ENDANGERED SPECIES ACT SECTION 7 CONSULTATION
BIOLOGICAL OPINION

Action Agency: U.S. Fish and Wildlife Service, Region 5

Activity: Issuance of Funds to 11 Northeast States and the District of Columbia through the Wildlife and Sport Fish Restoration Program
NER-2012-3996 GARFO-2012-00019

Date Issued: 23 Jan 13

Approved by: for John Bullard

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1.0 INTRODUCTION

The U.S. Fish and Wildlife Service (FWS) provides funds to several states through the Dingell-Johnson Sport Fish Restoration Grant program and the State Wildlife Grant Program. The states use these funds to carry out activities that benefit aquatic species. A detailed list of activities considered in this Opinion is included in Section 3.0 below. This Opinion is based on information provided by FWS and other available information as cited herein. A complete administrative record of this consultation will be kept on file at NMFS Northeast Regional Office.

2.0 CONSULTATION HISTORY

On February 6, 2012, we published two rules listing five Distinct Population Segments (DPS) of Atlantic sturgeon (77 *Federal Register* 5880 and 5914). The effective date of these rules was April 6, 2012. In response to the listing, FWS reviewed State programs that they fund to assess which programs may interact with Atlantic sturgeon. Through this process, the FWS identified programs carried out by several states that are funded by FWS through the Dingell-Johnson Sport Fish Restoration Program. In the spring of 2012, we completed consultation on the effects of surveys carried out by the State of Connecticut and the State of New Jersey (funded by FWS) on listed species. On June 15, 2012, FWS requested consultation with us to consider effects of this program on listed species. Because the actions carried out by the states are similar, they take place in the same geographic area, and affect the same species in the same manner, we determined it would be most efficient to combine the analysis of effects of these activities in one consultation. As such, while there are thirteen independent actions considered here (i.e., FWS providing funds to thirteen states), we are producing one Biological Opinion. This type of "multi-action" consultation is contemplated in the NMFS-FWS Section 7 Consultation Handbook (see page 5-5). This Opinion replaces the Opinions issued by us in 2012 on the effects of surveys carried out by New Jersey and Connecticut.

A draft of this Opinion was provided to USFWS, who subsequently shared it with the affected states, on October 26, 2012. On December 12, 2012, FWS requested that we include three additional surveys, to be carried out by the States of New Hampshire and Rhode Island, in this Opinion. These additions to the proposed action were made. Consolidated comments on the October 2012 draft were received from FWS on December 18, 2012 and incorporated here as appropriate.

3.0 DESCRIPTION OF THE PROPOSED ACTION

FWS Region 5 provides funds to 13 States and the District of Columbia under the Dingell-Johnson Sport Fish Restoration Grant program and the State Wildlife Grant Program. Vermont and West Virginia are the only two Northeast States that do not use these funds to conduct ongoing surveys in marine, estuarine or rivervine waters where NMFS listed species are present. The 11 other States (Maine, NH, MA, CT, RI, NY, NJ, PA, DE, MD, VA) and DC carry out a total of 86 studies, mostly on an annual basis. The list of activities considered in this Opinion is outlined in Table 1. Complete project descriptions and maps illustrating project locations are included in Appendix A. There are several broad categories of fisheries surveys including: hook and line; beach seine; bottom trawl; fishway trap; boat electrofishing; long line; fyke net; gill net; haul seine; push net; and, backpack electrofishing. These surveys occur in rivers, estuaries and in nearshore ocean waters. Of these 86 surveys, NMFS listed species (Atlantic sturgeon, shortnose sturgeon or sea turtles) have been encountered in 22. Details on past interactions with NMFS listed species during these surveys is contained in Section 8.0 below.

Table 1. Activities carried out by States and funded by USFWS considered in this Opinion

State	Grant	Survey	Location	Gear
ME	F-41-R	Striped Bass Acoustic Telemetry Study	Kennebec and Androscoggin estuaries	Hook and line
ME	F-41-R	Juvenile Striped Bass and Alosine Beach Seine Survey	Kennebec, Androscoggin and Penobscot estuaries	Beach seine (17m)
ME	F-43-R	Maine-New Hampshire Inshore Trawl Survey	Coastal Maine and New Hampshire	Bottom trawl (17.3m)
NH	F-61-R	Anadromous Alosid Restoration and Evaluation	Coastal rivers systems of New Hampshire	Fishway trap
NH	F-61-R	Estuarine Survey of Juvenile Finfish	Great Bay and Hampton Harbor estuaries	Beach seine (30.5m)
NH	F-61-R	Monitoring of Rainbow Smelt Spawning Activity	Oyster, Squamscott, and Winnicut Rivers	Fyke net
MA	T-3	Fish Community Assessments	Connecticut River and other rivers statewide	Boat electrofishing, Gill net, Beach seine
MA	T-3	Westfield River Fish Passage Facility Evaluation	Westfield River	Fishway trap
MA	T-3	Essex Dam Fish Passage Facility Evaluation	Merrimack River	Fishway trap
MA	F-56-R	Fishery Resource Assessment	Coastal Massachusetts	Bottom trawl (11.8m)
MA	F-56-R	Winter Founder Year Class Strength Survey	Cape Cod southern shore estuaries	Beach seine (6m)
MA	F-57-R	Cooperative Striped Bass Tagging Study	Cape Cod Bay, Nantucket Sound	Hook and line
MA	F-57-R	Massachusetts Large Pelagics Research Project	Massachusetts Bay, Cape Cod Bay, Nantucket Sound, Buzzards Bay	Hook and line

MA	F-57-R	Striped Bass Acoustic Telemetry Study	Massachusetts Bay	Hook and line
MA	F-57-R	Monitoring Spawning Behavior and Movement of Atlantic Cod - Hook and line	Massachusetts Bay	Hook and line
MA	F-57-R	Monitoring Spawning Behavior and Movement of Atlantic Cod - Long line	Massachusetts Bay	Long line
MA	F-67-R	Population and Spawning Habitat Monitoring for Rainbow Smelt	Parker, Crane, North, Saugus, Fore, Jones, Weweantic , Westport rivers	Fyke net
MA	F-67-R	Monitoring of Biological Parameters and Habitat Characteristics for River Herring and American Shad	Nemasket and Monument rivers, Town Brook	Dip net
MA	F-67-R	Restoration of American Shad in the Charles River	Charles River	Boat electrofishing
MA	F-67-R	River Herring Trap and Transfer	Nemasket, Agawam, Charles and Monument rivers	Beach seine
RI	F-61-R	Narragansett Bay Adult Winter Flounder Monitoring and Assessment	Providence and Seekonk River system, the Barrington River system, Greenwich Bay, and adjacent coves, the Kickamuit River, and Nanaquacket Pond	Fyke net
RI	F-61-R	Narragansett Bay Ventless Pot, Multi-species Monitoring and Assessment Program	Narragansett Bay	Fish pots
RI	F-61-R	Seasonal Fishery Assessment in Rhode Island and Block Island Sound	Rhode Island and Block Island sounds	Bottom trawl (12.1m)
RI	F-61-R	Narragansett Bay Monthly Fish Assessment	Narragansett Bay	Bottom trawl (12.1m)
RI	F-61-R	Young-of-the-Year Survey of Selected Rhode Island Coastal Ponds and Embayments	Rhode Island coastal ponds and	Beach seine

			embayments	
RI	F-61-R	Juvenile Marine Finfish Survey	Narragansett Bay	Beach seine
RI	T2-4-R	Abundance and Distribution of Blue Crab	Narragansett Bay and coastal ponds	Crab traps
CT	F-54-R	Long Island Sound Trawl Survey	Long Island Sound	Bottom trawl (9.1m)
CT	F-54-R	Estuarine Seine Survey	Connecticut shoreline	Beach seine (7.6m)
CT	F-54-R	Inshore Survey	Connecticut and Thames rivers	Beach seine (15.2m)
NY	F-49-R	New York Small Mesh Survey	Peconic Bay	Bottom trawl (4.9m)
NY	F-49-R	Long Island Sound Trap Survey	Long Island Sound	Fish traps
NY	F-49-R	Western Long Island Sound Seine Survey	Little Neck, Manhasset and Jamaica bays	Beach seine (61m, 152m)
NY	F-49-R	Young-of-the-Year American Eel Survey	Carmans River	Fyke net
NY	F-49-R	Artificial Reef Monitoring	Hempstead, Fire Island, Kismet and Moriches reefs	Fish traps
NY	F-49-R	Spawning Stock Survey of American Shad, River Herring and Striped Bass	Hudson River	Haul seine (152m, 305m)
NY	F-49-R	Striped Bass Electrofishing	Hudson River	Boat electrofishing
NY	F-49-R	Alosine Juvenile Abundance Survey	Hudson River	Beach seine (30.5m)
NY	F-49-R	Striped Bass Juvenile Abundance Survey	Hudson River	Beach seine (71m)
NY	F-49-R	American Shad Spawning Habitat Studies	Hudson River	Gill net
NJ	F-48-R	Delaware River Juvenile American Shad Outmigration	Delaware River	Haul seine (91m)
NJ	F-15-R	New Jersey Ocean Trawl Survey	Coastal New Jersey	Bottom trawl (25m)
NJ	F-15-R	Cooperative Striped Bass Tagging in Delaware Bay	Delaware Bay	Gill net
NJ	F-15-R	Delaware River Juvenile Striped Bass Seine Survey	Delaware River	Beach seine (30.5m)
NJ	F-15-R	Relative Abundance of Selected Finfish Species in Delaware Bay	Delaware Bay	Bottom trawl (4.9m)
PA	F-57-R	Estimate of Black Bass Population Density	Delaware River	Boat electrofishing
PA	F-57-R	Long Term Fish Population Monitoring and Management Technique	Delaware River	Boat electrofishing

		Evaluations		
DE	F-75-R	Delaware Tidal Largemouth Bass Monitoring Program	Nanticoke River	Boat electrofishing
DE	F-47-R	Delaware River Striped Bass Spawning Stock Assessment	Delaware River	Boat electrofishing
DE	F-42-R	Bottom Trawl Sampling of Adult Groundfish in Delaware Bay	Coastal waters of Delaware	Bottom trawl (9.3m)
DE	F-42-R	Bottom Trawl Sampling of Juvenile Fishes in Delaware's Estuaries	Delaware estuaries	Bottom trawl (4.9m)
DE	F-56-R	Atlantic Menhaden Young of the Year Survey	Indian River and Rehoboth Bay	Mid-water trawl (1.5m)
MD	F-48-R	Tidal Largemouth Bass Survey	Potomac River, upper Chesapeake Bay and its tributaries	Boat electrofishing
MD	F-48-R	Tidal Potomac River Blue Catfish Survey	Potomac River	Boat electrofishing
MD	F-50-R	Coastal Bays Fisheries Investigations Trawl Survey	Coastal bays of Maryland	Bottom trawl (4.9m)
MD	F-50-R	Coastal Bays Fisheries Investigations Beach Seine Survey	Coastal bays of Maryland	Beach seine (15.2m, 30m)
MD	F-50-R	Submerged Aquatic Vegetation Beach Seining Program	Coastal bays of Maryland	Beach seine (15.2m)
MD	F-57-R	Summer Juvenile American and Hickory Shad Seine Survey	Patuxent and Choptank rivers, Marshyhope Creek	Beach seine (61m)
MD	F-57-R	Spring Adult American and Hickory Shad Electrofishing Survey	Patuxent and Choptank rivers, Marshyhope Creek	Boat electrofishing
MD	F-57-R	Spring American Shad Gill Net Brood Stock Collection	Potomac River	Gill net
MD	F-57-R	Spring Hickory Shad Electrofishing Brood Stock Collection	Susquehanna River	Boat electrofishing
MD	F-61-R	Upper Chesapeake Bay Winter Trawl Survey	Upper Chesapeake Bay	Bottom trawl (7.6m)
MD	F-61-R	Fishery Independent Choptank River Fyke Net Survey	Choptank River	Fyke net
MD	F-61-R	Juvenile Trawl and Seine Survey	Chester River	Bottom trawl (4.9m), Beach seine (30.5m)
MD	F-61-R	Spring Striped Bass Experimental Drift Gill Net Survey	Potomac River and Upper Chesapeake Bay	Gill net
MD	F-61-R	Juvenile Striped Bass Seine Survey	Chesapeake Bay	Beach seine (30.5m)

MD	F-63-R	Marine and Estuarine Finfish Ecological and Habitat Investigations	Chesapeake Bay	Bottom trawl (4.9m), Beach seine (30.5m)
MD	F-110-R	Mycobacteriosis in Striped Bass Resident to Chesapeake Bay	Chesapeake Bay	Hook and line, Pound net, Beach seine
DC	F-2-R	Fish Population Surveys – Electrofishing	Potomac and Annacostia rivers	Boat electrofishing
DC	F-2-R	Fish Population Surveys – Seining	Potomac and Annacostia rivers	Beach seine (30.5m)
DC	F-2-R	Fish Tagging Surveys	Potomac and Annacostia rivers	Boat electrofishing
DC	F-2-R	Push Net Survey	Potomac and Annacostia rivers	Push net
DC	F-2-R	American Eel Studies	Potomac and Annacostia rivers	Backpack electrofishing and fish pots
DC	F-2-R	Fish Passage on Rock Creek	Potomac and Annacostia rivers	Backpack and boat electrofishing
DC	F-2-R	American Shad Stock Enhancement	Potomac River	Gill net
VA	F-111-R	Tidal River Fish Community Monitoring	James, Chickahominy, York and Rappahannock rivers	Boat electrofishing
VA	F-111-R	Tidal River Fish Catfish Surveys	James, Pamunkey, Piankatank, Mattaponi and Rappahannock rivers	Boat electrofishing
VA	F-111-R	American Shad Restoration - Gill Netting	James, Pamunkey, Potomac and Rappahannock rivers	Gill net
VA	F-111-R	American Shad Restoration – Electrofishing	James, Pamunkey, Potomac and Rappahannock rivers	Boat electrofishing
VA	F-111-R	Northern Snakehead Monitoring in Virginia	Potomac, Wicomico,	Boat electrofishing

			Rappahannock and Piankatank rivers	
VA	F-116-R	American Shad Monitoring Program - Gill Netting	York, James and Rappahannock rivers	Gill net
VA	F-116-R	American Shad Monitoring Program - Fyke Netting	York River	Fyke net
VA	F-104-R	Juvenile Fish Trawl Survey	Chesapeake Bay	Bottom trawl (9.1m)
VA	F-87-R	Juvenile Striped Bass Beach Seine Survey	Chesapeake Bay	Beach seine (30.5m)
VA	F-130-R	Chesapeake Bay Multispecies Monitoring and Assessment Program	Chesapeake Bay	Bottom trawl (13.7m)
VA	F-77-R	Striped Bass Spawning Stock Assessment - Gill Netting	James and Rappahannock rivers	Gill net

3.1 Action Area

The action area for Section 7 consultations is defined as all of the areas directly or indirectly affected by the Federal action, and not merely the immediate area involved in the action. We anticipate that the only effects on ESA-listed species and their habitat as a result of the proposed actions are the direct effects of interaction between listed species and sampling gear that will be used for the surveys, and the effects on other marine organisms (*i.e.*, prey) on or very near the seafloor from the sampling gear. The action area includes state waters where sampling occurs as described in Section 3.0 above, and generally consists of state waters from Maine through Virginia.

4.0 STATUS OF THE SPECIES

This section presents biological and ecological information relevant to formulating the Biological Opinion. Information on 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.

4.1 Listed Species and Critical Habitat in the Action Area that are not likely to be adversely affected by the action

We have determined that the actions being considered in the Opinion are not likely to adversely affect hawksbill sea turtles (*Eretmochelys imbricata*), North Atlantic right whales (right whales) (*Eubalaena glacialis*), humpback whales (*Megaptera novaeangliae*), fin whales (*Balaenoptera physalus*), sei whales (*Balaenoptera borealis*), blue whales (*Balaenoptera musculus*), and sperm whales (*Physeter macrocephalus*), all of which are listed as endangered species under the ESA. Additionally, critical habitat has been designated for right whales and the Gulf of Maine DPS of Atlantic salmon. We have determined that any effects to critical habitat will be insignificant and discountable. The analysis presented in this Opinion does not rely on the regulatory definition of "adverse modification or destruction" of critical habitat at issue in the 9th Circuit Court of

Appeals (Gifford Pinchot Task Force *et al.* v. U.S. Fish and Wildlife Service, No. 03-35279, August 6, 2004). Thus, these species and critical habitat will not be considered further in this Opinion. Below, we present our rationale for these determinations.

4.1.1 Hawksbill sea turtle

The hawksbill sea turtle is listed as endangered. This species is uncommon in the waters of the continental U.S. Hawksbills prefer coral reef habitats, such as those found in the Caribbean and Central America. Mona Island (Puerto Rico) and Buck Island (St. Croix, U.S. Virgin Islands) contain especially important foraging and nesting habitat for hawksbills. Within the continental U.S., nesting is restricted to the southeast coast of Florida and the Florida Keys, but nesting is rare in these areas. Hawksbills have been recorded from all the Gulf States and along the east coast of the U.S. as far north as Massachusetts, but sightings north of Florida are rare. Aside from Florida, Texas is the only other U.S. state where hawksbills are sighted with any regularity. Since hawksbill sea turtles are not expected to be present in the areas where the survey will take place, it is highly unlikely that the proposed action will affect this sea turtle species. The lack of any captures of hawksbill sea turtles in any of the activities considered here supports this determination.

