any non-lethal and lethal take in a reasonable amount of time, as well as avoid additional sources of injury and mortality to adult fish that may result from handling associated with sampling.

Term and Conditions #1 through #6 are specifically designed to monitor take. In order to effectively monitor and report the effects of this action, Term and Condition #5 requires collecting data from captured Atlantic and shortnose sturgeon. Collecting data from any captured sturgeon will enable NMFS to better monitor the take associated with this project. The implementation of Term and Condition #4 is necessary and appropriate to preserve any dead Atlantic or shortnose sturgeon so that they may be salvaged and examined to determine the cause of death. Genetic information is important to document, if possible, which population the fish comes from as well as whether the fish contains any unique genetic haplotypes. Additionally, tissue samples will provide information on contaminants found in the specimen.

If, during the course of the action, the level of incidental take is exceeded, reinitiation of consultation and review of the reasonable and prudent measures is required. As explained above, the best available information supports the determination that all lethal take associated with this action is likely to be from sampling with either the trawl gear or fyke nets. For any interaction with any gear type proposed that results in a lethal take, the NEFSC must immediately provide an explanation of the causes of the mortality and review with NMFS whether this take represents new information on the effects of the action that were not previously considered to determine the need for possible reinitiation of consultation and modification of the reasonable and prudent measures and/or terms and conditions.

10. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to

minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. NMFS has determined that the proposed action is not likely to jeopardize the continued existence of endangered shortnose sturgeon or threatened Gulf of Maine and endangered New York Bight DPSs of Atlantic sturgeon. NMFS recommends that NEFSC implement the following conservation recommendation:

1. In the unlikely event an Atlantic sturgeon is captured in a beach seine, the fish should be correctly identified with minimal handling and biological data obtained (e.g., measured) and released immediately without removing the fish from the water.
2. If any mortalities occur, the NEFSC should arrange for genetic and contaminant analysis of the specimen. If this recommendation is to be implemented, the fish should be immediately frozen and NMFS's NER should be contacted within 24 hours to provide instructions on shipping and preparation

11. REINITIATION OF CONSULTATION

This concludes formal consultation on the proposed estuary study by the NEFSC. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of taking specified in the incidental take statement is exceeded; (2) new information reveals effects of the action that may not have been previously considered; (3) the identified action is subsequently modified in a manner that causes an effect to listed species; or (4) a new species is listed or critical habitat designated that may be affected by the identified action. In instances where the amount or extent of incidental take is exceeded, Section 7 consultation must be reinitiated immediately.

12. LITERATURE CITED

- ASMFC (Atlantic States Marine Fisheries Commission). 1998. Amendment 1 to the interstate fishery management plan for Atlantic sturgeon. Management Report No. 31, 43 pp.
- ASMFC. 2009. Greene, K. E., J. L. Zimmerman, R. W. Laney, and J. C. Thomas-Blate. 2009. Atlantic coast diadromous fish habitat: A review of utilization, threats, recommendations for conservation, and research needs. Atlantic States Marine Fisheries Commission Habitat Management Series No. 9, Washington, D.C.
- ASMFC TC (Technical Committee). 2007. Special Report to the Atlantic Sturgeon Management Board: Estimation of Atlantic sturgeon bycatch in coastal Atlantic commercial fisheries of New England and the Mid-Atlantic. August 2007. 95 pp.
- ASSRT (Atlantic Sturgeon Status Review Team). 2007. Status review of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*). National Marine Fisheries Service. February 23, 2007. 188 pp.
- Bain, M. B. 1997. Atlantic and shortnose sturgeons of the Hudson River: Common and

- Divergent Life History Attributes. *Environmental Biology of Fishes* 48: 347-358.
- Bain, M., K. Arend, N. Haley, S. Hayes, J. Knight, S. Nack, D. Peterson, and M. Walsh. 1998. Sturgeon of the Hudson River: Final Report on 1993-1996 Research. Prepared for The Hudson River Foundation by the Department of Natural Resources, Cornell University, Ithaca, New York.
- Bain, M.B., N. Haley, D. Peterson, J. R. Waldman, and K. Arend. 2000. Harvest and habitats of Atlantic sturgeon *Acipenser oxyrinchus* Mitchill, 1815, in the Hudson River Estuary: Lessons for Sturgeon Conservation. *Instituto Espanol de Oceanografia. Boletin* 16: 43-53.
- Bain, Mark B., N. Haley, D. L. Peterson, K. K. Arend, K. E. Mills, P. J. Sullivan. 2007. Recovery of a US Endangered Fish. *PLoS ONE* 2(1): e168. doi:10.1371/journal.pone.0000168
- Bath, D.W., J.M. O'Conner, J.B. Albert and L.G. Arvidson. 1981. Development and identification of larval Atlantic sturgeon (*Acipenser oxyrinchus*) and shortnose sturgeon (*A. brevirostrum*) from the Hudson River estuary, New York. *Copeia* 1981:711-717.
- Benson, A.C., M. Trent, R.F. Sutton, T.G. Elliott, and T.G. Meronek. 2005. Evaluation of Sampling Techniques for Age-0 Lake Sturgeon in a Lake Michigan Tributary. *North American Journal of Fisheries Management* 25:4 1378-1385.
- Bigelow, H. B., and W. C. Schroeder. 1953. Fishes of the Gulf of Maine. *Fisheries Bulletin, U.S. Fish and Wildlife Service* 53, Washington, D.C.
- Boreman, J. 1997. Sensitivity of North American sturgeons and paddlefish to fishing mortality. *Environmental Biology of Fishes* 48: 399-405.
- Borodin, N. 1925. Biological observations on the Atlantic sturgeon, *Acipenser sturio*. *Transactions of the American Fisheries Society* 55: 184-190.
- Brundage, H. M., III, and R. E. Meadows. 1982. The Atlantic sturgeon, *Acipenser oxyrinchus*, in the Delaware River estuary. *U.S. National Marine Fisheries Service Fisheries Bulletin* 80:337-343.
- Buckley, J., and B. Kynard. 1981. Spawning and rearing of shortnose sturgeon from the Connecticut River. *Progressive Fish Culturist* 43:74-76.
- Buckley and Kynard 1981. Habitat use and behavior of pre-spawning and spawning shortnose sturgeon, *Acipenser brevirostrum*, in the Connecticut River. *North American Sturgeons*: 111-117.