4.1.2 Large Whales

Sperm whales and blue whales are listed as endangered. These species are unlikely to occur in areas where the surveys considered here will operate. During surveys for the Cetacean and Turtle Assessment Program (CeTAP), sperm whales were observed along the shelf edge, centered around the 1,000 m depth contour but extending seaward out to the 2,000 m depth contour (CeTAP 1982). Although blue whales are occasionally seen in U.S. waters, they are more commonly found in Canadian waters and are rare in continental shelf waters of the eastern U.S. (Waring *et al.* 2000). Given the predominantly offshore distribution of these two cetacean species, both are highly unlikely to occur in the action area which is limited to state waters.

North Atlantic right whales, humpback whales, fin whales, and sei whales may occur in the area where the ocean trawl surveys will be conducted; however, given the shallow depths (less than 15 fathoms) at which these surveys operate, occurrence is expected to be rare. None of these species are expected to be affected by the use of bottom otter trawl gear for the survey given the following. While these species may occur in the action area, large cetaceans have the speed and maneuverability to get out of the way of oncoming mobile gear, including trawl gear. The slow speed of the trawl survey (3.1 knots) and the short tow times (20 minutes) further reduce the potential for entanglement or any other interaction. Observations of many fishing trips using mobile gear (*e.g.*, dredge, trawl gear) have shown that entanglement or capture of large whales in these gear types is extremely rare and unlikely. No interactions with any species of whale has occurred during the state marine surveys considered in this Opinion or any similar surveys (*i.e.*, the NMFS Northeast Fisheries Science Center (NEFSC) spring and fall bottom trawl surveys or the Virginia Institute of Marine Science's (VIMS) Northeast Area Monitoring and Assessment Program (NEAMAP) Near Shore Trawl Program. Because of this, we have determined that it is extremely unlikely that any large whale would interact with any the trawl gear operated as part of the proposed actions.

We have also determined that in-water work for the survey will not have any adverse effects on cetacean prey. Right and sei whales feed on copepods (Horwood 2002; Kenney 2002). The use of trawl gear for the proposed project will not affect the availability of copepods for foraging right and sei whales. This is because copepods are very small organisms that will pass through the gear rather than being captured in it. Blue whales feed on euphausiids (krill) (Sears 2002) which, likewise, are too small to be captured in the gear. Humpback and fin whales also feed on krill as well as small schooling fish (*e.g.*, sand lance, herring, and mackerel) found within the water column (Aguilar 2002; Clapham 2002). The trawl gear used for the survey will operate on or very near the bottom. Therefore, the fish species caught in such gear would be species that live in benthic habitats (on or very near the bottom) such as flounders and other groundfish. Schooling fish such as herring and mackerel that occur within the water column are unlikely to be captured with this gear. Sperm whales feed on larger organisms that inhabit the deeper ocean regions (Whitehead 2002) outside of the action area. Based on this analysis, it is extremely unlikely that the trawl surveys will affect the availability of prey for any whale species.

4.1.3 Right Whale Critical Habitat

Certain New England waters were designated as critical habitat for Northern right whales[1] in 1994 (59 FR 28793). The Great South Channel critical habitat is the area bounded by 41º40′ N/69º45′ W; 41º00′ N/69º05′ W; 41º38′ W; and 42º10′ N/68º31′ W. The Cape Cod Bay critical habitat is the area bounded by 42º02.8′ N/70º10′ W; 42º12′ N/70º15′ W; 42º12′ N/70º30′ W; 41º46.8′ N/70º30′ W and on the south and east by the interior shore line of Cape Cod, Massachusetts. The Massachusetts trawl survey occurs in Cape Cod Bay.

We have determined that the actions being considered in the Opinion are not likely to adversely affect designated critical habitat for right whales in the Northwest Atlantic. This determination is based on the action's effects on the conservation value of the habitat that has been designated. Specifically, we considered whether the action was likely to affect the physical or biological features that afford the designated area value for the conservation of right whales. Cape Cod Bay was designated as critical habitat for right whales due to its importance as spring/summer foraging grounds for the species. What makes this area so critical is the presence of dense concentrations of copepods. The MA trawl survey will not affect the availability of copepods for foraging right whales because copepods are very small organisms that will pass through the sampling gear rather than being captured in it. Since the action being considered in this Opinion is not likely to affect the availability of copepods and these were the biological feature that characterized feeding habitat, this action is not likely to adversely affect designated critical habitat for right whales and, therefore, right whale critical habitat will not be considered further in this Opinion.

[1] In 2008, NMFS listed the endangered northern right whale (*Eubalaena spp.*) as two separate, endangered species: the North Pacific right whale (*E. japonica*) and North Atlantic right whale (*E. glacialis*) (*73 FR 12024*). We received a petition to revise the 1994 critical habitat designation in October 2009. In an October 2010 Federal Register notice, we announced that we intend to revise existing critical habitat by continuing our ongoing rulemaking process to designate critical habitat for North Atlantic right whales with the expectation that a proposed critical habitat rule for the North Atlantic right whale will be published in 2011. To date, we have not published a proposed rule so the 1994 critical habitat designation for northern right whales is the only critical habitat for right whales in the Atlantic.

4.1.4 GOM DPS Atlantic salmon Critical Habitat

The critical habitat designation for the GOM DPS consists of 45 specific areas that include approximately 19,571 km of perennial river, stream, and estuary habitat and 799 square km of lake habitat within the geographic area occupied by the GOM DPS at the time of listing, and in which are found those physical and biological features essential to the conservation of the species. The entire occupied range of the GOM DPS in which critical habitat is designated is within the State of Maine. Some of the activities proposed by the State of Maine occur within designated critical habitat for listed Atlantic salmon.

The action area is a known migratory corridor for both juvenile and adult Atlantic salmon. A migratory corridor free from physical and biological barriers that delay or prevent access of adult salmon seeking spawning grounds or prevent emigration of smolts to the marine environment is identified in the critical habitat designation as essential for the conservation of Atlantic salmon. The Primary Constituent Elements (PCE) for designated critical habitat of listed Atlantic salmon in the action area are:

1) Freshwater and estuary migratory sites free from physical and biological barriers that delay or prevent access of adult salmon seeking spawning grounds needed to support recovered populations;
2) Freshwater and estuary migration sites with abundant, diverse native fish communities to serve as a protective buffer against predation; and,
3) Freshwater and estuary migration sites free from physical and biological barriers that delay or prevent emigration of smolts to the marine environment.

We have analyzed the potential impacts of the projects on designated critical and PCEs in the action area. We have determined that the effects to these PCEs will be insignificant for the following reasons:

The project will not result in a migration barrier as the surveys will only affect a small portion of the river at any given time, and because no salmon will be prevented from passing through the action area. The projects will not alter the habitat in any way that would increase the risk of predation. There will be no water quality impacts of the proposed action and therefore the projects are not expected to affect water quality at the time of any salmon migrations in the action area. The project will not significantly affect the forage of juvenile or adult Atlantic salmon. Finally, as the action will not affect the natural structure of the nearshore habitat, there will be no reduction in the capacity of substrate, food resources, and natural cover to meet the conservation needs of listed Atlantic salmon. Based upon this reasoning, we have determined that any effects to designated critical habitat in the action area will be insignificant.

4.2 Listed Species in the Action Area that may be affected by the Proposed Action

This section will focus on the status of the various species within the action area, summarizing information necessary to establish the environmental baseline and to assess the effects of the proposed action. NMFS has determined that the actions we consider in the Opinion may adversely affect the following listed species:

Common name	Scientific name	ESA Status
Gulf of Maine DPS of Atlantic salmon	*Salmo salar*	Endangered
Northwest Atlantic DPS of loggerhead sea turtle	*Caretta caretta*	Threatened
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered
Green sea turtle	*Chelonia mydas*	Endangered[2]
Leatherback sea turtle	*Dermochelys coriacea*	Endangered
GOM DPS of Atlantic sturgeon	*Acipenser oxyrinchus oxyrinchus*	Threatened
New York Bight DPS of Atlantic sturgeon	*Acipenser oxyrinchus oxyrinchus*	Endangered
Chesapeake Bay DPS of Atlantic sturgeon	*Acipenser oxyrinchus oxyrinchus*	Endangered
South Atlantic DPS of Atlantic sturgeon	*Acipenser oxyrinchus oxyrinchus*	Endangered
Shortnose sturgeon	*Acipenser brevirostrum*	Endangered

Atlantic salmon

The only activities considered here that may result in the capture of listed Atlantic salmon area surveys that take place in Maine. NMFS holds an ESA Section 10 (a)(l)(A) research permit (ESA permit 697823) issued by 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. Maine DMR is a subpermittee on this permit. As all effects to Atlantic salmon resulting from the proposed action are considered and authorized under the Section 10 permit and accompanying section 7 consultation, any effects to Atlantic salmon will not be further considered in this Opinion.

4.3 Overview of Status of Sea Turtles

With the exception of loggerheads, sea turtles are listed under the ESA at the species level rather than as subspecies or distinct population segments (DPS). Therefore, information on the range-wide status of leatherback, Kemp's ridley and green sea turtles is included to provide the status of each species overall. Information on the status of loggerheads will only be presented for the DPS affected by this action. Additional background information on the range-wide status of these species can be found in a number of published documents, including sea turtle status reviews and biological reports (NMFS and USFWS 1995; Hirth 1997; Marine Turtle Expert Working Group [TEWG] 1998, 2000, 2007, 2009; NMFS and USFWS 2007a, 2007b, 2007c, 2007d; Conant *et al.* 2009), and recovery plans for the loggerhead sea turtle (NMFS and USFWS 2008), Kemp's ridley sea turtle (NMFS *et al.* 2011), leatherback sea turtle (NMFS and USFWS 1992, 1998a), Kemp's ridley sea turtle (NMFS *et al.* 2011)and green sea turtle (NMFS and USFWS 1991, 1998b).

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[2] Green sea turtles in U.S. waters are listed as threatened except for the Florida breeding population, which is listed as endangered. Due to the inability to distinguish between these populations away from the nesting beach, green sea turtles are considered endangered wherever they occur in U.S. waters

2010 BP Deepwater Horizon Oil Spill
The April 20, 2010, explosion of the Deepwater Horizon oil rig affected sea turtles in the Gulf of Mexico. There is an on-going assessment of the long-term effects of the spill on Gulf of Mexico marine life, including sea turtle populations. Following the spill, juvenile Kemp's ridley, green, and loggerhead sea turtles were found in *Sargassum* algae mats in the convergence zones, where currents meet and oil collected. Sea turtles found in these areas were often coated in oil and/or had ingested oil. Approximately 536 live adult and juvenile sea turtles were recovered from the Gulf and brought into rehabilitation centers; of these, 456 were visibly oiled (these and the following numbers were obtained from http://www.nmfs.noaa.gov/pr/health/oilspill/). To date, 469 of the live recovered sea turtles have been successfully returned to the wild, 25 died during rehabilitation, and 42 are still in care but are expected to be returned to the wild eventually. During the clean-up period, 613 dead sea turtles were recovered in coastal waters or on beaches in Mississippi, Alabama, Louisiana, and the Florida Panhandle. As of February 2011, 478 of these dead turtles had been examined. Many of the examined sea turtles showed indications that they had died as a result of interactions with trawl gear, most likely used in the shrimp fishery, and not as a result of exposure to or ingestion of oil.

During the spring and summer of 2010, nearly 300 sea turtle nests were relocated from the northern Gulf to the east coast of Florida with the goal of preventing hatchlings from entering the oiled waters of the northern Gulf. From these relocated nests, 14,676 sea turtles, including 14,235 loggerheads, 125 Kemp's ridleys, and 316 greens, were ultimately released from Florida beaches.

A thorough assessment of the long-term effects of the spill on sea turtles has not yet been completed. The spill resulted in the direct mortality of many sea turtles and may have had sublethal effects or caused environmental damage that will impact other sea turtles into the future. The population level effects of the spill and associated response activity are likely to remain unknown for some period into the future.

4.4 Northwest Atlantic DPS of loggerhead sea turtle
The loggerhead is the most abundant species of sea turtle in U.S. waters. Loggerhead sea turtles are found in temperate and subtropical waters and occupy a range of habitats including offshore waters, continental shelves, bays, estuaries, and lagoons. They are also exposed to a variety of natural and anthropogenic threats in the terrestrial and marine environment.

Listing History
Loggerhead sea turtles were listed as threatened throughout their global range on July 28, 1978. Since that time, several status reviews have been conducted to review the status of the species and make recommendations regarding its ESA listing status. Based on a 2007 5-year status review of the species, which discussed a variety of threats to loggerheads including climate change, NMFS and FWS determined that loggerhead sea turtles should not be delisted or reclassified as endangered. However, we also determined that an analysis and review of the species should be conducted in the future to determine whether DPSs should be identified for the loggerhead (NMFS and USFWS 2007a). Genetic differences exist between loggerhead sea

turtles that nest and forage in the different ocean basins (Bowen 2003; Bowen and Karl 2007). Differences in the maternally inherited mitochondrial DNA also exist between loggerhead nesting groups that occur within the same ocean basin (TEWG 2000; Pearce 2001; Bowen 2003; Bowen *et al.* 2005; Shamblin 2007; TEWG 2009; NMFS and USFWS 2008). Site fidelity of females to one or more nesting beaches in an area is believed to account for these genetic differences (TEWG 2000; Bowen 2003).

In part to evaluate those genetic differences, in 2008, NMFS and FWS established a Loggerhead Biological Review Team (BRT) to assess the global loggerhead population structure to determine whether DPSs exist and, if so, the status of each DPS. The BRT evaluated genetic data, tagging and telemetry data, demographic information, oceanographic features, and geographic barriers to determine whether population segments exist. The BRT report was completed in August 2009 (Conant *et al.* 2009). In this report, the BRT identified the following nine DPSs as being discrete from other conspecific population segments and significant to the species: (1) North Pacific Ocean, (2) South Pacific Ocean, (3) North Indian Ocean, (4) Southeast Indo-Pacific Ocean, (5) Southwest Indian Ocean, (6) Northwest Atlantic Ocean, (7) Northeast Atlantic Ocean, (8) Mediterranean Sea, and (9) South Atlantic Ocean.

The BRT concluded that although some DPSs are indicating increasing trends at nesting beaches (Southwest Indian Ocean and South Atlantic Ocean), available information about anthropogenic threats to juveniles and adults in neritic and oceanic environments indicate possible unsustainable additional mortalities. According to an analysis using expert opinion in a matrix model framework, the BRT report stated that all loggerhead DPSs have the potential to decline in the foreseeable future. Based on the threat matrix analysis, the potential for future decline was reported as greatest for the North Indian Ocean, Northwest Atlantic Ocean, Northeast Atlantic Ocean, Mediterranean Sea, and South Atlantic Ocean DPSs (Conant *et al.* 2009). The BRT concluded that the North Pacific Ocean, South Pacific Ocean, North Indian Ocean, Southeast Indo-Pacific Ocean, Northwest Atlantic Ocean, Northeast Atlantic Ocean, and Mediterranean Sea DPSs were at risk of extinction. The BRT concluded that although the Southwest Indian Ocean and South Atlantic Ocean DPSs were likely not currently at immediate risk of extinction, the extinction risk was likely to increase in the foreseeable future.

On March 16, 2010, NMFS and USFWS published a proposed rule (75 FR 12598) to divide the worldwide population of loggerhead sea turtles into nine DPSs, as described in the 2009 Status Review. Two of the DPSs were proposed to be listed as threatened and seven of the DPSs, including the Northwest Atlantic Ocean DPS, were proposed to be listed as endangered. NMFS and the USFWS accepted comments on the proposed rule through September 13, 2010 (75 FR 30769, June 2, 2010). On March 22, 2011 (76 FR 15932), NMFS and USFWS extended the date by which a final determination on the listing action will be made to no later than September 16, 2011. This action was taken to address the interpretation of the existing data on status and trends and its relevance to the assessment of risk of extinction for the Northwest Atlantic Ocean DPS, as well as the magnitude and immediacy of the fisheries bycatch threat and measures to reduce this threat. New information or analyses to help clarify these issues were requested by April 11, 2011.

On September 22, 2011, NMFS and USFWS issued a final rule (76 FR 58868), determining that the loggerhead sea turtle is composed of nine DPSs (as defined in Conant *et al*., 2009) that constitute species that may be listed as threatened or endangered under the ESA. Five DPSs were listed as endangered (North Pacific Ocean, South Pacific Ocean, North Indian Ocean, Northeast Atlantic Ocean, and Mediterranean Sea), and four DPSs were listed as threatened (Northwest Atlantic Ocean, South Atlantic Ocean, Southeast Indo-Pacific Ocean, and Southwest Indian Ocean). Note that the Northwest Atlantic Ocean (NWA) DPS and the Southeast Indo-Pacific Ocean DPS were originally proposed as endangered. The NWA DPS was determined to be threatened based on review of nesting data available after the proposed rule was published, information provided in public comments on the proposed rule, and further discussions within the agencies. The two primary factors considered were population abundance and population trend. NMFS and USFWS found that an endangered status for the NWA DPS was not warranted given the large size of the nesting population, the overall nesting population remains widespread, the trend for the nesting population appears to be stabilizing, and substantial conservation efforts are underway to address threats. This final listing rule became effective on October 24, 2011.

The September 2011 final rule also noted that critical habitat for the two DPSs occurring within the U.S. (NWA DPS and North Pacific DPS) will be designated in a future rulemaking. Information from the public related to the identification of critical habitat, essential physical or biological features for this species, and other relevant impacts of a critical habitat designation was solicited. Currently, no critical habitat is designated for any DPS of loggerhead sea turtles, and therefore, no critical habitat for any DPS occurs in the action area.

Presence of Loggerhead Sea Turtles in the Action Area

The effects of this proposed action are only experienced within the Atlantic Ocean. NMFS has considered the available information on the distribution of the 9 DPSs to determine the origin of any loggerhead sea turtles that may occur in the action area. As noted in Conant *et al.* (2009), the range of the four DPSs occurring in the Atlantic Ocean are as follows: NWA DPS – north of the equator, south of 60° N latitude, and west of 40° W longitude; Northeast Atlantic Ocean (NEA) DPS – north of the equator, south of 60° N latitude, east of 40° W longitude, and west of 5° 36' W longitude; South Atlantic DPS – south of the equator, north of 60° S latitude, west of 20° E longitude, and east of 60° W longitude; Mediterranean DPS – the Mediterranean Sea east of 5° 36' W longitude. These boundaries were determined based on oceanographic features, loggerhead sightings, thermal tolerance, fishery bycatch data, and information on loggerhead distribution from satellite telemetry and flipper tagging studies. While adults are highly structured with no overlap, there may be some degree of overlap by juveniles of the NWA, NEA, and Mediterranean DPSs on oceanic foraging grounds (Laurent *et al.* 1993, 1998; Bolten *et al.* 1998; LaCasella *et al.* 2005; Carreras *et al.* 2006, Monzón-Argüello *et al.* 2006; Revelles *et al.* 2007). Previous literature (Bowen *et al.* 2004) has suggested that there is the potential, albeit small, for some juveniles from the Mediterranean DPS to be present in U.S. Atlantic coastal foraging grounds. These conclusions must be interpreted with caution however, as they may reflect a shared common haplotype and lack of representative sampling at Eastern Atlantic rookeries rather than an actual presence of Mediterranean DPS turtles in US Atlantic coastal waters. A re-analysis of the data by the Atlantic loggerhead Turtle Expert Working Group has found that that it is unlikely that U.S. fishing fleets are interacting with either the Northeast

Atlantic loggerhead DPS or the Mediterranean loggerhead DPS (Peter Dutton, NMFS, Marine Turtle Genetics Program, Program Leader, personal communication, September 10, 2011). Given that the action area is a subset of the area fished by US fleets, it is reasonable to assume that based on this new analysis, no individuals from the Mediterranean DPS or Northeast Atlantic DPS would be present in the action area. Sea turtles of the South Atlantic DPS do not inhabit the action area of this consultation (Conant *et al.* 2009). As such, the remainder of this consultation will only focus on the NWA DPS, listed as threatened.

Distribution and Life History

Ehrhart *et al.* (2003) provided a summary of the literature identifying known nesting habitats and foraging areas for loggerheads within the Atlantic Ocean. Detailed information is also provided in the 5-year status review for loggerheads (NMFS and USFWS 2007a), the TEWG report (2009), and the final revised recovery plan for loggerheads in the Northwest Atlantic Ocean (NMFS and USFWS 2008), which is a second revision to the original recovery plan that was approved in 1984 and subsequently revised in 1991.

In the western Atlantic, waters as far north as 41° N to 42° N latitude are used for foraging by juveniles, as well as adults (Shoop 1987; Shoop and Kenney 1992; Ehrhart *et al.* 2003; Mitchell *et al.* 2003). In U.S. Atlantic waters, loggerheads commonly occur throughout the inner continental shelf from Florida to Cape Cod, Massachusetts and in the Gulf of Mexico from Florida to Texas, although their presence varies with the seasons due to changes in water temperature (Shoop and Kenney 1992; Epperly *et al.* 1995a, 1995b; Braun and Epperly 1996; Braun-McNeill *et al.* 2008; Mitchell *et al.* 2003). Loggerheads have been observed in waters with surface temperatures of 7°C to 30°C, but water temperatures ≥11°C are most favorable (Shoop and Kenney 1992; Epperly *et al.* 1995b). The presence of loggerhead sea turtles in U.S. Atlantic waters is also influenced by water depth. Aerial surveys of continental shelf waters north of Cape Hatteras, North Carolina indicated that loggerhead sea turtles were most commonly sighted in waters with bottom depths ranging from 22 m to 49 m deep (Shoop and Kenney 1992). However, more recent survey and satellite tracking data support that they occur in waters from the beach to beyond the continental shelf (Mitchell *et al.* 2003; Braun-McNeill and Epperly 2004; Mansfield 2006; Blumenthal *et al.* 2006; Hawkes *et al.* 2006; McClellan and Read 2007; Mansfield *et al.* 2009).

Loggerhead sea turtles occur year round in ocean waters off North Carolina, South Carolina, Georgia, and Florida. In these areas of the South Atlantic Bight, water temperature is influenced by the proximity of the Gulf Stream. As coastal water temperatures warm in the spring, loggerheads begin to migrate to inshore waters of the Southeast United States (*e.g.*, Pamlico and Core Sounds) and also move up the U.S. Atlantic coast (Epperly *et al.* 1995a, 1995b, 1995c; Braun-McNeill and Epperly 2004), occurring in Virginia foraging areas as early as April/May and on the most northern foraging grounds in the Gulf of Maine in June (Shoop and Kenney 1992). The trend is reversed in the fall as water temperatures cool. The large majority leave the Gulf of Maine by mid-September but some turtles may remain in Mid-Atlantic and Northeast areas until late fall. By December, loggerheads have migrated from inshore and more northern coastal waters to waters offshore of North Carolina, particularly off of Cape Hatteras, and waters further south where the influence of the Gulf Stream provides temperatures favorable to sea turtles (Shoop and Kenney 1992; Epperly *et al.* 1995b).

Recent studies have established that the loggerhead's life history is more complex than previously believed. Rather than making discrete developmental shifts from oceanic to neritic environments, research is showing that both adults and (presumed) neritic stage juveniles continue to use the oceanic environment and will move back and forth between the two habitats (Witzell 2002; Blumenthal *et al.* 2006; Hawkes *et al.* 2006; McClellan and Read 2007; Mansfield *et al.* 2009). One of the studies tracked the movements of adult post-nesting females and found that differences in habitat use were related to body size with larger adults staying in coastal waters and smaller adults traveling to oceanic waters (Hawkes *et al.* 2006). A tracking study of large juveniles found that the habitat preferences of this life stage were also diverse with some remaining in neritic waters and others moving off into oceanic waters (McClellan and Read 2007). However, unlike the Hawkes *et al.* (2006) study, there was no significant difference in the body size of turtles that remained in neritic waters versus oceanic waters (McClellan and Read 2007).

Pelagic and benthic juveniles are omnivorous and forage on crabs, mollusks, jellyfish, and vegetation at or near the surface (Dodd 1988; NMFS and USFWS 2008). Sub-adult and adult loggerheads are primarily coastal dwelling and typically prey on benthic invertebrates such as mollusks and decapod crustaceans in hard bottom habitats (NMFS and USFWS 2008).

As presented below, Table 3 from the 2008 loggerhead recovery plan (Table 2 in this Opinion) highlights the key life history parameters for loggerheads nesting in the United States.

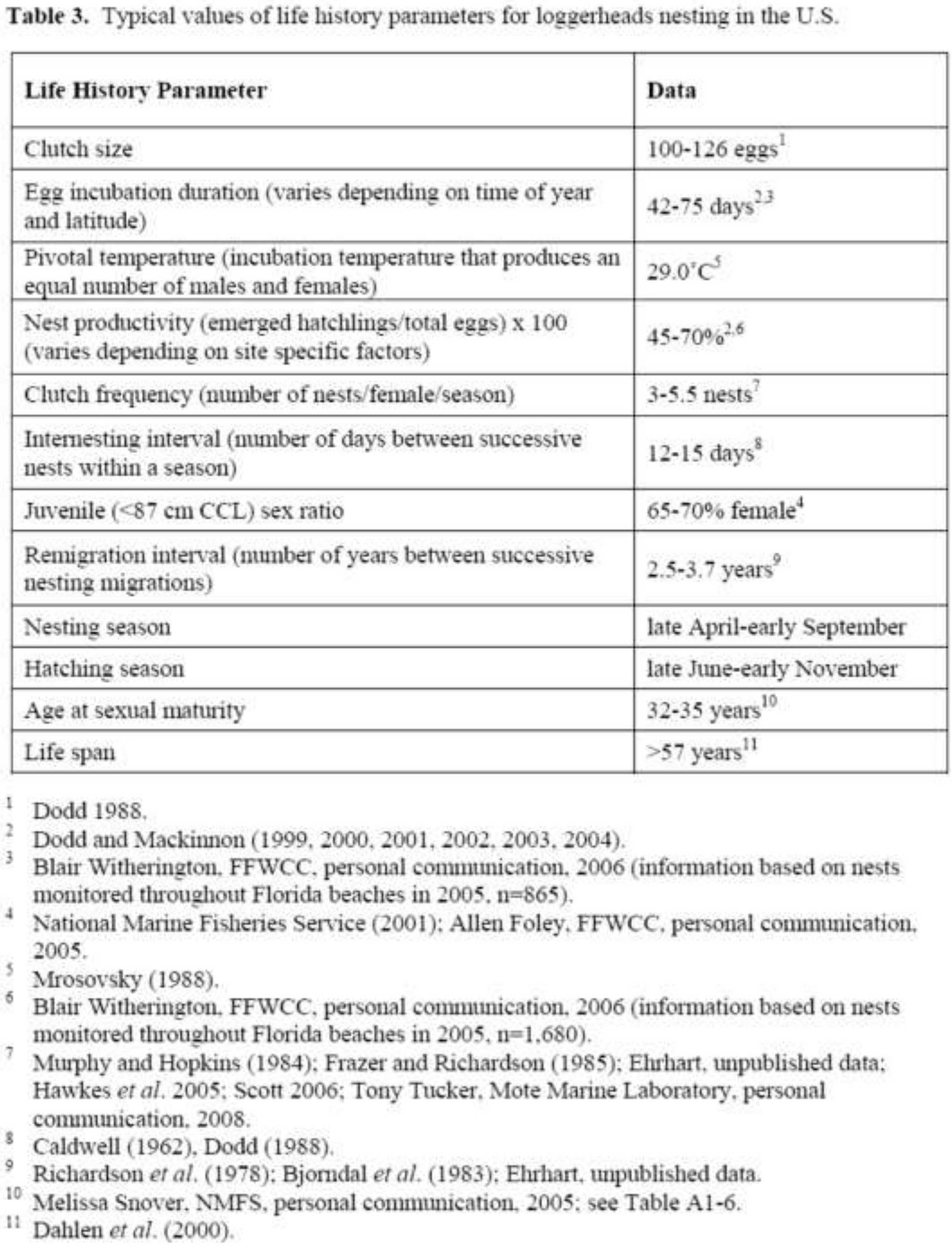

Table 3. Typical values of life history parameters for loggerheads nesting in the U.S.

Life History Parameter	**Data**
Clutch size	100-126 eggs[1]
Egg incubation duration (varies depending on time of year and latitude)	42-75 days[2,3]
Pivotal temperature (incubation temperature that produces an equal number of males and females)	29.0°C[5]
Nest productivity (emerged hatchlings/total eggs) x 100 (varies depending on site specific factors)	45-70%[2,6]
Clutch frequency (number of nests/female/season)	3-5.5 nests[7]
Internesting interval (number of days between successive nests within a season)	12-15 days[8]
Juvenile (<87 cm CCL) sex ratio	65-70% female[4]
Remigration interval (number of years between successive nesting migrations)	2.5-3.7 years[9]
Nesting season	late April-early September
Hatching season	late June-early November
Age at sexual maturity	32-35 years[10]
Life span	>57 years[11]

[1] Dodd 1988.

[2] Dodd and Mackinnon (1999, 2000, 2001, 2002, 2003, 2004).

[3] Blair Witherington, FFWCC, personal communication, 2006 (information based on nests monitored throughout Florida beaches in 2005, n=865).

[4] National Marine Fisheries Service (2001); Allen Foley, FFWCC, personal communication, 2005.

[5] Mrosovsky (1988).

[6] Blair Witherington, FFWCC, personal communication, 2006 (information based on nests monitored throughout Florida beaches in 2005, n=1,680).

[7] Murphy and Hopkins (1984); Frazer and Richardson (1985); Ehrhart, unpublished data; Hawkes *et al.* 2005; Scott 2006; Tony Tucker, Mote Marine Laboratory, personal communication, 2008.

[8] Caldwell (1962), Dodd (1988).

[9] Richardson *et al.* (1978); Bjorndal *et al.* (1983); Ehrhart, unpublished data.

[10] Melissa Snover, NMFS, personal communication, 2005; see Table A1-6.

[11] Dahlen *et al.* (2000).

Population Dynamics and Status

By far, the majority of Atlantic nesting occurs on beaches of the southeastern United States (NMFS and USFWS 2007a). For the past decade or so, the scientific literature has recognized five distinct nesting groups, or subpopulations, of loggerhead sea turtles in the Northwest Atlantic, divided geographically as follows: (1) a northern group of nesting females that nest from North Carolina to northeast Florida at about 29° N latitude; (2) a south Florida group of nesting females that nest from 29° N latitude on the east coast to Sarasota on the west coast; (3) a Florida Panhandle group of nesting females that nest around Eglin Air Force Base and the beaches near Panama City, Florida; (4) a Yucatán group of nesting females that nest on beaches of the eastern Yucatán Peninsula, Mexico; and (5) a Dry Tortugas group that nests on beaches of the islands of the Dry Tortugas, near Key West, Florida and on Cal Sal Bank (TEWG 2009). Genetic analyses of mitochondrial DNA, which a sea turtle inherits from its mother, indicate that there are genetic differences between loggerheads that nest at and originate from the beaches used by each of the five identified nesting groups of females (TEWG 2009). However, analyses of microsatellite loci from nuclear DNA, which represents the genetic contribution from both parents, indicates little to no genetic differences between loggerheads originating from nesting beaches of the five Northwest Atlantic nesting groups (Pearce and Bowen 2001; Bowen 2003; Bowen *et al.* 2005; Shamblin 2007). These results suggest that female loggerheads have site fidelity to nesting beaches within a particular area, while males provide an avenue of gene flow between nesting groups by mating with females that originate from different nesting groups (Bowen 2003; Bowen *et al.* 2005). The extent of such gene flow, however, is unclear (Shamblin 2007).

The lack of genetic structure makes it difficult to designate specific boundaries for the nesting subpopulations based on genetic differences alone. Therefore, the Loggerhead Recovery Team recently used a combination of geographic distribution of nesting densities, geographic separation, and geopolitical boundaries, in addition to genetic differences, to reassess the designation of these subpopulations to identify recovery units in the 2008 recovery plan.

In the 2008 recovery plan, the Loggerhead Recovery Team designated five recovery units for the Northwest Atlantic population of loggerhead sea turtles based on the aforementioned nesting groups and inclusive of a few other nesting areas not mentioned above. The first four of these recovery units represent nesting assemblages located in the Southeast United States. The fifth recovery unit is composed of all other nesting assemblages of loggerheads within the Greater Caribbean, outside the United States, but which occur within U.S. waters during some portion of their lives. The five recovery units representing nesting assemblages are: (1) the Northern Recovery Unit (NRU: Florida/Georgia border through southern Virginia), (2) the Peninsular Florida Recovery Unit (PFRU: Florida/Georgia border through Pinellas County, Florida), (3) the Dry Tortugas Recovery Unit (DTRU: islands located west of Key West, Florida), (4) the Northern Gulf of Mexico Recovery Unit (NGMRU: Franklin County, Florida through Texas), and (5) the Greater Caribbean Recovery Unit (GCRU: Mexico through French Guiana, Bahamas, Lesser Antilles, and Greater Antilles).

The Recovery Team evaluated the status and trends of the Northwest Atlantic loggerhead population for each of the five recovery units, using nesting data available as of October 2008 (NMFS and USFWS 2008). The level and consistency of nesting coverage varies among recovery units, with coverage in Florida generally being the most consistent and thorough over time. Since 1989, nest count surveys in Florida have occurred in the form of statewide surveys (a near complete census of entire Florida nesting) and index beach surveys (Witherington *et al.* 2009). Index beaches were established to standardize data collection methods and maintain a constant level of effort on key nesting beaches over time.

Note that NMFS and USFWS (2008), Witherington *et al.* (2009), and TEWG (2009) analyzed the status of the nesting assemblages within the NWA DPS using standardized data collected over periods ranging from 10-23 years. These analyses used different analytical approaches, but found the same finding that there had been a significant, overall nesting decline within the NWA DPS. However, with the addition of nesting data from 2008-2010, the trend line changes showing a very slight negative trend, but the rate of decline is not statistically different from zero (76 FR 58868, September 22, 2011). The nesting data presented in the Recovery Plan (through 2008) is described below, with updated trend information through 2010 for two recovery units.