- Burton, W. 1993. Effects of bucket dredging on water quality in the Delaware River and the potential for effects on fisheries resources. Prepared by Versar, Inc. for the Delaware Basin Fish and Wildlife Management Cooperative, unpublished report. 30 pp.
- Carlson, D.M., and K.W. Simpson. 1987. Gut contents of juvenile shortnose sturgeon in the upper Hudson estuary. *Copeia* 1987:796-802
- Caron, F., D. Hatin, and R. Fortin. 2002. Biological characteristics of adult Atlantic sturgeon (*Acipenser oxyrinchus*) in the Saint Lawrence River estuary and the effectiveness of management rules. *Journal of Applied Ichthyology* 18: 580-585.
- Cobb, J.N. 1899. The sturgeon fishery of Delaware River and Bay. Report of Commissioner of Fish and Fisheries 25:369-380.
- Collins, M.R., S.G. Rogers, and T.I.J. Smith. 1996. Bycatch of Sturgeons along the Southern Atlantic Coast of the USA. *North American Journal of Fisheries Management*. (16): 24-29.
- Collins, M. R., S. G. Rogers, T. I. J. Smith, and M. L. Moser. 2000. Primary factors affecting sturgeon populations in the southeastern United States: fishing mortality and degradation of essential habitats. *Bulletin of Marine Science* 66: 917-928.
- Cooper, K.R. 1989. Effects of Polychlorinated Dibenzo-p-Dioxins and Polychlorinated Dibenzofurans on Aquatic Organisms. *Aquatic Sciences*. 1(2): 227-242.
- Crance, J. H. 1986. Habitat suitability index model and instream flow suitability curves: shortnose sturgeon. USFWS. Biological Report. 82(10.129). 31pp.
- Crance, J. H. 1987. Habitat suitability index curves for anadromous fishes. *In: Common Strategies of Anadromous and Catadromous Fishes*, M. J. Dadswell (ed.). Bethesda, Maryland, American Fisheries Society. Symposium 1: 554.
- Crouse, D. T. 1999. The consequences of delayed maturity in a human dominated world. Pages 95-202 in J. A. Musick, editor. *Life in the slow lane: ecology and conservation of long-lived marine animals*. American Fisheries Society, Symposium 23, Bethesda, Maryland.
- Dadswell, M.J. 1979. Biology and population characteristics of the shortnose sturgeon, *Acipenser brevirostrum* LeSueur 1818 (Osteichthyes:Acipenseridae), in the Saint John River Estuary, New Brunswick, Canada. *Can. J. Zool.* (57): 2186-2210
- Dadswell, M.J., B.D. Taubert, T.S. Squiers, D. Marchette, and J. Buckley. 1984. Synopsis of biological data on shortnose sturgeon, *Acipenser brevirostrum* LeSueur 1818. National Oceanic and Atmospheric Administration Technical Report NMFS 14, Washington, D.C. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

- Damon-Randall, K. et al. 2012a. Composition of Atlantic sturgeon in rivers, estuaries and marine waters. March 2012. Report from the August 10-11, 2011 workshop on the distribution of Atlantic sturgeon in the Northeast. US Dept of Commerce. 32pp. NMFS NERO Protected Resources Division. Available from: NMFS NERO PRD, 55 Great Republic Drive, Gloucester, MA 01930.
- Damon-Randall, K. 2012b. Memorandum to the Record regarding population estimates for Atlantic sturgeon. March 7, 2012. 8 pp.
- Dees, L. T. 1961. Sturgeons. United States Department of the Interior Fish and Wildlife Service, Bureau of Commercial Fisheries, Washington, D.C.
- Dionne, M. 2000. Ecosystem indicator: fish. pp. 15-17 in Regional Standards to Identify and Evaluate Tidal Wetland Restoration in the Gulf of Maine, Neckles, H.A. and M. Dionne eds. Wells National Estuarine Research Reserve, Maine.
- Dionne, P. 2010a. Partial and Differential Migration of Shortnose sturgeon in the Gulf of Maine. November 2010. 30 pp. Chapter 1 of Masters Thesis, Unpublished. University of Maine. In Maine DMR. 2010. Final Report to NMFS Protected Resources Office for Award Number NA07NMF4720053.
- Dionne, P. 2010b. Seasonal Abundance of shortnose sturgeon in the Penobscot River, Maine. November 2010. 30 pp. Chapter 2 of Masters Thesis, Unpublished. University of Maine. In Maine DMR. 2010. Final Report to NMFS Protected Resources Office for Award Number NA07NMF4720053.
- Dovel, W.J. 1978. The Biology and management of shortnose and Atlantic sturgeons of the Hudson River. Performance report for the period April 1, to September 30, 1978. Submitted to N.Y. State Department of Environmental Conservation.
- Dovel, W.J. 1979. Biology and management of shortnose and Atlantic sturgeon of the Hudson River. New York State Department of Environmental Conservation, AFS9-R, Albany.
- Dovel. 1981. The Endangered Shortnose Sturgeon of the Hudson Estuary: It's Life History and Vulnerability to the activities of Man. Final Report to the Federal Energy Regulatory Commission, Washington, D.C. Oceanic Society. Contract No. DE-AC 39-79 RC-10074.
- Dovel, W. L. and T. J. Berggren. 1983. Atlantic sturgeon of the Hudson River Estuary, New York. New York Fish and Game Journal 30: 140-172.
- Dovel, W.L., A. W. Pekovitch, and T. J. Berggren. 1992. Biology of the Shortnose Sturgeon (*Acipenser brevirostrum* Lesueur, 1818) in the Hudson River. Estuary, New York. NMFS Supp. Doc 5: 187-216.
- Dunton, K.J., A. Jordaan, K.A. McKown, D.O. Conover, and M.J. Frisk. 2010. Abundance and distribution of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) within the Northwest