From the beginning of standardized index surveys in 1989 until 1998, the PFRU, the largest nesting assemblage in the Northwest Atlantic by an order of magnitude, had a significant increase in the number of nests. However, from 1998 through 2008, there was a 41% decrease in annual nest counts from index beaches, which represent an average of 70% of the statewide nesting activity (NMFS and USFWS 2008). From 1989-2008, the PFRU had an overall declining nesting trend of 26% (95% CI: -42% to -5%; NMFS and USFWS 2008). With the addition of nesting data through 2010, the nesting trend for the PFRU does not show a nesting decline statistically different from zero (76 FR 58868, September 22, 2011). The NRU, the second largest nesting assemblage of loggerheads in the United States, has been declining at a rate of 1.3% annually since 1983 (NMFS and USFWS 2008). The NRU dataset included 11 beaches with an uninterrupted time series of coverage of at least 20 years; these beaches represent approximately 27% of NRU nesting (in 2008). Through 2008, there was strong statistical data to suggest the NRU has experienced a long-term decline, but with the inclusion of nesting data through 2010, nesting for the NRU is showing possible signs of stabilizing (76 FR 58868, September 22, 2011). Evaluation of long-term nesting trends for the NGMRU is difficult because of changed and expanded beach coverage. However, the NGMRU has shown a significant declining trend of 4.7% annually since index nesting beach surveys were initiated in 1997 (NMFS and USFWS 2008). No statistical trends in nesting abundance can be determined for the DTRU because of the lack of long-term data. Similarly, statistically valid analyses of long-term nesting trends for the entire GCRU are not available because there are few long-term standardized nesting surveys representative of the region. Additionally, changing survey effort at monitored beaches and scattered and low-level nesting by loggerheads at many locations currently precludes comprehensive analyses (NMFS and USFWS 2008).

Sea turtle census nesting surveys are important in that they provide information on the relative abundance of nesting each year, and the contribution of each nesting group to total nesting of the species. Nest counts can also be used to estimate the number of reproductively mature females nesting annually. The 2008 recovery plan compiled information on mean number of loggerhead nests and the approximated counts of nesting females per year for four of the five identified recovery units (*i.e.*, nesting groups). They are: (1) for the NRU, a mean of 5,215 loggerhead nests per year (from 1989-2008) with approximately 1,272 females nesting per year; (2) for the PFRU, a mean of 64,513 nests per year (from 1989-2007) with approximately 15,735 females nesting per year; (3) for the DTRU, a mean of 246 nests per year (from 1995-2004, excluding 2002) with approximately 60 females nesting per year; and (4) for the NGMRU, a mean of 906 nests per year (from 1995-2007) with approximately 221 females nesting per year. For the

GCRU, the only estimate available for the number of loggerhead nests per year is from Quintana Roo, Yucatán, Mexico, where a range of 903-2,331 nests per year was estimated from 1987-2001 (NMFS and USFWS 2007a). There are no annual nest estimates available for the Yucatán since 2001 or for any other regions in the GCRU, nor are there any estimates of the number of nesting females per year for any nesting assemblage in this recovery unit. Note that the above values for average nesting females per year were based upon 4.1 nests per female per Murphy and Hopkins (1984).

Genetic studies of juvenile and a few adult loggerhead sea turtles collected from Northwest Atlantic foraging areas (beach strandings, a power plant in Florida, and North Carolina fisheries) show that the loggerheads that occupy East Coast U.S. waters originate from these Northwest Atlantic nesting groups; primarily from the nearby nesting beaches of southern Florida, as well as the northern Florida to North Carolina beaches, and finally from the beaches of the Yucatán Peninsula, Mexico (Rankin-Baransky *et al.* 2001; Witzell *et al.* 2002; Bass *et al.* 2004; Bowen *et al.* 2004). The contribution of these three nesting assemblages varies somewhat among the foraging habitats and age classes surveyed along the east coast. The distribution is not random and bears a significant relationship to the proximity and size of adjacent nesting colonies (Bowen *et al.* 2004). Bass *et al.* (2004) attribute the variety in the proportions of sea turtles from loggerhead turtle nesting assemblages documented in different east coast foraging habitats to a complex interplay of currents and the relative size and proximity of nesting beaches.

Unlike nesting surveys, in-water studies of sea turtles typically sample both sexes and multiple age classes. In-water studies have been conducted in some areas of the Northwest Atlantic and provide data by which to assess the relative abundance of loggerhead sea turtles and changes in abundance over time (Maier *et al.* 2004; Morreale *et al.* 2005; Mansfield 2006; Ehrhart *et al.* 2007; Epperly *et al.* 2007). The TEWG (2009) used raw data from six in-water study sites to conduct trend analyses. They identified an increasing trend in the abundance of loggerheads from three of the four sites located in the Southeast United States, one site showed no discernible trend, and the two sites located in the northeast United States showed a decreasing trend in abundance of loggerheads. The 2008 loggerhead recovery plan also includes a full discussion of in-water population studies for which trend data have been reported, and a brief summary will be provided here.

Maier *et al.* (2004) used fishery-independent trawl data to establish a regional index of loggerhead abundance for the southeast coast of the United States (Winyah Bay, South Carolina to St. Augustine, Florida) during the period 2000-2003. A comparison of loggerhead catch data from this study with historical values suggested that in-water populations of loggerhead sea turtles along the southeast U.S. coast appear to be larger, possibly an order of magnitude higher than they were 25 years ago, but the authors caution a direct comparison between the two studies given differences in sampling methodology (Maier *et al.* 2004). A comparison of catch rates for sea turtles in pound net gear fished in the Pamlico-Albemarle Estuarine Complex of North Carolina between the years 1995-1997 and 2001-2003 found a significant increase in catch rates for loggerhead sea turtles for the latter period (Epperly *et al.* 2007). A long-term, on-going study of loggerhead abundance in the Indian River Lagoon System of Florida found a significant increase in the relative abundance of loggerheads over the last 4 years of the study (Ehrhart *et al.*

2007). However, there was no discernible trend in loggerhead abundance during the 24-year time period of the study (1982-2006) (Ehrhart *et al.* 2007). At St. Lucie Power Plant, data collected from 1977-2004 show an increasing trend of loggerheads at the power plant intake structures (FPL and Quantum Resources 2005).

In contrast to these studies, Morreale *et al.* (2005) observed a decline in the percentage and relative numbers of loggerhead sea turtles incidentally captured in pound net gear fished around Long Island, New York during the period 2002-2004 in comparison to the period 1987-1992, with only two loggerheads (of a total 54 turtles) observed captured in pound net gear during the period 2002-2004. This is in contrast to the previous decade's study where numbers of individual loggerheads ranged from 11 to 28 per year (Morreale *et al.* 2005). No additional loggerheads were reported captured in pound net gear in New York through 2007, although two were found cold-stunned on Long Island bay beaches in the fall of 2007 (Memo to the File, L. Lankshear, December 2007). Potential explanations for this decline include major shifts in loggerhead foraging areas and/or increased mortality in pelagic or early benthic stage/age classes (Morreale *et al.* 2005). Using aerial surveys, Mansfield (2006) also found a decline in the densities of loggerhead sea turtles in Chesapeake Bay over the period 2001-2004 compared to aerial survey data collected in the 1980s. Significantly fewer loggerheads ($p<0.05$) were observed in both the spring (May-June) and the summer (July-August) of 2001-2004 compared to those observed during aerial surveys in the 1980s (Mansfield 2006). A comparison of median densities from the 1980s to the 2000s suggested that there had been a 63.2% reduction in densities during the spring residency period and a 74.9% reduction in densities during the summer residency period (Mansfield 2006). The decline in observed loggerhead populations in Chesapeake Bay may be related to a significant decline in prey, namely horseshoe crabs and blue crabs, with loggerheads redistributing outside of Bay waters (NMFS and USFWS 2008).

As with other turtle species, population estimates for loggerhead sea turtles are difficult to determine, largely given their life history characteristics. However, a recent loggerhead assessment using a demographic matrix model estimated that the loggerhead adult female population in the western North Atlantic ranges from 16,847 to 89,649, with a median size of 30,050 (NMFS SEFSC 2009). The model results for population trajectory suggest that the population is most likely declining, but this result was very sensitive to the choice of the position of the parameters within their range and hypothesized distributions. The pelagic stage survival parameter had the largest effect on the model results. As a result of the large uncertainty in our knowledge of loggerhead life history, at this point predicting the future populations or population trajectories of loggerhead sea turtles with precision is very uncertain. It should also be noted that additional analyses are underway which will incorporate any newly available information.

As part of the Atlantic Marine Assessment Program for Protected Species (AMAPPS), line transect aerial abundance surveys and turtle telemetry studies were conducted along the Atlantic coast in the summer of 2010. AMAPPS is a multi-agency initiative to assess marine mammal, sea turtle, and seabird abundance and distribution in the Atlantic. Aerial surveys were conducted from Cape Canaveral, Florida to the Gulf of St. Lawrence, Canada. Satellite tags on juvenile loggerheads were deployed in two locations – off the coasts of northern Florida to South Carolina (n=30) and off the New Jersey and Delaware coasts (n=14). As presented in NMFS

NEFSC (2011), the 2010 survey found a preliminary total surface abundance estimate within the entire study area of about 60,000 loggerheads (CV=0.13) or 85,000 if a portion of unidentified hard-shelled sea turtles were included (CV=0.10). Surfacing times were generated from the satellite tag data collected during the aerial survey period, resulting in a 7% (5%-11% inter-quartile range) median surface time in the South Atlantic area and a 67% (57%-77% inter-quartile range) median surface time to the north. The calculated preliminary regional abundance estimate is about 588,000 loggerheads along the U.S. Atlantic coast, with an inter-quartile range of 382,000-817,000 (NMFS NEFSC 2011). The estimate increases to approximately 801,000 (inter-quartile range of 521,000-1,111,000) when based on known loggerheads and a portion of unidentified turtle sightings. The density of loggerheads was generally lower in the north than the south; based on number of turtle groups detected, 64% were seen south of Cape Hatteras, North Carolina, 30% in the southern Mid-Atlantic Bight, and 6% in the northern Mid-Atlantic Bight. Although they have been seen farther north in previous studies (*e.g.*, Shoop and Kenney 1992), no loggerheads were observed during the aerial surveys conducted in the summer of 2010 in the more northern zone encompassing Georges Bank, Cape Cod Bay, and the Gulf of Maine. These estimates of loggerhead abundance over the U.S. Atlantic continental shelf are considered very preliminary. A more thorough analysis will be completed pending the results of further studies related to improving estimates of regional and seasonal variation in loggerhead surface time (by increasing the sample size and geographical area of tagging) and other information needed to improve the biases inherent in aerial surveys of sea turtles (*e.g.*, research on depth of detection and species misidentification rate). This survey effort represents the most comprehensive assessment of sea turtle abundance and distribution in many years. Additional aerial surveys and research to improve the abundance estimates are anticipated in 2011-2014, depending on available funds.

Threats

The diversity of a sea turtle's life history leaves them susceptible to many natural and human impacts, including impacts while they are on land, in the neritic environment, and in the oceanic environment. The 5-year status review and 2008 recovery plan provide a summary of natural as well as anthropogenic threats to loggerhead sea turtles (NMFS and USFWS 2007a, 2008). Amongst those of natural origin, hurricanes are known to be destructive to sea turtle nests. Sand accretion, rainfall, and wave action that result from these storms can appreciably reduce hatchling success. Other sources of natural mortality include cold-stunning, biotoxin exposure, and native species predation.

Anthropogenic factors that impact hatchlings and adult females on land, or the success of nesting and hatching include: beach erosion, beach armoring, and nourishment; artificial lighting; beach cleaning; beach pollution; increased human presence; recreational beach equipment; vehicular and pedestrian traffic; coastal development/construction; exotic dune and beach vegetation; removal of native vegetation; and poaching. An increased human presence at some nesting beaches or close to nesting beaches has led to secondary threats such as the introduction of exotic fire ants, feral hogs, dogs, and an increased presence of native species (*e.g.*, raccoons, armadillos, and opossums), which raid nests and feed on turtle eggs (NMFS and USFWS 2007a, 2008). Although sea turtle nesting beaches are protected along large expanses of the Northwest Atlantic coast (in areas like Merritt Island, Archie Carr, and Hobe Sound National Wildlife Refuges), other areas along these coasts have limited or no protection. Sea turtle nesting and hatching success on unprotected high density East Florida nesting beaches from Indian River to Broward County are affected by all of the above threats.

Loggerheads are affected by a completely different set of anthropogenic threats in the marine environment. These include oil and gas exploration, coastal development, and transportation; marine pollution; underwater explosions; hopper dredging; offshore artificial lighting; power plant entrainment and/or impingement; entanglement in debris; ingestion of marine debris; marina and dock construction and operation; boat collisions; poaching; and fishery interactions.

A 1990 National Research Council (NRC) report concluded that for juveniles, subadults, and breeding adults in coastal waters, the most important source of human caused mortality in U.S. Atlantic waters was fishery interactions. The sizes and reproductive values of sea turtles taken by fisheries vary significantly, depending on the location and season of the fishery, and size-selectivity resulting from gear characteristics. Therefore, it is possible for fisheries that interact with fewer, more reproductively valuable turtles to have a greater detrimental effect on the population than one that takes greater numbers of less reproductively valuable turtles (Wallace *et al.* 2008). The Loggerhead Biological Review Team determined that the greatest threats to the NWA DPS of loggerheads result from cumulative fishery bycatch in neritic and oceanic habitats (Conant *et al.* 2009). Attaining a more thorough understanding of the characteristics, as well as the quantity of sea turtle bycatch across all fisheries is of great importance.

Finkbeiner *et al.* (2011) compiled cumulative sea turtle bycatch information in U.S. fisheries from 1990 through 2007, before and after implementation of bycatch mitigation measures. Information was obtained from peer reviewed publications and NMFS documents (e.g., Biological Opinions and bycatch reports). In the Atlantic, a mean estimate of 137,700 bycatch interactions, of which 4,500 were mortalities, occurred annually (since implementation of bycatch mitigation measures). Kemp's ridleys interacted with fisheries most frequently, with the highest level of mean annual mortality (2,700), followed by loggerheads (1,400), greens (300), and leatherbacks (40). The Southeast/Gulf of Mexico shrimp trawl fishery was responsible for the vast majority of U.S. interactions (up to 98%) and mortalities (more than 80%). While this provides an initial cumulative bycatch assessment, there are a number of caveats that should be considered when interpreting this information, such as sampling inconsistencies and limitations.

Of the many fisheries known to adversely affect loggerheads, the U.S. South Atlantic and Gulf of Mexico shrimp fisheries were considered to pose the greatest threat of mortality to neritic juvenile and adult age classes of loggerheads (NRC 1990, Finkbeiner *et al.* 2011). Significant changes to the South Atlantic and Gulf of Mexico shrimp fisheries have occurred since 1990, and the effects of these shrimp fisheries on ESA-listed species, including loggerhead sea turtles, have been assessed several times through section 7 consultation. There is also a lengthy regulatory history with regard to the use of Turtle Excluder Devices (TEDs) in the U.S. South Atlantic and Gulf of Mexico shrimp fisheries (Epperly and Teas 2002; NMFS 2002a; Lewison *et al.* 2003). The current section 7 consultation on the U.S. South Atlantic and Gulf of Mexico shrimp fisheries was completed in 2002 and estimated the total annual level of take for loggerhead sea turtles to be 163,160 interactions (the total number of turtles that enter a shrimp trawl, which may then escape through the TED or fail to escape and be captured) with 3,948 of those takes being lethal (NMFS 2002a).

In addition to improvements in TED designs and TED enforcement, interactions between loggerheads and the shrimp fishery have also been declining because of reductions in fishing effort unrelated to fisheries management actions. The 2002 Opinion take estimates are based in part on fishery effort levels. In recent years, low shrimp prices, rising fuel costs, competition with imported products, and the impacts of recent hurricanes in the Gulf of Mexico have all impacted the shrimp fleets; in some cases reducing fishing effort by as much as 50% for offshore waters of the Gulf of Mexico (GMFMC 2007). As a result, loggerhead interactions and mortalities in the Gulf of Mexico have been substantially less than projected in the 2002 Opinion. In 2008, the estimated annual number of interactions between loggerheads and shrimp trawls in the Gulf of Mexico shrimp fishery is 23,336, with 647 (2.8%) of those interactions resulting in mortality (Memo from Dr. B. Ponwith, Southeast Fisheries Science Center to Dr. R. Crabtree, Southeast Region, PRD, December 2008). A new Biological Opinion on the Shrimp FMP was completed in May 2012; this Opinion does not contain a quantitative estimate of the number of interactions between loggerheads and the shrimp fishery.

Loggerhead sea turtles are also known to interact with non-shrimp trawl, gillnet, longline, dredge, pound net, pot/trap, and hook and line fisheries. The NRC (1990) report stated that other U.S. Atlantic fisheries collectively accounted for 500 to 5,000 loggerhead deaths each year, but recognized that there was considerable uncertainty in the estimate. The reduction of sea turtle captures in fishing operations is identified in recovery plans and 5-year status reviews as a priority for the recovery of all sea turtle species. In the threats analysis of the loggerhead recovery plan, trawl bycatch is identified as the greatest source of mortality. While loggerhead bycatch in U.S. Mid-Atlantic bottom otter trawl gear was previously estimated for the period 1996-2004 (Murray 2006, 2008), a recent bycatch analysis estimated the number of loggerhead sea turtle interactions with U.S. Mid-Atlantic bottom trawl gear from 2005-2008 (Warden 2011a). Northeast Fisheries Observer Program data from 1994-2008 were used to develop a model of interaction rates and those predicted rates were applied to 2005-2008 commercial fishing data to estimate the number of interactions for the trawl fleet. The number of predicted average annual loggerhead interactions for 2005-2008 was 292 (CV=0.13, 95% CI=221-369), with an additional 61 loggerheads (CV=0.17, 95% CI=41-83) interacting with trawls but being released through a TED. Of the 292 average annual observable loggerhead interactions, approximately 44 of those were adult equivalents. Warden (2011b) found that latitude, depth and SST were associated with the interaction rate, with the rates being highest south of 37°N latitude in waters < 50 m deep and SST > 15°C. This estimate is a decrease from the average annual loggerhead bycatch in bottom otter trawls during 1996-2004, estimated to be 616 sea turtles (CV=0.23, 95% CI over the 9-year period: 367-890) (Murray 2006, 2008).