Atlantic Ocean, determined from five fishery-independent surveys. *Fishery Bulletin* 108:450-465.

Elliott, W. and Simmonds, M. 2007. *Whales in Hot Water? The Impact of a Changing Climate on Whales, Dolphins and Porpoises: A call for action.* WWF-International, Gland Switzerland / WDCS, Chippenham, UK

ERC, Inc. (Environmental Research and Consulting, Inc.). 2003. Contaminant analysis of tissues from a shortnose sturgeon (*Acipenser brevirostrum*) from the Kennebec River, Maine. Report submitted to National Marine Fisheries Service, Protected Resources Division, Gloucester, MA. 5 pp.

Erickson, D.L. et al. 2011 Use of pop-up satellite archival tags to identify oceanic-migratory patterns for adult Atlantic sturgeon, *Acipenser oxyrinchus oxyrinchus* Mitchell, 1815. *J. Appl. Ichthyol.* 27: 356-365.

Eyler, S., M. Mangold, and S. Minkinen. 2004. Atlantic Coast sturgeon tagging database. Summary Report prepared by US Fish and Wildlife Service, Maryland Fishery Resource Office, Annapolis, Maryland.

Eyler, S. 2011. Personal Communication. E-Mail to Jessica Pruden, NMFS. March 14, 2011.

Fernandes, S.J., M.T. Kinnison, and G.B. Zydlewski. 2006. *Draft Investigation into the distribution and abundance of Atlantic sturgeon and other diadromous species in the Penobscot River.* Report in progress.

Fernandes, S.J., M.T. Kinnison, and G.B. Zydlewski. 2008. Investigation into the distribution and abundance of Atlantic sturgeon and other diadromous species in the Penobscot River, Maine: with special notes on the distribution and abundance of federally endangered shortnose sturgeon (*Acipenser brevirostrum*). 2007 Annual Report.

Fernandes, S.J., G.B. Zydlewski, J.D. Zydlewski, G.S. Wippelhauser, and M.T. Kinnison. 2010. Seasonal Distribution and Movements of Shortnose Sturgeon and Atlantic Sturgeon in the Penobscot River Estuary, Maine. *Transactions of the American Fisheries Society* 139:1436-1449.

Flournoy, P.H., S.G. Rogers, and P.S. Crawford. 1992. Restoration of shortnose sturgeon in the Altamaha River, Georgia. Final Report to the U.S. Fish and Wildlife Service, Atlanta, Georgia.

Foster, N.W. and C.G. Atkins. 1869. Second report of the Commissioners of Fisheries of the state of Maine 1868. Owen and Nash, Printers to the State, Augusta, ME.

Geoghegan, P., M.T. Mattson and R.G. Keppel. 1992. Distribution of shortnose sturgeon in the

- Hudson River, 1984-1988. IN Estuarine Research in the 1980s, C. Lavett Smith, Editor. Hudson River Environmental Society, Seventh symposium on Hudson River ecology. State University of New York Press, Albany NY, USA.
- Gilbert, C.R. 1989. Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Mid-Atlantic Bight): Atlantic and shortnose sturgeons. US Fish and Wildlife Service and US Army Corps of Engineers. Biological Report 82 (11.122).
- Grunwald, C., J. Stabile, J. R. Waldman, R. Gross, and I. Wirgin. 2002. Population genetics of shortnose sturgeon *Acipenser brevirostrum* based on mitochondrial DNA control region sequences. *Molecular Ecology* 11:1885-1898.
- Haley, N. 1996. Juvenile sturgeon use in the Hudson River Estuary. Master's thesis. University of Massachusetts, Amherst, MA, USA.
- Haley, N. J. 1999. Habitat characteristics and resource use patterns of sympatric sturgeons in the Hudson River estuary. Master's thesis. University of Massachusetts, Amherst.
- Hall, W.J., T.I.J. Smith, and S.D. Lamprecht. 1991. Movements and habitats of shortnose sturgeon *Acipenser brevirostrum* in the Savannah River. *Copeia* (3):695-702.
- Hagan, S.M., and K.W. Able. 2003. Seasonal changes of the pelagic fish assemblage in a temperate estuary. *Estuarine, Coastal and Shelf Science* 56:15-29.
- Hatin, D., R. Fortin, and F. Caron. 2002. Movements and aggregation areas of adult Atlantic sturgeon (*Acipenser oxyrinchus*) in the St. Lawrence River estuary, Quebec. *Canadian Journal of Applied Ichthyology* 18:586-594.
- Heidt, A. R., and R. J. Gilbert. 1978. The shortnose sturgeon in the Altamaha River Drainage, Georgia. Rept. to NMFS. 16 p.
- Holland, B. F., Jr. and G. F. Yelverton. 1973. Distribution and biological studies of anadromous fishes offshore North Carolina. North Carolina Department of Natural and Economic Resources SSR 24, 132 pages.
- Hulme, P.E. 2005. Adapting to climate change: is there scope for ecological management in the face of global threat? *Journal of Applied Ecology* 43: 617-627. IPCC (Intergovernmental Panel on Climate Change) 2007. Fourth Assessment Report. Valencia, Spain.
- ICES (International Council for the Exploration of the Sea). 2005. Ecosystems effects of fishing: impacts, metrics, and management strategies. ICES Cooperative Research Report, No. 272, 177 pp.