There have been several published estimates of the number of loggerheads taken annually as a result of the dredge fishery for Atlantic sea scallops, ranging from a low of zero in 2005 (Murray 2007) to a high of 749 in 2003 (Murray 2004). Murray (2011) recently re-evaluated loggerhead sea turtle interactions in scallop dredge gear from 2001-2008. In that paper, the average number of annual observable interactions of hard-shelled sea turtles in the Mid-Atlantic scallop dredge fishery prior to the implementation of chain mats (January 1, 2001 through September 25, 2006) was estimated to be 288 turtles (CV = 0.14, 95% CI: 209-363) [equivalent to 49 adults], 218 of which were loggerheads [equivalent to 37 adults]. After the implementation of chain mats, the average annual number of observable interactions was estimated to be 20 hard-shelled sea turtles (CV = 0.48, 95% CI: 3-42), 19 of which were loggerheads. If the rate of observable interactions from dredges without chain mats had been applied to trips with chain mats, the estimated number of observable and inferred interactions of hard-shelled sea turtles after chain mats were implemented would have been 125 turtles per year (CV = 0.15, 95% CI: 88-163) [equivalent to 22 adults], 95 of which were loggerheads [equivalent to 16 adults]. Interaction rates of hard-shelled turtles were correlated with sea surface temperature, depth, and use of a chain mat. Results from this recent analysis suggest that chain mats and fishing effort reductions have contributed to the decline in estimated loggerhead sea turtle interactions with scallop dredge gear after 2006 (Murray 2011).

An estimate of the number of loggerheads taken annually in U.S. Mid-Atlantic gillnet fisheries has also recently been published (Murray 2009a, b). From 1995-2006, the annual bycatch of loggerheads in U.S. Mid-Atlantic gillnet gear was estimated to average 350 turtles (CV=0.20, 95% CI over the 12-year period: 234 to 504). Bycatch rates were correlated with latitude, sea surface temperature, and mesh size. The highest predicted bycatch rates occurred in warm waters of the southern Mid-Atlantic in large-mesh gillnets (Murray 2009a).

The U.S. tuna and swordfish longline fisheries that are managed under the Highly Migratory Species (HMS) FMP are estimated to capture 1,905 loggerheads (no more than 339 mortalities) for each 3-year period starting in 2007 (NMFS 2004a). NMFS has mandated gear changes for the HMS fishery to reduce sea turtle bycatch and the likelihood of death from those incidental takes that would still occur (Garrison and Stokes 2010). In 2010, there were 40 observed interactions between loggerhead sea turtles and longline gear used in the HMS fishery (Garrison and Stokes 2011a, 2011b). All of the loggerheads were released alive, with the vast majority released with all gear removed. While 2010 total estimates are not yet available, in 2009, 242.9 (95% CI: 167.9-351.2) loggerhead sea turtles are estimated to have been taken in the longline fisheries managed under the HMS FMP based on the observed takes (Garrison and Stokes 2010). The 2009 estimate is considerably lower than those in 2006 and 2007 and is consistent with historical averages since 2001 (Garrison and Stokes 2010). This fishery represents just one of several longline fisheries operating in the Atlantic Ocean. Lewison *et al.* (2004) estimated that 150,000-200,000 loggerheads were taken in all Atlantic longline fisheries in 2000 (including the U.S. Atlantic tuna and swordfish longline fisheries as well as others).

Documented takes also occur in other fishery gear types and by non-fishery mortality sources (*e.g.*, hopper dredges, power plants, vessel collisions), but quantitative estimates are unavailable. Past and future impacts of global climate change are considered in Section 6.0 below.

Summary of Status for Loggerhead Sea Turtles
Loggerheads are a long-lived species and reach sexual maturity relatively late at around 32-35 years in the Northwest Atlantic (NMFS and USFWS 2008). The species continues to be affected by many factors occurring on nesting beaches and in the water. These include poaching, habitat

loss, and nesting predation that affects eggs, hatchlings, and nesting females on land, as well as fishery interactions, vessel interactions, marine pollution, and non-fishery (*e.g.*, dredging) operations affecting all sexes and age classes in the water (NRC 1990; NMFS and USFWS 2007a, 2008). As a result, loggerheads still face many of the original threats that were the cause of their listing under the ESA.

As mentioned previously, a final revised recovery plan for loggerhead sea turtles in the Northwest Atlantic was recently published by NMFS and FWS in December 2008. The revised recovery plan is significant in that it identifies five unique recovery units, which comprise the population of loggerheads in the Northwest Atlantic, and describes specific recovery criteria for each recovery unit. The recovery plan noted a decline in annual nest counts for three of the five recovery units for loggerheads in the Northwest Atlantic, including the PFRU, which is the largest (in terms of number of nests laid) in the Atlantic Ocean. The nesting trends for the other two recovery units could not be determined due to an absence of long term data.

NMFS convened a new Loggerhead Turtle Expert Working Group (TEWG) to review all available information on Atlantic loggerheads in order to evaluate the status of this species in the Atlantic. A final report from the Loggerhead TEWG was published in July 2009. In this report, the TEWG indicated that it could not determine whether the decreasing annual numbers of nests among the Northwest Atlantic loggerhead subpopulations were due to stochastic processes resulting in fewer nests, a decreasing average reproductive output of adult females, decreasing numbers of adult females, or a combination of these factors. Many factors are responsible for past or present loggerhead mortality that could impact current nest numbers; however, no single mortality factor stands out as a likely primary factor. It is likely that several factors compound to create the current decline, including incidental capture (in fisheries, power plant intakes, and dredging operations), lower adult female survival rates, increases in the proportion of first-time nesters, continued directed harvest, and increases in mortality due to disease. Regardless, the TEWG stated that "it is clear that the current levels of hatchling output will result in depressed recruitment to subsequent life stages over the coming decades" (TEWG 2009). However, the report does not provide information on the rate or amount of expected decrease in recruitment but goes on to state that the ability to assess the current status of loggerhead subpopulations is limited due to a lack of fundamental life history information and specific census and mortality data.

While several documents reported the decline in nesting numbers in the NWA DPS (NMFS and USFWS 2008, TEWG 2009), when nest counts through 2010 are analyzed, the nesting trends from 1989-2010 are not significantly different than zero for all recovery units within the NWA DPS for which there are enough data to analyze (76 FR 58868, September 22, 2011). The SEFSC (2009) estimated the number of adult females in the NWA DPS at 30,000, and if a 1:1 adult sex ratio is assumed, the result is 60,000 adults in this DPS. Based on the reviews of nesting data, as well as information on population abundance and trends, NMFS and USFWS determined in the September 2011 listing rule that the NWA DPS should be listed as threatened. They found that an endangered status for the NWA DPS was not warranted given the large size of the nesting population, the overall nesting population remains widespread, the trend for the nesting population appears to be stabilizing, and substantial conservation efforts are underway to address threats.

4.5 Kemp's Ridley Sea Turtles

Distribution and Life History
The Kemp's ridley is one of the least abundant of the world's sea turtle species. In contrast to loggerhead, leatherback, and green sea turtles, which are found in multiple oceans of the world, Kemp's ridleys typically occur only in the Gulf of Mexico and the northwestern Atlantic Ocean (NMFS *et al.* 2011).

Kemp's ridleys mature at 10-17 years (Caillouet *et al.* 1995; Schmid and Witzell 1997; Snover *et al.* 2007; NMFS and USFWS 2007c). Nesting occurs from April through July each year with hatchlings emerging after 45-58 days (NMFS *et al.* 2011). Females lay an average of 2.5 clutches within a season (TEWG 1998, 2000) and the mean remigration interval for adult females is 2 years (Marquez *et al.* 1982; TEWG 1998, 2000).

Once they leave the nesting beach, hatchlings presumably enter the Gulf of Mexico where they feed on available S*argassum* and associated infauna or other epipelagic species (NMFS *et al.* 2011). The presence of juvenile turtles along both the U.S. Atlantic and Gulf of Mexico coasts, where they are recruited to the coastal benthic environment, indicates that post-hatchlings are distributed in both the Gulf of Mexico and Atlantic Ocean (TEWG 2000).

The location and size classes of dead turtles recovered by the STSSN suggests that benthic immature developmental areas occur along the U.S. coast and that these areas may change given resource quality and quantity (TEWG 2000). Developmental habitats are defined by several characteristics, including coastal areas sheltered from high winds and waves such as embayments and estuaries, and nearshore temperate waters shallower than 50 m (NMFS and USFWS 2007c). The suitability of these habitats depends on resource availability, with optimal environments providing rich sources of crabs and other invertebrates. Kemp's ridleys consume a variety of crab species, including *Callinectes*, *Ovalipes*, *Libinia*, and *Cancer* species. Mollusks, shrimp, and fish are consumed less frequently (Bjorndal 1997). A wide variety of substrates have been documented to provide good foraging habitat, including seagrass beds, oyster reefs, sandy and mud bottoms, and rock outcroppings (NMFS and USFWS 2007c).

Foraging areas documented along the U.S. Atlantic coast include Charleston Harbor, Pamlico Sound (Epperly *et al.* 1995c), Chesapeake Bay (Musick and Limpus 1997), Delaware Bay (Stetzar 2002), and Long Island Sound (Morreale and Standora 1993; Morreale *et al.* 2005). For instance, in the Chesapeake Bay, Kemp's ridleys frequently forage in submerged aquatic grass beds for crabs (Musick and Limpus 1997). Upon leaving Chesapeake Bay in autumn, juvenile Kemp's ridleys migrate down the coast, passing Cape Hatteras in December and January (Musick and Limpus 1997). These larger juveniles are joined by juveniles of the same size from North Carolina sounds and smaller juveniles from New York and New England to form one of the densest concentrations of Kemp's ridleys outside of the Gulf of Mexico (Epperly *et al.* 1995a, 1995b; Musick and Limpus 1997).

Adult Kemp's ridleys are found in the coastal regions of the Gulf of Mexico and southeastern United States, but are typically rare in the northeastern U.S. waters of the Atlantic (TEWG 2000). Adults are primarily found in nearshore waters of 37 m or less that are rich in crabs and have a sandy or muddy bottom (NMFS and USFWS 2007c).

Population Dynamics and Status

The majority of Kemp's ridleys nest along a single stretch of beach near Rancho Nuevo, Tamaulipas, Mexico (Carr 1963; NMFS and USFWS 2007c; NMFS *et al.* 2011). There is a limited amount of scattered nesting to the north and south of the primary nesting beach (NMFS and USFWS 2007c). Nesting often occurs in synchronized emergences termed *arribadas*. The number of recorded nests reached an estimated low of 702 nests in 1985, corresponding to fewer than 300 adult females nesting in that season (TEWG 2000; NMFS and USFWS 2007c; NMFS *et al.* 2011). Conservation efforts by Mexican and U.S. agencies have aided this species by eliminating egg harvest, protecting eggs and hatchlings, and reducing at-sea mortality through fishing regulations (TEWG 2000). Since the mid-1980s, the number of nests observed at Rancho Nuevo and nearby beaches has increased 14-16% per year (Heppell *et al.* 2005), allowing cautious optimism that the population is on its way to recovery. An estimated 5,500 females nested in the State of Tamaulipas over a 3-day period in May 2007 and over 4,000 of those nested at Rancho Nuevo (NMFS and USFWS 2007c). In 2008, 17,882 nests were documented on Mexican nesting beaches (NMFS 2011). There is limited nesting in the United States, most of which is located in South Texas. While six nests were documented in 1996, a record 195 nests were found in 2008 (NMFS 2011).

Threats

Kemp's ridleys face many of the same natural threats as loggerheads, including destruction of nesting habitat from storm events, predators, and oceanographic-related events such as cold-stunning. Although cold-stunning can occur throughout the range of the species, it may be a greater risk for sea turtles that utilize the more northern habitats of Cape Cod Bay and Long Island Sound. In the last five years (2006-2010), the number of cold-stunned turtles on Cape Cod beaches averaged 115 Kemp's ridleys, 7 loggerheads, and 7 greens (NMFS unpublished data). The numbers ranged from a low in 2007 of 27 Kemp's ridleys, 5 loggerheads, and 5 greens to a high in 2010 of 213 Kemp's ridleys, 4 loggerheads, and 14 greens. Annual cold stun events vary in magnitude; the extent of episodic major cold stun events may be associated with numbers of turtles utilizing Northeast U.S. waters in a given year, oceanographic conditions, and/or the occurrence of storm events in the late fall. Although many cold-stunned turtles can survive if they are found early enough, these events represent a significant source of natural mortality for Kemp's ridleys.

Like other sea turtle species, the severe decline in the Kemp's ridley population appears to have been heavily influenced by a combination of exploitation of eggs and impacts from fishery interactions. From the 1940s through the early 1960s, nests from Ranch Nuevo were heavily exploited, but beach protection in 1967 helped to curtail this activity (NMFS *et al.* 2011). Following World War II, there was a substantial increase in the number of trawl vessels, particularly shrimp trawlers, in the Gulf of Mexico where adult Kemp's ridley sea turtles occur. Information from fisheries observers helped to demonstrate the high number of turtles taken in these shrimp trawls (USFWS and NMFS 1992). Subsequently, NMFS has worked with the industry to reduce sea turtle takes in shrimp trawls and other trawl fisheries, including the development and use of turtle excluder devices (TEDs). As described above, there is lengthy regulatory history with regard to the use of TEDs in the U.S. South Atlantic and Gulf of Mexico shrimp fisheries (NMFS 2002a; Epperly 2003; Lewison *et al.* 2003). The 2002 Biological Opinion on shrimp trawling in the southeastern United States concluded that 155,503 Kemp's ridley sea turtles would be taken annually in the fishery with 4,208 of the takes resulting in mortality (NMFS 2002a).

Although modifications to shrimp trawls have helped to reduce mortality of Kemp's ridleys, a recent assessment found that the Southeast/Gulf of Mexico shrimp trawl fishery remained responsible for the vast majority of U.S. fishery interactions (up to 98%) and mortalities (more than 80%). Finkbeiner *et al.* (2011) compiled cumulative sea turtle bycatch information in U.S. fisheries from 1990 through 2007, before and after implementation of bycatch mitigation measures. Information was obtained from peer reviewed publications and NMFS documents (e.g., Biological Opinions and bycatch reports). In the Atlantic, a mean estimate of 137,700 bycatch interactions, of which 4,500 were mortalities, occurred annually (since implementation of bycatch mitigation measures). Kemp's ridleys interacted with fisheries most frequently, with the highest level of mean annual mortality (2,700), followed by loggerheads (1,400), greens (300), and leatherbacks (40). While this provides an initial cumulative bycatch assessment, there are a number of caveats that should be considered when interpreting this information, such as sampling inconsistencies and limitations.

This species is also affected by other sources of anthropogenic impact (fishery and non-fishery related), similar to those discussed above. Three Kemp's ridley captures in Mid-Atlantic trawl fisheries were documented by NMFS observers between 1994 and 2008 (Warden and Bisack 2010), and eight Kemp's ridleys were documented by NMFS observers in mid-Atlantic sink gillnet fisheries between 1995 and 2006 (Murray 2009a). Additionally, in the spring of 2000, a total of five Kemp's ridley carcasses were recovered from the same North Carolina beaches where 275 loggerhead carcasses were found. The cause of death for most of the turtles recovered was unknown, but the mass mortality event was suspected by NMFS to have been from a large-mesh gillnet fishery for monkfish and dogfish operating offshore in the preceding weeks (67 FR 71895, December 3, 2002). The five Kemp's ridley carcasses that were found are likely to have been only a minimum count of the number of Kemp's ridleys that were killed or seriously injured as a result of the fishery interaction, since it is unlikely that all of the carcasses washed ashore. The NMFS Northeast Fisheries Science Center also documented 14 Kemp's ridleys entangled in or impinged on Virginia pound net leaders from 2002-2005. Note that bycatch estimates for Kemp's ridleys in various fishing gear types (*e.g.*, trawl, gillnet, dredge) are not available at this time, largely due to the low number of observed interactions precluding a robust estimate. Kemp's ridley interactions in non-fisheries have also been observed; for example, the Oyster Creek Nuclear Generating Station in Barnegat Bay, New Jersey, recorded a total of 27 Kemp's ridleys (15 of which were found alive) impinged or captured on their intake screens from 1992-2006 (NMFS 2006).

Summary of Status for Kemp's Ridley Sea Turtles

The majority of Kemp's ridleys nest along a single stretch of beach near Rancho Nuevo, Tamaulipas, Mexico (Carr 1963; NMFS and USFWS 2007c; NMFS *et al.* 2011). The number of nesting females in the Kemp's ridley population declined dramatically from the late 1940s through the mid-1980s, with an estimated 40,000 nesting females in a single *arribada* in 1947 and fewer than 300 nesting females in the entire 1985 nesting season (TEWG 2000; NMFS *et al.* 2011). However, the total annual number of nests at Rancho Nuevo gradually began to increase in the 1990s (NMFS and USFWS 2007c). Based on the number of nests laid in 2006 and the remigration interval for Kemp's ridley sea turtles (1.8-2 years), there were an estimated 7,000-8,000 adult female Kemp's ridley sea turtles in 2006 (NMFS and USFWS 2007c). The number of adult males in the population is unknown, but sex ratios of hatchlings and immature Kemp's ridleys suggest that the population is female-biased, suggesting that the number of adult males is less than the number of adult females (NMFS and USFWS 2007c). While there is cautious optimism for recovery, events such as the Deepwater Horizon oil release, and stranding events associated increased skimmer trawl use and poor TED compliance in the northern Gulf of Mexico may dampen recent population growth.