- Jarvis, P.L., J. S. Ballantyne, and W. E. Hogans. 2001. The influence of salinity on the growth of juvenile shortnose sturgeon. *North American Journal of Aquaculture*. 63:272-276.
- Jenkins, W.E., T.I.J. Smith, L.D. Heyward, and D.M. Knott. 1993. Tolerance of shortnose sturgeon, *Acipenser brevirostrum*, juveniles to different salinity and dissolved oxygen concentrations. *Proceedings of the Southeast Association of Fish and Wildlife Agencies*, Atlanta, Georgia.
- Johnson, J. H., D. S. Dropkin, B. E. Warkentine, J. W. Rachlin, and W. D. Andrews. 1997. Food habits of Atlantic sturgeon off the central New Jersey coast. *Transactions of the American Fisheries Society* 126: 166-170.
- Johnson, H. 1982. Fisheries production in Albemarle Sound. Page 55 in *Albemarle Sound trends and management*. University of North Carolina, Sea Grant College Program, Raleigh. UNC-SG 82-02.
- Kahnle, A. W., K. A. Hattala, K. A. McKown, C. A. Shirey, M. R. Collins, T. S. Squiers, Jr., and T. Savoy. 1998. Stock status of Atlantic sturgeon of Atlantic coast estuaries. Report for the Atlantic States Marine Fisheries Commission: Draft III, Washington, D.C.
- Kahnle, A.W., K.A. Hattala, K.A. McKown. 2007. Status of Atlantic sturgeon of the Hudson River Estuary, New York, USA. *American Fisheries Society Symposium*. 56:347-363.
- Kieffer and Kynard 1993. Annual movements of shortnose and Atlantic sturgeons in the Merrimack River, Massachusetts. *Transactions of the American Fisheries Society* 122: 1088-1103.
- Kieffer and Kynard. In press. Pre-spawning migration and spawning of Connecticut River shortnose sturgeon. *American Fisheries Society*. 86 pages.
- Kieffer, M., and B. Kynard. 1996. Spawning of shortnose sturgeon in the Merrimack River. *Transactions of the American Fisheries Society* 125:179-186.
- King, T. L., B. A. Lubinski, and A. P. Spidle. 2001. Microsatellite DNA variation in Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) and cross-species amplification in the Acipenseridae. *Conservation Genetics* 2: 103-119.
- Kocan, R.M. 1993. Connecticut River shortnose sturgeon-sediment toxicity study. School of Fisheries HF-15, University of Washington, Seattle, Washington.
- Kynard, B. 1996. Twenty-one years of passing shortnose sturgeon in fish lifts on the Connecticut River: what has been learned? Draft report by National Biological Service, Conte Anadromous Fish Research Center, Turners Falls, MA. 19 pp.

- Kynard, B. 1997. Life history, latitudinal patterns, and status of shortnose sturgeon. *Environmental Biology of Fishes* 48:319-334.
- Kynard, B. 1998. Twenty-two years of passing shortnose sturgeon in fish lifts on the Connecticut River: What has been learned? In: Fish migration and fish bypasses, M. Jungwirth, S. Schmutz, and S. Weiss, Editors. pp. 255-264.
- Kynard, B. and M. Horgan. 2002. Ontogenetic behavior and migration of Atlantic sturgeon, *Acipenser oxyrinchus oxyrinchus*, and shortnose sturgeon, *A. brevirostrum*, with notes on social behavior. *Environmental Behavior of Fishes* 63: 137-150.
- Laney, R.W., J.E. Hightower, B.R. Versak, M.F. Mangold, W.W. Cole Jr., and S.E. Winslow. 2007. Distribution, habitat use, and size of Atlantic sturgeon captured during cooperative winter tagging cruises, 1988–2006. Pages 167-182. In J. Munro, D. Hatin, J. E. Hightower, K. McKown, K. J. Sulak, A. W. Kahnle, and F. Caron, (eds.) *Anadromous sturgeons: habitats, threats, and management*. Am. Fish. Soc. Symp. 56, Bethesda, MD.
- Lazzari, M. A., J. C. O'Herron, and R. W. Hastings. 1986. Occurrence of juvenile Atlantic sturgeon, *Acipenser oxyrinchus*, in the upper tidal Delaware River. *Estuaries* 9:356–361.
- Lichter, J., H. Caron, T.S. Pasakarnis, S.L. Rodgers, T.S. Squiers Jr., and C.S. Todd. 2006. The ecological collapse and partial recovery of a freshwater tidal ecosystem. *Northeastern Naturalist* 13:153–178.
- Love, R.H. 1971. Dorsal-aspect target strength of an individual fish. *J. Acoust. Soc. Am.* 49:816–823
- Mangin, E. 1964. Croissance en Longueur de Trois Esturgeons d'Amerique du Nord: *Acipenser oxyrhynchus*, Mitchill, *Acipenser fulvescens*, Rafinesque, et *Acipenser brevirostris* LeSueur. *Verh. Int. Ver. Limnology* 15: 968-974.
- McCleave, J.D., S.M. Fried and A.K. Towt. 1977. Daily movements of shortnose sturgeon, *Acipenser brevirostrum*, in a Maine estuary. *Copeia* 1977:149-157.
- MDEP (Maine Department of Environmental Protection). 2004. 2004 Integrated Water Quality Monitoring and Assessment Report. DEPLW0665. Maine Department of Environmental Protection. Augusta, ME. 243 pp. and appendices.
- Moser, M.L. and S.W. Ross. 1995. Habitat use and movements of shortnose and Atlantic sturgeons in the lower Cape Fear River, North Carolina. *Transactions of the American Fisheries Society* 124:225-234.
- Mohler, J.W. 2003. Culture Manual for the Atlantic Sturgeon: *Acipenser Oxyrinchus Oxyrinchus*. US Fish & Wildlife Service, Region 5.

- Murawski, S.A. and A.L. Pacheco. 1977. Biological and fisheries data on Atlantic sturgeon, *Acipenser oxyrinchus* (Mitchill). National Marine Fisheries Service Technical Series Report 10: 1-69.
- Munro, J., R.E. Edwards and A.W. Kahnle 2007. Anadromous Sturgeons: Habitats, Threats and Management Synthesis and Summary. American Fisheries Society Symposium 56: 1-15.
- NAST (National Assessment Synthesis Team). 2008. Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change, US Global Change Research Program, Washington DC, 2000
<http://www.usgcrp.gov/usgcrp/Library/nationalassessment/1IntroA.pdf>
- NEFSC. 2011. Summary of discard estimates for Atlantic sturgeon. Report prepared by Tim Miller and Gary Shepard, NEFSC Population Dynamics Branch, NMFS Northeast Fisheries Science Center. August 19, 2011.
- NMFS, 1996. Status Review of shortnose sturgeon in the Androscoggin and Kennebec Rivers. Northeast Regional Office, National Marine Fisheries Service, unpublished report. 26 pp.
- National Marine Fisheries Service (NMFS). 1998. Recovery plan for the shortnose sturgeon (*Acipenser brevirostrum*). Prepared by the Shortnose Sturgeon Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland 104 pp.
- Niklitschek, J. E. 2001. Bioenergetics modeling and assessment of suitable habitat for juvenile Atlantic and shortnose sturgeons (*Acipenser oxyrinchus* and *A. brevirostrum*) in the Chesapeake Bay. Dissertation. University of Maryland at College Park, College Park.
- Niklitschek, E. J. and D. H. Secor. 2005. Modeling spatial and temporal variation of suitable nursery habitats for Atlantic sturgeon in the Chesapeake Bay. *Estuarine, Coastal and Shelf Science* 64: 135-148.
- Niklitschek, E. J. and D. H. Secor. 2010. Experimental and field evidence of behavioural habitat selection by juvenile Atlantic *Acipenser oxyrinchus oxyrinchus* and shortnose *Acipenser brevirostrum* sturgeons. *Journal of Fish Biology* 77: 1293–1308.
- Normandeau Associates, 2001. Bath Iron Works dredge monitoring results. Prepared by Normandeau Associates, Inc. Yarmouth, Maine, unpublished report. 11 pp.
- NYHS (New York Historical Society as cited by Dovel as Mitchell. S. 1811). 1809. Volume 1. Collections of the New-York Historical Society for the year 1809.
- O'Connell, M.F. and E.G.M. Ash. 1993. Smolt size in relation to age at first maturity of Atlantic salmon (*Salmo salar*): the role of lacustrine habitat. *J. Fish Biol.* 42(4):551-569.

- O'Herron, J.C., K.W. Able, and R.W. Hastings. 1993. Movements of shortnose sturgeon (*Acipenser brevirostrum*) in the Delaware River. *Estuaries* 16:235-240.
- O'Malley, M. et al. 2011. Maine Estuaries Diadromous Survey: The Penobscot Estuarine Fish Community and Ecosystem Survey, Phase II (2011): Gear testing and full sampling plan development. Unpublished Sampling Plan and Biological Assessment.
- O'Malley, M. et al. 2012. The Penobscot Estuarine Fish Community and Ecosystem Survey (2012-2016): Northeast Fisheries Science Center; Biological Assessment and full sampling plan. Unpublished report 17 pp.
- Parker E. 2007. Ontogeny and life history of shortnose sturgeon (*Acipenser brevirostrum* Lesueur 1818): effects of latitudinal variation and water temperature. Ph.D. Dissertation. University of Massachusetts, Amherst. 62 pp.
- Pekovitch, A.W. 1979. Distribution and some life history aspects of shortnose sturgeon (*Acipenser brevirostrum*) in the upper Hudson River Estuary. Hazleton Environmental Sciences Corporation. 67 pp.
- Peterson, D. L., M. Bain, and N. Haley. 2000. Evidence of declining recruitment of Atlantic sturgeon in the Hudson River. *North American Journal of Fisheries Management* 20: 231-238.
- Pikitch, E. K.; Doukakis, P.; Lauck, L.; Chakrabarty, P.; Erickson, D. L., 2005: Status, trends and management of sturgeon and paddlefish fisheries. *Fish Fish.* 6, 233–265.
- Richmond, A., and B. Kynard. 1995. Ontogenic behavior of shortnose sturgeon. *Copeia* 1995:172-182.
- Rochard, E., M. Lepage, and L. Meauze. 1997. Identification and characterization of the marine distribution of the European sturgeon, *Acipenser sturio*. *Aquatic Living Resources* 10: 101-109.
- Rogers, S.G., P.H. Flournoy, and W. Weber. 1994. Status and restoration of Atlantic sturgeon in Georgia. Final Report to the National Marine Fisheries Service, Southeast Regional Office, St. Petersburg, Florida.
- Rogers, S.G., and W. Weber. 1995. Status and restoration of Atlantic and shortnose sturgeons in Georgia. Final report to NMFS for grant NA46FA102-01.
- Rogers, S.G., and W. Weber. 1995a. Movements of shortnose sturgeon in the Altamaha River system, Georgia. Contributions Series #57. Coastal Resources Division, Georgia Department of Natural Resources, Brunswick, Georgia.
- Rogers, S.G., and W. Weber. 1995b. Status and restoration of Atlantic and shortnose sturgeons