As with the other sea turtle species, fishery mortality accounts for a large proportion of annual human-caused mortality outside the nesting beaches, while other activities like dredging, pollution, and habitat destruction account for an unknown level of other mortality. Based on their 5-year status review of the species, NMFS and USFWS (2007c) determined that Kemp's ridley sea turtles should not be reclassified as threatened under the ESA. A revised bi-national recovery plan was published for public comment in 2010, and in September 2011, NMFS, USFWS, and the Services and the Secretary of Environment and Natural Resources, Mexico (SEMARNAT) released the second revision to the Kemp's ridley recovery plan.

4.6 Green Sea Turtles

Green sea turtles are distributed circumglobally, and can be found in the Pacific, Indian, and Atlantic Oceans as well as the Mediterranean Sea (NMFS and USFWS 1991, 2007d; Seminoff 2004). In 1978, the Atlantic population of the green sea turtle was listed as threatened under the ESA, except for the breeding populations in Florida and on the Pacific coast of Mexico, which were listed as endangered. As it is difficult to differentiate between breeding populations away from the nesting beaches, all green sea turtles in the water are considered endangered.

Pacific Ocean

Green sea turtles occur in the western, central, and eastern Pacific. Foraging areas are also found throughout the Pacific and along the southwestern U.S. coast (NMFS and USFWS 1998b). In the western Pacific, major nesting rookeries at four sites including Heron Island (Australia), Raine Island (Australia), Guam, and Japan were evaluated and determined to be increasing in abundance, with the exception of Guam which appears stable (NMFS and USFWS 2007d). In the central Pacific, nesting occurs on French Frigate Shoals, Hawaii, which has also been reported as increasing with a mean of 400 nesting females annually from 2002-2006 (NMFS and USFWS 2007d). The main nesting sites for the green sea turtle in the eastern Pacific are located in Michoacan, Mexico and in the Galapagos Islands, Ecuador (NMFS and USFWS 2007d). The number of nesting females per year exceeds 1,000 females at each site (NMFS and USFWS 2007d). However, historically, greater than 20,000 females per year are believed to have nested in Michoacan alone (Cliffton *et al.* 1982; NMFS and USFWS 2007d). The Pacific Mexico green turtle nesting population (also called the black turtle) is considered endangered.

Historically, green sea turtles were used in many areas of the Pacific for food. They were also commercially exploited, which, coupled with habitat degradation, led to their decline in the Pacific (NMFS and USFWS 1998b). Green sea turtles in the Pacific continue to be affected by poaching, habitat loss or degradation, fishing gear interactions, and fibropapillomatosis, which is a viral disease that causes tumors in affected turtles (NMFS and USFWS 1998b; NMFS 2004b).

Indian Ocean

There are numerous nesting sites for green sea turtles in the Indian Ocean. One of the largest nesting sites for green sea turtles worldwide occurs on the beaches of Oman where an estimated 20,000 green sea turtles nest annually (Hirth 1997; Ferreira *et al.* 2003). Based on a review of the 32 Index Sites used to monitor green sea turtle nesting worldwide, Seminoff (2004) concluded that declines in green sea turtle nesting were evident for many of the Indian Ocean Index Sites. While several of these had not demonstrated further declines in the more recent past, only the Comoros Island Index Site in the western Indian Ocean showed evidence of increased nesting (Seminoff 2004).

Mediterranean Sea

There are four nesting concentrations of green sea turtles in the Mediterranean from which data are available – Turkey, Cyprus, Israel, and Syria. Currently, approximately 300-400 females nest each year, about two-thirds of which nest in Turkey and one-third in Cyprus. Although green sea turtles are depleted from historic levels in the Mediterranean Sea (Kasparek *et al.* 2001), nesting data gathered since the early 1990s in Turkey, Cyprus, and Israel show no apparent trend in any direction. However, a declining trend is apparent along the coast of Palestine/Israel, where 300-350 nests were deposited each year in the 1950s (Sella 1982) compared to a mean of 6 nests per year from 1993-2004 (Kuller 1999; Y. Levy, Israeli Sea Turtle Rescue Center, unpublished data). A recent discovery of green sea turtle nesting in Syria adds roughly 100 nests per year to green sea turtle nesting activity in the Mediterranean (Rees *et al.* 2005). That such a major nesting concentration could have gone unnoticed until recently (the Syria coast was surveyed in 1991, but nesting activity was attributed to loggerheads) bodes well for the ongoing speculation that the unsurveyed coast of Libya may also host substantial nesting.

Atlantic Ocean

Distribution and Life History

As has occurred in other oceans of its range, green sea turtles were once the target of directed fisheries in the United States and throughout the Caribbean. In 1890, over one million pounds of green sea turtles were taken in a directed fishery in the Gulf of Mexico (Doughty 1984). However, declines in the turtle fishery throughout the Gulf of Mexico were evident by 1902 (Doughty 1984).

In the western Atlantic, large juvenile and adult green sea turtles are largely herbivorous, occurring in habitats containing benthic algae and seagrasses from Massachusetts to Argentina, including the Gulf of Mexico and Caribbean (Wynne and Schwartz 1999). Green sea turtles occur seasonally in Mid-Atlantic and Northeast waters such as Chesapeake Bay and Long Island Sound (Musick and Limpus 1997; Morreale and Standora 1998; Morreale *et al.* 2005), which serve as foraging and developmental habitats.

Some of the principal feeding areas in the western Atlantic Ocean include the upper west coast of Florida, the Florida Keys, and the northwestern coast of the Yucatán Peninsula. Additional important foraging areas in the western Atlantic include the Mosquito and Indian River Lagoon systems and nearshore wormrock reefs between Sebastian and Ft. Pierce Inlets in Florida, Florida Bay, the Culebra archipelago and other Puerto Rico coastal waters, the south coast of Cuba, the Mosquito Coast of Nicaragua, the Caribbean coast of Panama, and scattered areas along Colombia and Brazil (Hirth 1971). The waters surrounding the island of Culebra, Puerto Rico, and its outlying keys are designated critical habitat for the green sea turtle.

Age at maturity for green sea turtles is estimated to be 20-50 years (Balazs 1982; Frazer and Ehrhart 1985; Seminoff 2004). As is the case with the other sea turtle species described above, adult females may nest multiple times in a season (average 3 nests/season with approximately 100 eggs/nest) and typically do not nest in successive years (NMFS and USFWS 1991; Hirth 1997).

Population Dynamics and Status

Like other sea turtle species, nest count information for green sea turtles provides information on the relative abundance of nesting, and the contribution of each nesting group to total nesting of the species. Nest counts can also be used to estimate the number of reproductively mature females nesting annually. The 5-year status review for the species identified eight geographic areas considered to be primary sites for threatened green sea turtle nesting in the Atlantic/Caribbean, and reviewed the trend in nest count data for each (NMFS and USFWS 2007d). These include: (1) Yucatán Peninsula, Mexico, (2) Tortuguero, Costa Rica, (3) Aves Island, Venezuela, (4) Galibi Reserve, Suriname, (5) Isla Trindade, Brazil, (6) Ascension Island, United Kingdom, (7) Bioko Island, Equatorial Guinea, and (8) Bijagos Achipelago, Guinea-Bissau (NMFS and USFWS 2007d). Nesting at all of these sites is considered to be stable or increasing with the exception of Bioko Island, which may be declining. However, the lack of sufficient data precludes a meaningful trend assessment for this site (NMFS and USFWS 2007d).

Seminoff (2004) reviewed green sea turtle nesting data for eight sites in the western, eastern, and central Atlantic, including all of the above threatened nesting sites with the exception that nesting in Florida was reviewed in place of Isla Trindade, Brazil. He concluded that all sites in the central and western Atlantic showed increased nesting with the exception of nesting at Aves Island, Venezuela, while both sites in the eastern Atlantic demonstrated decreased nesting. These sites are not inclusive of all green sea turtle nesting in the Atlantic Ocean. However, other sites are not believed to support nesting levels high enough that would change the overall status of the species in the Atlantic (NMFS and USFWS 2007d).

By far, the most important nesting concentration for green sea turtles in the western Atlantic is in Tortuguero, Costa Rica (NMFS and USFWS 2007d). Nesting in the area has increased considerably since the 1970s and nest count data from 1999-2003 suggest nesting by 17,402-

37,290 females per year (NMFS and USFWS 2007d). The number of females nesting per year on beaches in the Yucatán, at Aves Island, Galibi Reserve, and Isla Trindade number in the hundreds to low thousands, depending on the site (NMFS and USFWS 2007d).

The status of the endangered Florida breeding population was also evaluated in the 5-year review (NMFS and USFWS 2007d). The pattern of green sea turtle nesting shows biennial peaks in abundance, with a generally positive trend since establishment of the Florida index beach surveys in 1989. This trend is perhaps due to increased protective legislation throughout the Caribbean (Meylan *et al.* 1995), as well as protections in Florida and throughout the United States (NMFS and USFWS 2007d).

The statewide Florida surveys (2000-2006) have shown that a mean of approximately 5,600 nests are laid annually in Florida, with a low of 581 in 2001 to a high of 9,644 in 2005 (NMFS and USFWS 2007d). Most nesting occurs along the east coast of Florida, but occasional nesting has been documented along the Gulf coast of Florida, at Southwest Florida beaches, as well as the beaches in the Florida Panhandle (Meylan *et al.* 1995). More recently, green sea turtle nesting occurred on Bald Head Island, North Carolina (just east of the mouth of the Cape Fear River), Onslow Island, and Cape Hatteras National Seashore. One green sea turtle nested on a beach in Delaware in 2011, although its occurrence was considered very rare.

Threats

Green sea turtles face many of the same natural threats as loggerhead and Kemp's ridley sea turtles. In addition, green sea turtles appear to be particularly susceptible to fibropapillomatosis, an epizootic disease producing lobe-shaped tumors on the soft portion of a turtle's body. Juveniles appear to be most affected in that they have the highest incidence of disease and the most extensive lesions, whereas lesions in nesting adults are rare. Also, green sea turtles frequenting nearshore waters, areas adjacent to large human populations, and areas with low water turnover, such as lagoons, have a higher incidence of the disease than individuals in deeper, more remote waters. The occurrence of fibropapilloma tumors may result in impaired foraging, breathing, or swimming ability, leading potentially to death (George 1997).

As with the other sea turtle species, incidental fishery mortality accounts for a large proportion of annual human-caused mortality outside the nesting beaches. Witherington *et al.* (2009) observes that because green sea turtles spend a shorter time in oceanic waters and as older juveniles occur on shallow seagrass pastures (where benthic trawling is unlikely), they avoid high mortalities in pelagic longline and benthic trawl fisheries. Although the relatively low number of observed green sea turtle captures makes it difficult to estimate bycatch rates and annual take levels, green sea turtles have been observed captured in the pelagic driftnet, pelagic longline, southeast shrimp trawl, and mid-Atlantic trawl and gillnet fisheries. Murray (2009a) also lists five observed captures of green turtle in Mid-Atlantic sink gillnet gear between 1995 and 2006.

Finkbeiner *et al.* (2011) compiled cumulative sea turtle bycatch information in U.S. fisheries from 1990 through 2007, before and after implementation of bycatch mitigation measures. Information was obtained from peer reviewed publications and NMFS documents (e.g., Biological Opinions and bycatch reports). In the Atlantic, a mean estimate of 137,700 bycatch interactions, of which 4,500 were mortalities, occurred annually (since implementation of bycatch mitigation measures). Kemp's ridleys interacted with fisheries most frequently, with the highest level of mean annual mortality (2,700), followed by loggerheads (1,400), greens (300), and leatherbacks (40). The Southeast/Gulf of Mexico shrimp trawl fishery was responsible for the vast majority of U.S. interactions (up to 98%) and mortalities (more than 80%). While this provides an initial cumulative bycatch assessment, there are a number of caveats that should be considered when interpreting this information, such as sampling inconsistencies and limitations.

Other activities like channel dredging, marine debris, pollution, vessel strikes, power plant impingement, and habitat destruction account for an unquantifiable level of other mortality. Stranding reports indicate that between 200-400 green sea turtles strand annually along the eastern U.S. coast from a variety of causes most of which are unknown (STSSN database).

Summary of Status of Green Sea Turtles

A review of 32 Index Sites[3] distributed globally revealed a 48-67% decline in the number of mature females nesting annually over the last three generations[4] (Seminoff 2004). An evaluation of green sea turtle nesting sites was also conducted as part of the 5-year status review of the species (NMFS and USFWS 2007d). Of the 23 threatened nesting groups assessed in that report for which nesting abundance trends could be determined, ten were considered to be increasing, nine were considered stable, and four were considered to be decreasing (NMFS and USFWS 2007d). Nesting groups were considered to be doing relatively well (the number of sites with increasing nesting were greater than the number of sites with decreasing nesting) in the Pacific, western Atlantic, and central Atlantic (NMFS and USFWS 2007d). However, nesting populations were determined to be doing relatively poorly in Southeast Asia, eastern Indian Ocean, and perhaps the Mediterranean. Overall, based on mean annual reproductive effort, the report estimated that 108,761 to 150,521 females nest each year among the 46 threatened and endangered nesting sites included in the evaluation (NMFS and USFWS 2007d). However, given the late age to maturity for green sea turtles, caution is urged regarding the status for any of the nesting groups since no area has a dataset spanning a full green sea turtle generation (NMFS and USFWS 2007d).

Seminoff (2004) and NMFS and USFWS (2007d) made comparable conclusions with regard to nesting for four nesting sites in the western Atlantic that indicate sea turtle abundance is increasing in the Atlantic Ocean. Each also concluded that nesting at Tortuguero, Costa Rica represented the most important nesting area for green sea turtles in the western Atlantic and that nesting had increased markedly since the 1970s (Seminoff 2004; NMFS and USFWS 2007d).

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[3] The 32 Index Sites include all of the major known nesting areas as well as many of the lesser nesting areas for which quantitative data are available.

[4] Generation times ranged from 35.5 years to 49.5 years for the assessment depending on the Index Beach site

However, the 5-year review also noted that the Tortuguero nesting stock continued to be affected by ongoing directed take at their primary foraging area in Nicaragua (NMFS and USFWS 2007d). The endangered breeding population in Florida appears to be increasing based upon index nesting data from 1989-2010 (NMFS 2011).

As with the other sea turtle species, fishery mortality accounts for a large proportion of annual human-caused mortality outside the nesting beaches, while other activities like hopper dredging, pollution, and habitat destruction account for an unknown level of other mortality. Based on its 5-year status review of the species, NMFS and USFWS (2007d) determined that the listing classification for green sea turtles should not be changed. However, it was also determined that an analysis and review of the species should be conducted in the future to determine whether DPSs should be identified (NMFS and USFWS 2007d).

4.7 Leatherback Sea Turtles

Leatherback sea turtles are widely distributed throughout the oceans of the world, including the Atlantic, Pacific, and Indian Oceans, and the Mediterranean Sea (Ernst and Barbour 1972). Leatherbacks are the largest living turtles and range farther than any other sea turtle species. Their large size and tolerance of relatively low water temperatures allows them to occur in boreal waters such as those off Labrador and in the Barents Sea (NMFS and USFWS 1995).

In 1980, the leatherback population was estimated at approximately 115,000 adult females globally (Pritchard 1982). By 1995, this global population of adult females was estimated to have declined to 34,500 (Spotila *et al.* 1996). The most recent population size estimate for the North Atlantic alone is a range of 34,000-94,000 adult leatherbacks (TEWG 2007). Thus, there is substantial uncertainty with respect to global population estimates of leatherback sea turtles.

Pacific Ocean

Leatherback nesting has been declining at all major Pacific basin nesting beaches for the last two decades (Spotila *et al.* 1996, 2000; NMFS and USFWS 1998a, 2007b; Sarti *et al.* 2000). In the western Pacific, major nesting beaches occur in Papua New Guinea, Indonesia, Solomon Islands, and Vanuatu, with an approximate 2,700-4,500 total breeding females, estimated from nest counts (Dutton *et al.* 2007). While there appears to be overall long term population decline, the Indonesian nesting aggregation at Jamursba-Medi is currently stable (since 1999), although there is evidence to suggest a significant and continued decline in leatherback nesting in Papua New Guinea and Solomon Islands over the past 30 years (NMFS 2011). Leatherback sea turtles disappeared from India before 1930, have been virtually extinct in Sri Lanka since 1994, and appear to be approaching extinction in Malaysia (Spotila *et al.* 2000). In Fiji, Thailand, and Australia, leatherback sea turtles have only been known to nest in low densities and scattered sites.

The largest, extant leatherback nesting group in the Indo-Pacific lies on the North Vogelkop coast of West Papua, Indonesia, with 3,000-5,000 nests reported annually in the 1990s (Suárez *et al.* 2000). However, in 1999, local villagers started reporting dramatic declines in sea turtles near their villages (Suárez 1999). Declines in nesting groups have been reported throughout the western Pacific region where observers report that nesting groups are well below abundance levels that were observed several decades ago (*e.g.*, Suárez 1999).

Leatherback sea turtles in the western Pacific are threatened by poaching of eggs, killing of nesting females, human encroachment on nesting beaches, incidental capture in fishing gear, beach erosion, and egg predation by animals.

In the eastern Pacific Ocean, major leatherback nesting beaches are located in Mexico and Costa Rica, where nest numbers have been declining. According to reports from the late 1970s and early 1980s, beaches located on the Mexican Pacific coasts of Michoacán, Guerrero, and Oaxaca sustained a large portion, perhaps 50%, of all global nesting by leatherbacks (Sarti *et al.* 1996). A dramatic decline has been seen on nesting beaches in Pacific Mexico, where aerial survey data was used to estimate that tens of thousands of leatherback nests were laid on the beaches in the 1980s (Pritchard 1982), but a total of only 120 nests on the four primary index beaches (combined) were counted in the 2003-2004 season (Sarti Martinez *et al.* 2007). Since the early 1980s, the Mexican Pacific population of adult female leatherback turtles has declined to slightly more than 200 during 1998-1999 and 1999-2000 (Sarti *et al.* 2000). Spotila *et al.* (2000) reported the decline of the leatherback nesting at Playa Grande, Costa Rica, which had been the fourth largest nesting group in the world and the most important nesting beach in the Pacific. Between 1988 and 1999, the nesting group declined from 1,367 to 117 female leatherback sea turtles. Based on their models, Spotila *et al.* (2000) estimated that the group could fall to less than 50 females by 2003-2004. Another, more recent, analysis of the Costa Rican nesting beaches indicates a decline in nesting during 15 years of monitoring (1989-2004) with approximately 1,504 females nesting in 1988-1989 to an average of 188 females nesting in 2000-2001 and 2003-2004 (NMFS and USFWS 2007b), indicating that the reductions in nesting females were not as extreme as the reductions predicted by Spotila *et al.* (2000).

On September 26, 2007, NMFS received a petition to revise the critical habitat designation for leatherback sea turtles to include waters along the U.S. West Coast. On December 28, 2007, NMFS published a positive 90-day finding on the petition and convened a critical habitat review team. On January 26, 2012, NMFS published a final rule to revise the critical habitat designation to include three particular areas of marine habitat. The designation includes approximately 16,910 square miles along the California coast from Point Arena to Point Arguello east of the 3,000 meter depth contour, and 25,004 square miles from Cape Flattery, Washington to Cape Blanco, Oregon east of the 2,000 meter depth contour. The areas comprise approximately 41,914 square miles of marine habitat and include waters from the ocean surface down to a maximum depth of 262 feet. The designated critical habitat areas contain the physical or biological feature essential to the conservation of the species that may require special management conservation or protection. In particular, the team identified one Primary Constituent Element: the occurrence of prey species, primarily scyphomedusae of the order Semaeostomeae, of sufficient condition, distribution, diversity, abundance and density necessary to support individual as well as population growth, reproduction, and development of leatherbacks.

Leatherbacks in the eastern Pacific face a number of threats to their survival. For example, commercial and artisanal swordfish fisheries off Chile, Columbia, Ecuador, and Peru; purse seine fisheries for tuna in the eastern tropical Pacific Ocean; and California/Oregon drift gillnet fisheries are known to capture, injure, or kill leatherbacks in the eastern Pacific Ocean. Given the declines in leatherback nesting in the Pacific, some researchers have concluded that the leatherback is on the verge of extinction in the Pacific Ocean (*e.g.,* Spotila *et al.* 1996, 2000).

Indian Ocean

Leatherbacks nest in several areas around the Indian Ocean. These sites include Tongaland, South Africa (Pritchard 2002) and the Andaman and Nicobar Islands (Andrews *et al.* 2002). Intensive survey and tagging work in 2001 provided new information on the level of nesting in the Andaman and Nicobar Islands (Andrews *et al.* 2002). Based on the survey and tagging work, it was estimated that 400-500 female leatherbacks nest annually on Great Nicobar Island (Andrews *et al.* 2002). The number of nesting females using the Andaman and Nicobar Islands combined was estimated around 1,000 (Andrews and Shanker 2002). Some nesting also occurs along the coast of Sri Lanka, although in much smaller numbers than in the past (Pritchard 2002).

Mediterranean Sea

Casale *et al.* (2003) reviewed the distribution of leatherback sea turtles in the Mediterranean. Among the 411 individual records of leatherback sightings in the Mediterranean, there were no nesting records. Nesting in the Mediterranean is believed to be extremely rare if it occurs at all. Leatherbacks found in Mediterranean waters originate from the Atlantic Ocean (P. Dutton, NMFS, unpublished data).

Atlantic Ocean

Distribution and Life History

Evidence from tag returns and strandings in the western Atlantic suggests that adult leatherback sea turtles engage in routine migrations between northern temperate and tropical waters (NMFS and USFWS 1992). Leatherbacks are frequently thought of as a pelagic species that feed on jellyfish (*e.g.*, *Stomolophus, Chryaora*, and *Aurelia* species) and tunicates (*e.g.*, salps, pyrosomas) (Rebel 1974; Davenport and Balazs 1991). However, leatherbacks are also known to use coastal waters of the U.S. continental shelf (James *et al.* 2005a; Eckert *et al.* 2006; Murphy *et al.* 2006), as well as the European continental shelf on a seasonal basis (Witt *et al.* 2007).

Tagging and satellite telemetry data indicate that leatherbacks from the western North Atlantic nesting beaches use the entire North Atlantic Ocean (TEWG 2007). For example, leatherbacks tagged at nesting beaches in Costa Rica have been found in Texas, Florida, South Carolina, Delaware, and New York (STSSN database). Leatherback sea turtles tagged in Puerto Rico, Trinidad, and the Virgin Islands have also been subsequently found on U.S. beaches of southern, Mid-Atlantic, and northern states (STSSN database). Leatherbacks from the South Atlantic nesting assemblages (West Africa, South Africa, and Brazil) have not been re-sighted in the western North Atlantic (TEWG 2007).

The CETAP aerial survey of the outer Continental Shelf from Cape Hatteras, North Carolina to Cape Sable, Nova Scotia conducted between 1978 and 1982 showed leatherbacks to be present throughout the area with the most numerous sightings made from the Gulf of Maine south to Long Island. Leatherbacks were sighted in water depths ranging from 1 to 4,151 m, but 84.4% of sightings were in waters less than 180 m (Shoop and Kenney 1992). Leatherbacks were sighted in waters within a sea surface temperature range similar to that observed for loggerheads; from 7°-27.2°C (Shoop and Kenney 1992). However, leatherbacks appear to have a greater tolerance for colder waters in comparison to loggerhead sea turtles since more leatherbacks were found at the lower temperatures (Shoop and Kenney 1992). Studies of satellite tagged leatherbacks suggest that they spend 10%-41% of their time at the surface, depending on the phase of their migratory cycle (James *et al.* 2005b). The greatest amount of surface time (up to 41%) was recorded when leatherbacks occurred in continental shelf and slope waters north of 38°N (James *et al.* 2005b).

In 1979, the waters adjacent to Sandy Point, St. Croix, U.S. Virgin Islands were designated as critical habitat for the leatherback sea turtle. On February 2, 2010, NMFS received a petition to revise the critical habitat designation for leatherback sea turtles to include waters adjacent to a major nesting beach in Puerto Rico. NMFS published a 90-day finding on the petition on July 16, 2010, which found that the petition did not present substantial scientific information indicating that the petitioned revision was warranted. The original petitioners submitted a second petition on November 2, 2010 to revise the critical habitat designation to again include waters adjacent to a major nesting beach in Puerto Rico, including additional information on the usage of the waters. NMFS determined on May 5, 2011, that a revision to critical habitat off Puerto Rico may be warranted, and an analysis is underway. Note that on August 4, 2011, FWS issued a determination that revision to critical habitat along Puerto Rico should be made and will be addressed during the future planned status review.

Leatherbacks are a long lived species (>30 years). They were originally believed to mature at a younger age than loggerhead sea turtles, with a previous estimated age at sexual maturity of about 13-14 years for females with 9 years reported as a likely minimum (Zug and Parham 1996) and 19 years as a likely maximum (NMFS SEFSC 2001). However, new sophisticated analyses suggest that leatherbacks in the Northwest Atlantic may reach maturity at 24.5-29 years of age (Avens *et al.* 2009). In the United States and Caribbean, female leatherbacks nest from March through July. In the Atlantic, most nesting females average between 150-160 cm curved carapace length (CCL), although smaller (<145 cm CCL) and larger nesters are observed (Stewart *et al.* 2007, TEWG 2007). They nest frequently (up to seven nests per year) during a nesting season and nest about every 2-3 years. They produce 100 eggs or more in each clutch and can produce 700 eggs or more per nesting season (Schultz 1975). However, a significant portion (up to approximately 30%) of the eggs can be infertile. Therefore, the actual proportion of eggs that can result in hatchlings is less than the total number of eggs produced per season. As is the case with other sea turtle species, leatherback hatchlings enter the water soon after hatching. Based on a review of all sightings of leatherback sea turtles of <145 cm CCL, Eckert (1999) found that leatherback juveniles remain in waters warmer than 26°C until they exceed 100 cm CCL.

Population Dynamics and Status

As described earlier, sea turtle nesting survey data is important in that it provides information on the relative abundance of nesting, and the contribution of each population/subpopulation to total nesting of the species. Nest counts can also be used to estimate the number of reproductively mature females nesting annually, and as an indicator of the trend in the number of nesting females in the nesting group. The 5-year review for leatherback sea turtles (NMFS and USFWS 2007b) compiled the most recent information on mean number of leatherback nests per year for each of the seven leatherback populations or groups of populations that were identified by the Leatherback TEWG as occurring within the Atlantic. These are: Florida, North Caribbean, Western Caribbean, Southern Caribbean, West Africa, South Africa, and Brazil (TEWG 2007).

In the United States, the Florida Statewide Nesting Beach Survey program has documented an increase in leatherback nesting numbers from 98 nests in 1988 to between 800 and 900 nests in the early 2000s (NMFS and USFWS 2007b). Stewart *et al.* (2011) evaluated nest counts from 68 Florida beaches over 30 years (1979-2008) and found that nesting increased at all beaches with trends ranging from 3.1%-16.3% per year, with an overall increase of 10.2% per year. An analysis of Florida's index nesting beach sites from 1989-2006 shows a substantial increase in leatherback nesting in Florida during this time, with an annual growth rate of approximately 1.17 (TEWG 2007). The TEWG reports an increasing or stable nesting trend for all of the seven populations or groups of populations with the exception of the Western Caribbean and West Africa. The leatherback rookery along the northern coast of South America in French Guiana and Suriname supports the majority of leatherback nesting in the western Atlantic (TEWG 2007), and represents more than half of total nesting by leatherback sea turtles worldwide (Hilterman and Goverse 2004). Nest numbers in Suriname have shown an increase and the long-term trend for the Suriname and French Guiana nesting group seems to show an increase (Hilterman and Goverse 2004). In 2001, the number of nests for Suriname and French Guiana combined was 60,000, one of the highest numbers observed for this region in 35 years (Hilterman and Goverse 2004). The TEWG (2007) report indicates that using nest numbers from 1967-2005, a positive population growth rate was found over the 39-year period for French Guinea and Suriname, with a 95% probability that the population was growing. Given the magnitude of leatherback nesting in this area compared to other nest sites, negative impacts in leatherback sea turtles in this area could have profound impacts on the entire species.

The CETAP aerial survey conducted from 1978-1982 estimated the summer leatherback population for the northeastern United States at approximately 300-600 animals (from near Nova Scotia, Canada to Cape Hatteras, North Carolina) (Shoop and Kenney 1992). However, the estimate was based on turtles visible at the surface and does not include those that were below the surface out of view. Therefore, it likely underestimated the leatherback population for the northeastern United States at the time of the survey. Estimates of leatherback abundance of 1,052 turtles (C.V. = 0.38) and 1,174 turtles (C.V. = 0.52) were obtained from surveys conducted from Virginia to the Gulf of St. Lawrence in 1995 and 1998, respectively (Palka 2000). However, since these estimates were also based on sightings of leatherbacks at the surface, the author considered the estimates to be negatively biased and the true abundance of leatherbacks may be 4.27 times higher (Palka 2000).

Threats

The 5-year status review (NMFS and USFWS 2007b) and TEWG (2007) report provide summaries of natural as well as anthropogenic threats to leatherback sea turtles. Of the Atlantic sea turtle species, leatherbacks seem to be the most vulnerable to entanglement in fishing gear, trap/pot gear in particular. This susceptibility may be the result of their body type (large size, long pectoral flippers, and lack of a hard shell), their diving and foraging behavior, their distributional overlap with the gear, their possible attraction to gelatinous organisms and algae that collect on buoys and buoy lines at or near the surface, and perhaps to the lightsticks used to attract target species in longline fisheries. Leatherbacks entangled in fishing gear generally have a reduced ability to feed, dive, surface to breathe, or perform any other behavior essential to survival (Balazs 1985). In addition to drowning from forced submergence, they may be more susceptible to boat strikes if forced to remain at the surface, and entangling lines can constrict blood flow resulting in tissue necrosis. The long-term impacts of entanglement on leatherback health remain unclear. Innis *et al.* (2010) conducted a health evaluation of leatherback sea turtles during direct capture (n=12) and disentanglement (n=7). They found no significant difference in many of the measured health parameters between entangled and directly captured turtles. However, blood parameters, including but not limited to sodium, chloride, and blood urea nitrogen, for entangled turtles showed several key differences that were most likely due to reduced foraging and associated seawater ingestion, as well as a general stress response.

Finkbeiner *et al.* (2011) compiled cumulative sea turtle bycatch information in U.S. fisheries from 1990 through 2007, before and after implementation of bycatch mitigation measures. Information was obtained from peer reviewed publications and NMFS documents (e.g., Biological Opinions and bycatch reports). In the Atlantic, a mean estimate of 137,700 bycatch interactions, of which 4,500 were mortalities, occurred annually (since implementation of bycatch mitigation measures). Kemp's ridleys interacted with fisheries most frequently, with the highest level of mean annual mortality (2,700), followed by loggerheads (1,400), greens (300), and leatherbacks (40). The Southeast/Gulf of Mexico shrimp trawl fishery was responsible for the vast majority of U.S. interactions (up to 98%) and mortalities (more than 80%). While this provides an initial cumulative bycatch assessment, there are a number of caveats that should be considered when interpreting this information, such as sampling inconsistencies and limitations.

Leatherbacks have been documented interacting with longline, trap/pot, trawl, and gillnet fishing gear. For instance, an estimated 6,363 leatherback sea turtles were documented as caught by the U.S. Atlantic tuna and swordfish longline fisheries between 1992-1999 (NMFS SEFSC 2001). Currently, the U.S. tuna and swordfish longline fisheries managed under the HMS FMP are estimated to capture 1,764 leatherbacks (no more than 252 mortalities) for each 3-year period starting in 2007 (NMFS 2004a). In 2010, there were 26 observed interactions between leatherback sea turtles and longline gear used in the HMS fishery (Garrison and Stokes 2011a, 2011b). All leatherbacks were released alive, with all gear removed for the majority of captures.

While 2010 total estimates are not yet available, in 2009, 285.8 (95% CI: 209.6-389.7) leatherback sea turtles are estimated to have been taken in the longline fisheries managed under the HMS FMP based on the observed takes (Garrison and Stokes 2010). The 2009 estimate continues a downward trend since 2007 and remains well below the average prior to implementation of gear regulations (Garrison and Stokes 2010). Since the U.S. fleet accounts for only 5%-8% of the longline hooks fished in the Atlantic Ocean, adding up the under-represented observed takes of the other 23 countries actively fishing in the area would likely result in annual take estimates of thousands of leatherbacks over different life stages (NMFS SEFSC 2001). Lewison *et al.* (2004) estimated that 30,000-60,000 leatherbacks were taken in all Atlantic longline fisheries in 2000 (including the U.S. Atlantic tuna and swordfish longline fisheries, as well as others).

Leatherbacks are susceptible to entanglement in the lines associated with trap/pot gear used in several fisheries. From 1990-2000, 92 entangled leatherbacks were reported from New York through Maine (Dwyer *et al.* 2002). Additional leatherbacks stranded wrapped in line of unknown origin or with evidence of a past entanglement (Dwyer *et al.* 2002). More recently, from 2002 to 2010, NMFS received 137 reports of sea turtles entangled in vertical lines from Maine to Virginia, with 128 events confirmed (verified by photo documentation or response by a trained responder; NMFS 2008a). Of the 128 confirmed events during this period, 117 events involved leatherbacks. NMFS identified the gear type and fishery for 72 of the 117 confirmed events, which included lobster (42[5]), whelk/conch (15), black sea bass (10), crab (2), and research pot gear (1). A review of leatherback mortality documented by the STSSN in Massachusetts suggests that vessel strikes and entanglement in fixed gear (primarily lobster pots and whelk pots) are the principal sources of this mortality (Dwyer *et al.* 2002).

Leatherback interactions with the U.S. South Atlantic and Gulf of Mexico shrimp fisheries are also known to occur (NMFS 2002). Leatherbacks are likely to encounter shrimp trawls working in the coastal waters off the U.S. Atlantic coast (from Cape Canaveral, Florida through North Carolina) as they make their annual spring migration north. For many years, TEDs that were required for use in the U.S. South Atlantic and Gulf of Mexico shrimp fisheries were less effective for leatherbacks as compared to the smaller, hard-shelled turtle species, because the TED openings were too small to allow leatherbacks to escape. To address this problem, NMFS issued a final rule on February 21, 2003, to amend the TED regulations (68 FR 8456, February 21, 2003). Modifications to the design of TEDs are now required in order to exclude leatherbacks as well as large benthic immature and sexually mature loggerhead and green sea turtles. Given those modifications, Epperly *et al.* (2002) anticipated an average of 80 leatherback mortalities a year in shrimp gear interactions, dropping to an estimate of 26 leatherback mortalities in 2009 due to effort reduction in the Southeast shrimp fishery (Memo from Dr. B. Ponwith, SEFSC, to Dr. R. Crabtree, SERO, January 5, 2011).