- in Georgia. Final Report to the National Marine Fisheries Service, Southeast Regional Office, St. Petersburg, Florida.
- Rosenthal, H., and D.F. Alderdice. 1976. Sublethal effects of environmental stressors, natural and pollutional, on marine fish eggs and larvae. *Journal of the Fisheries Research Board of Canada* 33:2047-2065.
- Ruelle, R., and C. Henry. 1992. Organochlorine Compounds in Pallid Sturgeon. *Contaminant Information Bulletin*, June, 1992.
- Ruelle, R., and K.D. Keenlyne. 1993. Contaminants in Missouri River pallid sturgeon. *Bull. Environ. Contam. Toxicol.* 50: 898-906.
- Ruelle, R. and C. Henry. 1994. Life history observations and contaminant evaluation of pallid sturgeon. Final Report U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, South Dakota Field Office, 420 South Garfield Avenue, Suite 400, Pierre, South Dakota 57501-5408.
- Schueller, P. and D.L. Peterson. 2006. Population status and spawning movements of Atlantic sturgeon in the Altamaha River, Georgia. Presentation to the 14th American Fisheries Society Southern Division Meeting, San Antonio, February 8-12th, 2006.
- Scott, W.B. and E.J. Crossman. 1973. Freshwater fishes of Canada. *Fisheries Research Board of Canada. Bulletin* 184. pp. 80-82.
- Scott, W. B., and M. G. Scott. 1988. Atlantic fishes of Canada. *Canadian Bulletin of Fisheries and Aquatic Sciences* 219:1-731.
- Secor, D.H. and J.R. Waldman. 1999. Historical abundance of Delaware Bay Atlantic sturgeon and potential rate of recovery. *American Fisheries Society Symposium* 23: 203-216.
- Secor, D.H. and E.J. Niklitschek. 2001. Hypoxia and Sturgeons: Report to the Chesapeake Bay Program Dissolved Oxygen Criteria Team. Chesapeake Biological Laboratory, University of Maryland Center for Environmental Science, Solomons, MD. Technical Report Series No. TS-314-01-CBL
- Secor, D. H. 2002. Atlantic sturgeon fisheries and stock abundances during the late nineteenth century. Pages 89-98 in W. Van Winkle, P. J. Anders, D. H. Secor, and D. A. Dixon, editors. *Biology, management, and protection of North American sturgeon. American Fisheries Society Symposium* 28, Bethesda, Maryland.
- Seesholtz, A., 2005. Sturgeon distribution and habitat use: Addendum including other fishes in the lower Feather River SP-F3.2 TASK 3A, Oroville Facilities Relicensing FERC Project No. 2100.

- Shirey, C. A., C. C. Martin, and E. J. Stetzar. 1999. Atlantic sturgeon abundance and movement in the lower Delaware River. Grant #A86FAO315 to NMFS. Delaware Division of Fish and Wildlife, Smyrna, Delaware.
- Shuman, D. A., R.A. Klumb, and G.A. Wanner. 2009. Pallid Sturgeon Population Assessment and Fish Community Monitoring for the Missouri River: Segments 5 and 6. United States Fish and Wildlife Service.
- Simpson, P. 2008. Movements and Habitat Use of Delaware River Atlantic Sturgeon, *Acipenser oxyrinchus*. Masters Thesis Natural Resources Graduate Program of Delaware State University. 141 pp. Dover, Delaware
- Sindermann, C. J. 1994. Quantitative effects of pollution on marine and anadromous fish populations. NOAA Technical Memorandum NMFS-F/NEC-104, National Marine Fisheries Service, Woods Hole, Massachusetts.
- Smith, T.I.J. and J.P. Clugston. 1997. Status and management of Atlantic sturgeon, *Acipenser oxyrinchus*, in North America. *Environmental Biology of Fishes* 48: 335-346.
- Smith, T. I. J., D. E. Marchette, and G. F. Ulrich. 1984. The Atlantic sturgeon fishery in South Carolina. *North American Journal of Fisheries Management* 4:164-176.
- Smith, T.I.J. 1985. The fishery, biology, and management of Atlantic sturgeon, *Acipenser oxyrinchus*, in North America. *Environmental Biology of Fishes* 14(1): 61-72.
- Smith, T. I. J., D. E. Marchette, and R. A. Smiley. 1982. Life history, ecology, culture and management of Atlantic sturgeon, *Acipenser oxyrinchus oxyrinchus*, Mitchill, in South Carolina: Final report to the United States Fish and Wildlife Service. South Carolina Wildlife and Marine Resources Department, Columbia, South Carolina.
- Snyder, D.E. 1988. Description and identification of shortnose and Atlantic sturgeon larvae. *American Fisheries Society Symposium* 5:7-30.
- Spells, A. 1998. Atlantic sturgeon population evaluation utilizing a fishery dependent reward program in Virginia's major western shore tributaries to the Chesapeake Bay. U.S. Fish and Wildlife Service, Charles City, Virginia.
- Stevenson, J.T., and D.H. Secor. 1999. Age determination and growth of Hudson River Atlantic sturgeon, *Acipenser oxyrinchus*. *Fishery Bulletin* 97: 153-166.
- Stein, A.B., K.D. Friedland, and M. Sutherland. 2004. Atlantic sturgeon marine bycatch and mortality on the continental shelf of the Northeast United States. *North American Journal of Fisheries Management* 24: 171-183.
- Squiers, T.S., and M. Smith. 1979. Distribution and abundance of shortnose sturgeon in

the Kennebec River estuary. Final Report to the National Marine Fisheries Service, Gloucester, Massachusetts.

Squiers, T. 2004. State of Maine 2004 Atlantic sturgeon compliance report to the Atlantic States Marine Fisheries Commission. Report submitted to Atlantic States Marine Fisheries Commission, December 22, 2004, Washington, D.C.

Sweka, J. A., J. Mohler, and M. J. Millard. 2006. Relative abundance sampling of juvenile Atlantic sturgeon in the Hudson River. Final study report for the New York Department of Environmental Conservation, Hudson River Fisheries Unit, New Paltz, New York.

Taub, S.H. 1990. Interstate fishery management plan for Atlantic sturgeon. Fisheries Management Report No. 17. Atlantic States Marine Fisheries Commission, Washington, D.C. 73 pp.

Taubert, B.D. 1980b. Biology of shortnose sturgeon (*Acipenser brevirostrum*) in the Holyoke Pool, Connecticut River, Massachusetts. Ph.D. Thesis, University of Massachusetts, Amherst, 136 p.

Taubert, B.D. 1980. Reproduction of shortnose sturgeon, *Acipenser brevirostrum*, in the Holyoke Pool, Connecticut River, Massachusetts. *Copeia* 1980:114-117.

Taubert, B.D., and M.J. Dadswell. 1980. Description of some larval shortnose sturgeon (*Acipenser brevirostrum*) from the Holyoke Pool, Connecticut River, Massachusetts, USA, and the Saint John River, New Brunswick, Canada. *Canadian Journal of Zoology* 58:1125-1128.

USACOE (United States Army Corps of Engineers). 1990. Penobscot River Basin Study. USACOE New England Division. Waltham, MA. 48 pp. and appendices.

U.S. Department of the Interior. 1973. Threatened Wildlife of the United States. Resource Publication 114, March 1973.

U.S. Fish and Wildlife Service (USFWS). 2005. Final biological opinion to the Federal Highway Administration on the proposed replacement of a bridge over Cathance Stream on Route 86 in Marion Township, Washington County, Maine. Old Town, ME.

Van den Avyle, M. J. 1983. Species profiles: life histories and environmental requirements (South Atlantic) - Atlantic sturgeon. U.S. Fish and Wildlife Service, Division of Biological Services FWS/OBS-82/11. U.S. Army Corps Eng. TREL-82-4. 38 pp.

Van Eenennaam, J.P., S.I. Doroshov, G.P. Moberg, J.G. Watson, D.S. Moore and J. Linares. 1996. Reproductive conditions of the Atlantic sturgeon (*Acipenser oxyrinchus*) in the Hudson River. *Estuaries* 19: 769-777.

Van Eenennaam, J.P., and S.I. Doroshov. 1998. Effects of age and body size on gonadal

- development of Atlantic sturgeon. *Journal of Fish Biology* 53: 624-637.
- Varanasi, U. 1992. Chemical contaminants and their effects on living marine resources. pp. 59-71. in: R. H. Stroud (ed.) *Stemming the Tide of Coastal Fish Habitat Loss*. Proceedings of the Symposium on Conservation of Fish Habitat, Baltimore, Maryland. Marine Recreational Fisheries Number 14. National Coalition for Marine Conservation, Inc., Savannah Georgia.
- Vladykov, V.D., and J.R. Greeley. 1963. Order Acipenseroidae. Pages 24-60 in *Fishes of the western North Atlantic*. Part III. Memoirs of the Sears Foundation for Marine Research 1.
- Waldman, J.R., J.T. Hart, and I.I. Wirgin. 1996. Stock composition of the New York Bight Atlantic sturgeon fishery based on analysis of mitochondrial DNA. *Transactions of the American Fisheries Society* 125: 364-371.
- Waldman, J. R., and I. I. Wirgin. 1998. Status and restoration options for Atlantic sturgeon in North America. *Conservation Biology* 12: 631-638.
- Waldman, J. et al. 2002. Impacts of life history and biogeography on the genetic stock structure of Atlantic sturgeon *Acipenser oxyrinchus oxyrinchus*, Gulf sturgeon *A. oxyrinchus desotoi*, and shortnose sturgeon *A. brevirostrum*. *J. Appl. Ichthyol.* 18:509-518.
- Walsh, M.G., M.B. Bain, T. Squires, J.R. Waldman, and Isaac Wirgin. 2001. Morphological and genetic variation among shortnose sturgeon *Acipenser brevirostrum* from adjacent and distant rivers. *Estuaries* Vol. 24, No. 1, p. 41-48. February 2001.
- Weber, W. 1996. Population size and habitat use of shortnose sturgeon, *Acipenser brevirostrum*, in the Ogeechee River system, Georgia. Masters Thesis, University of Georgia, Athens, Georgia.
- Welsh, Stuart A., Michael F. Mangold, Jorgen E. Skjveland, and Albert J. Spells. 2002. Distribution and Movement of Shortnose Sturgeon (*Acipenser brevirostrum*) in the Chesapeake Bay. *Estuaries* Vol. 25 No. 1: 101-104.
- Wirgin, I., Grunwald, C., Carlson, E., Stabile, J., Peterson, D.L. and J. Waldman. 2005. Rangelwide population structure of shortnose sturgeon *Acipenser brevirostrum* based on sequence analysis of mitochondrial DNA control region. *Estuaries* 28:406-21.
- Wirgin, I., J.R. Waldman, J. Rosko, R. Gross, M.R. Collins, S.G. Rogers, and J. Stabile. 2000. Genetic structure of Atlantic sturgeon populations based on mitochondrial DNA control region sequences. *Transactions of the American Fisheries Society*. 129:476-486.
- Wirgin, I. et al. In Prep. Stock origin of Atlantic sturgeon in the Minas Basin of the Bay of

Fundy. 22 pp.

Wirgin, I. and T. King. 2011. Mixed Stock Analysis of Atlantic sturgeon from coastal locales and a non-spawning river. Presented at February 2011 Atlantic and shortnose sturgeon workshop.

Woodland, R.J. and D. H. Secor. 2007. Year-class strength and recovery of endangered shortnose sturgeon in the Hudson River, New York. *Transaction of the American Fisheries Society* 136:72-81 .

Young, J. R., T. B. Hoff, W. P. Dey, and J. G. Hoff. 1988. Management recommendations for a Hudson River Atlantic sturgeon fishery based on an age-structured population model. *Fisheries Research in the Hudson River*. State of University of New York Press, Albany, New York. pp. 353.

Ziegeweid, J.R., C.A. Jennings, D.L. Peterson and M.C. Black. 2008. Effects of salinity, temperature, and weight on the survival of young-of-year shortnose sturgeon. *Transactions of the American Fisheries Society* 137: 1490-1499.

Zydlewski, G. 2009a. Penobscot River Restoration: Documentation of shortnose sturgeon spawning and characterization of spawning habitat. NOAA Restoration Center Community-Based Restoration Program (CRP), Progress Report: Jan. 1, 2008 – Dec. 31, 2009. University of Maine. School of Marine Sciences.

Zydlewski, G. 2009b. Cianbro Constructors, LLC Penobscot River Operations, Brewer, Maine Shortnose Sturgeon monitoring, July 2008 – October 2008. University of Maine. School of Marine Sciences.

Zydlewski, G., P. Dionne, and M. Kinnison. 2010. Investigation into the distribution and abundance of shortnose sturgeon in the Penobscot River, Maine. 5 pp. *In* Maine DMR. 2010. Final Report to NMFS Protected Resources Office for Award Number NA07NMF4720053.

APPENDIX A

Incident Report of Shortnose Sturgeon Take
Page 1 of 2

Species _____
Date _____ Time (specimen found) _____

Geographic Site _____
Location: Lat/Long _____

Sampling method/Gear Type _____
Location where specimen recovered

Weather conditions _____

Water temp: Surface _____ Below midwater (if known) _____
Water Depth: _____ Salinity _____ DO _____

Species Information: (please designate cm/m or inches.)

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 # _____

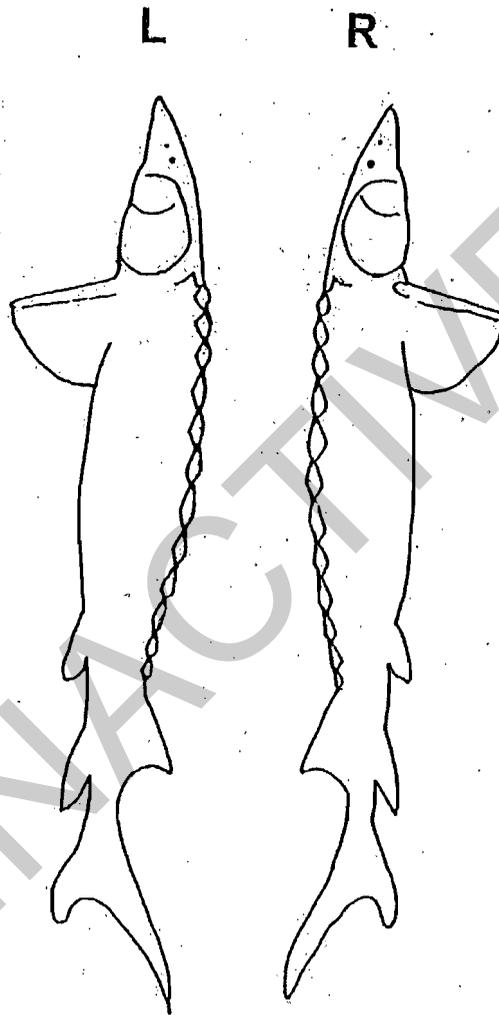
Photograph attached: YES / NO
(please label species, date, geographic site and vessel name on back of photograph)

Comments/other (include justification on how species was identified)

Observer's Name: _____
Observer's Signature _____

Incident Report of Shortnose Sturgeon Take
Page 2 of 2

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



Description of fish condition:

APPENDIX C

Procedure for obtaining fin clips from sturgeon for genetic analysis

Updated April 2009

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 Jessica Pruden at NMFS Northeast Regional Office (978-282-8482) to report that a sample is being sent and to discuss proper shipping procedures.