Other trawl fisheries are also known to interact with leatherback sea turtles although on a much smaller scale. In October 2001, for example, a NMFS fisheries observer documented the take of a leatherback in a bottom otter trawl fishing for *Loligo* squid off of Delaware. TEDs are not

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[5] One case involved both lobster and whelk/conch gear.

currently required in this fishery. In November 2007, fisheries observers reported the capture of a leatherback sea turtle in bottom otter trawl gear fishing for summer flounder.

Gillnet fisheries operating in the waters of the Mid-Atlantic states are also known to capture, injure, and/or kill leatherbacks when these fisheries and leatherbacks co-occur. Data collected by the NEFSC Fisheries Observer Program from 1994-1998 (excluding 1997) indicate that a total of 37 leatherbacks were incidentally captured (16 lethally) in drift gillnets set in offshore waters from Maine to Florida during this period. Observer coverage for this period ranged from 54%-92%. In North Carolina, six additional leatherbacks were reported captured in gillnet sets in the spring (NMFS SEFSC 2001). In addition to these, in September 1995, two dead leatherbacks were removed from an 11-inch (28.2-cm) monofilament shark gillnet set in the nearshore waters off of Cape Hatteras (STSSN unpublished data reported in NMFS SEFSC 2001). Lastly, Murray (2009a) reports five observed leatherback captures in Mid-Atlantic sink gillnet fisheries between 1994 and 2008.

Fishing gear interactions can occur throughout the range of leatherbacks. Entanglements occur in Canadian waters where Goff and Lien (1988) reported that 14 of 20 leatherbacks encountered off the coast of Newfoundland/Labrador were entangled in fishing gear including salmon net, herring net, gillnet, trawl line, and crab pot line. Leatherbacks are known to drown in fish nets set in coastal waters of Sao Tome, West Africa (Castroviejo *et al.* 1994; Graff 1995). Gillnets are one of the suspected causes for the decline in the leatherback sea turtle population in French Guiana (Chevalier *et al.* 1999), and gillnets targeting green and hawksbill sea turtles in the waters of coastal Nicaragua also incidentally catch leatherback sea turtles (Lagueux *et al.*1998). Observers on shrimp trawlers operating in the northeastern region of Venezuela documented the capture of six leatherbacks from 13,600 trawls (Marcano and Alio-M. 2000). An estimated 1,000 mature female leatherback sea turtles are caught annually in fishing nets off of Trinidad and Tobago with mortality estimated to be between 50%-95% (Eckert and Lien 1999). Many of the sea turtles do not die as a result of drowning, but rather because the fishermen cut them out of their nets (NMFS SEFSC 2001).

Leatherbacks may be more susceptible to marine debris ingestion than other sea turtle species due to the tendency of floating debris to concentrate in convergence zones that juveniles and adults use for feeding (Shoop and Kenney 1992; Lutcavage *et al.* 1997). Investigations of the necropsy results of leatherback sea turtles revealed that a substantial percentage (34% of the 408 leatherback necropsies' recorded between 1885 and 2007) reported plastic within the turtles' stomach contents, and in some cases (8.7% of those cases in which plastic was reported), blockage of the gut was found in a manner that may have caused the mortality (Mrosovsky *et al.* 2009). An increase in reports of plastic ingestion was evident in leatherback necropsies conducted after the late 1960s (Mrosovsky *et al.* 2009). Along the coast of Peru, intestinal contents of 19 of 140 (13%) leatherback carcasses were found to contain plastic bags and film (Fritts 1982). The presence of plastic debris in the digestive tract suggests that leatherbacks might not be able to distinguish between prey items (*e.g.*, jellyfish) and plastic debris (Mrosovsky 1981). Balazs (1985) speculated that plastic objects may resemble food items by their shape, color, size, or even movements as they drift about, and induce a feeding response in leatherbacks.

Summary of Status for Leatherback Sea Turtles
In the Pacific Ocean, the abundance of leatherback sea turtles on nesting beaches has declined dramatically over the past 10 to 20 years. Nesting groups throughout the eastern and western Pacific Ocean have been reduced to a fraction of their former abundance by the combined effects of human activities that have reduced the number of nesting females and reduced the reproductive success of females that manage to nest (for example, egg poaching) (NMFS and USFWS 2007b). No reliable long term trend data for the Indian Ocean populations are currently available. While leatherbacks are known to occur in the Mediterranean Sea, nesting in this region is not known to occur (NMFS and USFWS 2007b).

Nest counts in many areas of the Atlantic Ocean show increasing trends, including for beaches in Suriname and French Guiana which support the majority of leatherback nesting (NMFS and USFWS 2007b). The species as a whole continues to face numerous threats in nesting and marine habitats. As with the other sea turtle species, fishery mortality accounts for a large proportion of annual human-caused mortality outside the nesting beaches, while other activities like pollution and habitat destruction account for an unknown level of other mortality. The long term recovery potential of this species may be further threatened by observed low genetic diversity, even in the largest nesting groups like French Guiana and Suriname (NMFS and USFWS 2007b).

Based on its 5-year status review of the species, NMFS and USFWS (2007b) determined that endangered leatherback sea turtles should not be delisted or reclassified. However, it was also determined that an analysis and review of the species should be conducted in the future to determine whether DPSs should be identified (NMFS and USFWS 2007b).

4.8 Atlantic sturgeon

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

The Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) is a subspecies of sturgeon distributed along the eastern coast of North America from Hamilton Inlet, Labrador, Canada to Cape Canaveral, Florida, USA (Scott and Scott, 1988; ASSRT, 2007; T. Savoy, CT DEP, pers. comm.). NMFS has delineated U.S. populations of Atlantic sturgeon into five DPSs[6] (77 FR 5880 and 77 FR 5914). These are: the Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs (see Figure 1). 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

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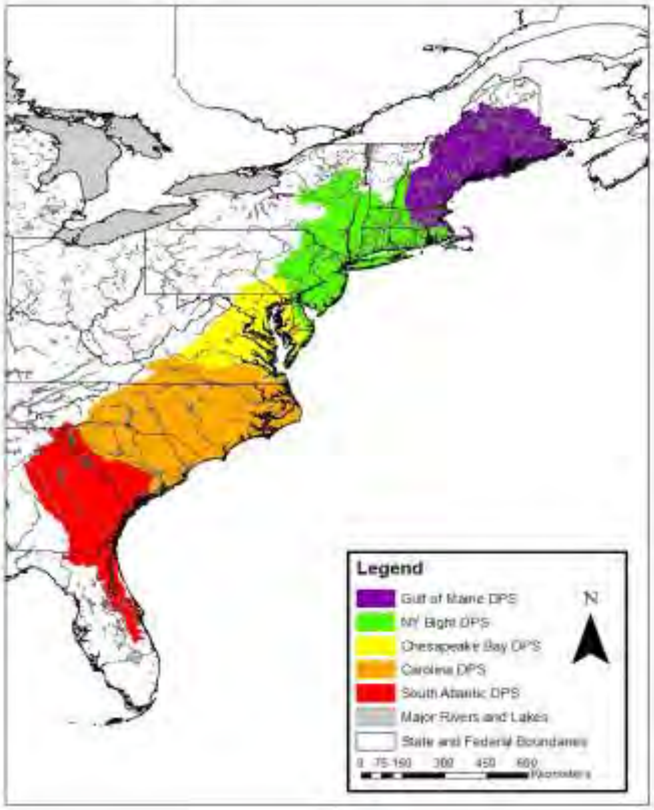
[6] To be considered for listing under the ESA, a group of organisms must constitute a “species.” A “species” is defined in section 3 of the ESA to include “any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds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

sturgeon from each DPS and Canada occur throughout the full range of the subspecies. Therefore, sturgeon originating from any of the five DPSs can be affected by threats in the marine, estuarine and riverine environment that occur far from natal spawning rivers.

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

As described below, individuals originating from the five listed DPSs may 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.

Figure 1. Map Depicting the Boundaries of the five Atlantic sturgeon DPSs



4.8.1 Atlantic sturgeon life history

Atlantic sturgeon are long lived (approximately 60 years), late maturing, estuarine dependent, anadromous[7] fish (Bigelow and Schroeder, 1953; Vladykov and Greeley 1963; Mangin, 1964; Pikitch *et al.*, 2005; Dadswell, 2006; ASSRT, 2007).

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

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

Table 3. Descriptions of Atlantic sturgeon life history stages.

They are a relatively large fish, even amongst sturgeon species (Pikitch *et al.*, 2005). Atlantic sturgeon are bottom feeders that suck food into a ventrally-located protruding mouth (Bigelow and Schroeder, 1953). Four barbels in front of the mouth assist the sturgeon in locating prey (Bigelow and Schroeder, 1953). Diets of adult and migrant subadult Atlantic sturgeon include mollusks, gastropods, amphipods, annelids, decapods, isopods, and fish such as sand lance (Bigelow and Schroeder, 1953; ASSRT, 2007; Guilbard *et al.*, 2007; Savoy, 2007). While in the river, Atlantic sturgeon feed on aquatic insects, insect larvae, and other invertebrates (Bigelow and Schroeder, 1953; ASSRT, 2007; Guilbard *et al.*, 2007).

Rate of maturation is affected by water temperature and gender. In general: (1) Atlantic sturgeon that originate from southern systems grow faster and mature sooner than Atlantic sturgeon that

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

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

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

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

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

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

4.8.2 Distribution and Abundance

Atlantic sturgeon underwent significant range-wide declines from historical abundance levels due to overfishing in the mid to late 19th century when a caviar market was established (Scott and

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

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

4.8.3 Threats faced by Atlantic sturgeon throughout their range

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

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

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

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

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

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

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

4.8.4 Gulf of Maine DPS of Atlantic sturgeon

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

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

Several threats play a role in shaping the current status of Gulf of Maine DPS Atlantic sturgeon.

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

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

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

Works Dams affects the likelihood of spawning occurring in this river. The Essex Dam on the Merrimack River blocks access to approximately 58% of historically accessible habitat in this river. Atlantic sturgeon occur in the Merrimack River but spawning has not been documented. Like the Penobscot, it is unknown how the Essex Dam affects the likelihood of spawning occurring in this river.

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

There are no empirical abundance estimates for the Gulf of Maine DPS. The Atlantic sturgeon SRT (2007) presumed that the Gulf of Maine DPS was comprised of less than 300 spawning adults per year, based on abundance estimates for the Hudson and Altamaha River riverine populations of Atlantic sturgeon. Surveys of the Kennebec River over two time periods, 1977-1981 and 1998-2000, resulted in the capture of nine adult Atlantic sturgeon (Squiers, 2004). However, since the surveys were primarily directed at capture of shortnose sturgeon, the capture gear used may not have been selective for the larger-sized, adult Atlantic sturgeon; several hundred subadult Atlantic sturgeon were caught in the Kennebec River during these studies.

Summary of the Gulf of Maine DPS

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

Some of the impacts from the threats that contributed to the decline of the Gulf of Maine DPS have been removed (e.g., directed fishing), or reduced as a result of improvements in water quality and removal of dams (e.g., the Edwards Dam on the Kennebec River in 1999). There are strict regulations on the use of fishing gear in Maine state waters that incidentally catch sturgeon. In addition, there have been reductions in fishing effort in state and federal waters, which most likely would result in a reduction in bycatch mortality of Atlantic sturgeon. A significant amount of fishing in the Gulf of Maine is conducted using trawl gear, which is known to have a much lower mortality rate for Atlantic sturgeon caught in the gear compared to sink gillnet gear

(ASMFC, 2007). Atlantic sturgeon from the GOM DPS are not commonly taken as bycatch in areas south of Chatham, MA, with only 8 percent (e.g., 7 of the 84 fish) of interactions observed in the Mid Atlantic/Carolina region being assigned to the Gulf of Maine DPS (Wirgin and King, 2011). Tagging results also indicate that Gulf of Maine DPS fish tend to remain within the waters of the Gulf of Maine and only occasionally venture to points south. However, data on Atlantic sturgeon incidentally caught in trawls and intertidal fish weirs fished in the Minas Basin area of the Bay of Fundy(Canada) indicate that approximately 35 percent originated from the Gulf of Maine DPS (Wirgin *et al.*, in draft).

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

4.8.5 New York Bight DPS of Atlantic sturgeon

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

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

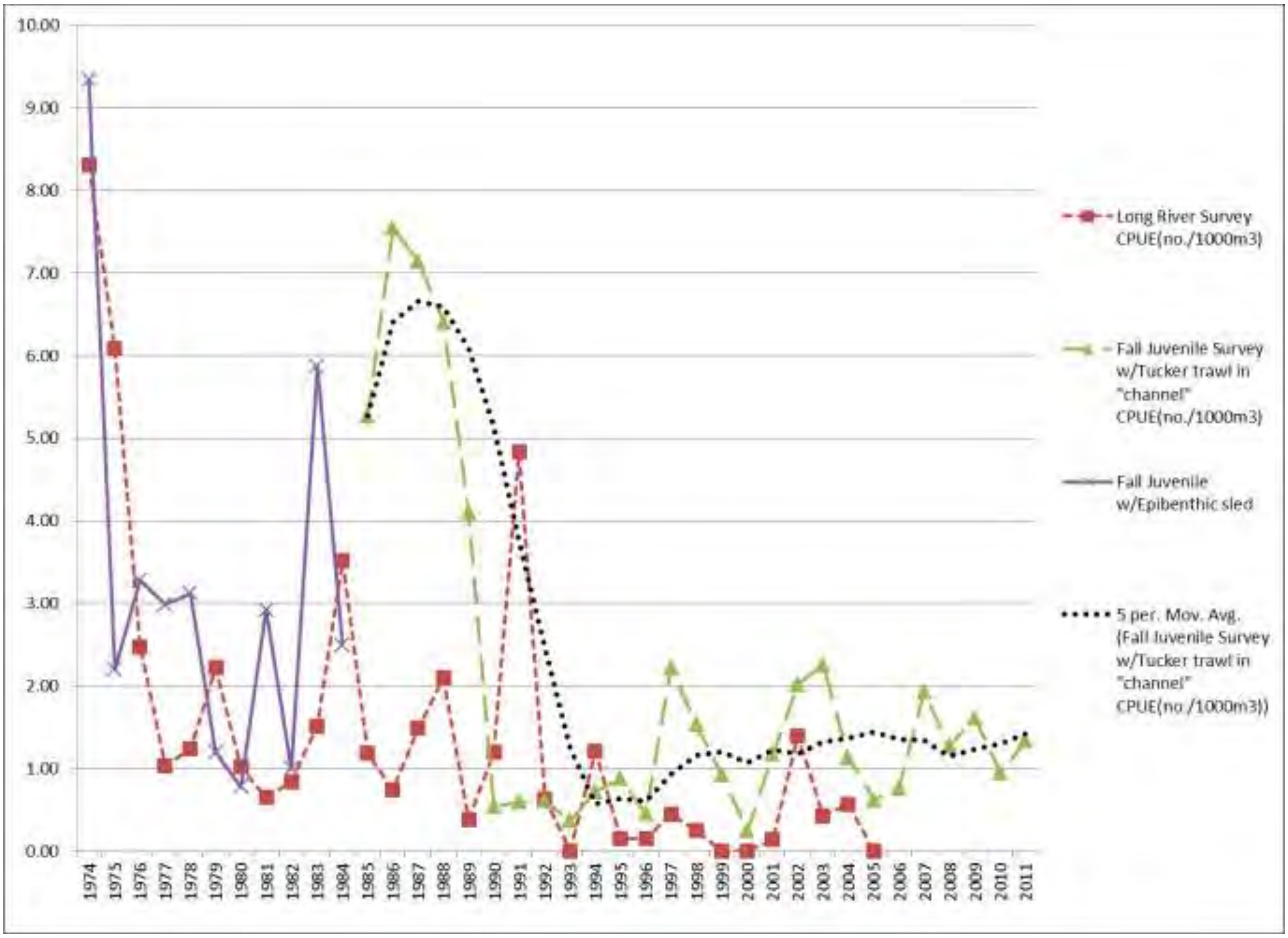
In October of 1994, the NYDEC stocked 4,929 marked age-0 Atlantic sturgeon, provided by a USFWS hatchery, into the Hudson Estuary at Newburgh Bay. These fish were reared from Hudson River brood stock. In 1995, Cornell University sampling crews collected 15 stocked and 14 wild age-1 Atlantic sturgeon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

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

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

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

As evidenced by estimates of juvenile abundance, the Atlantic sturgeon population in the Hudson River has declined over time. Peterson et al. (2000) found that the abundance of age-1 Atlantic sturgeon in the Hudson River declined 80% from 1977 to 1995. Similarly, longterm indices of juvenile abundance (the Hudson River Long River and Fall Shoals surveys) demonstrate a longterm declining trend in juvenile abundance. The figure below (Figure 2) illustrates the CPUE of Atlantic sturgeon in the two longterm surveys of the Hudson River. Please note that the Fall Shoals survey switched gear types in 1985. We do not have the CPUE data for the Long River Survey for 2006-2011.



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

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

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

Summary of the New York Bight DPS

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

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

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

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

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

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

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

4.8.6 Chesapeake Bay DPS of Atlantic sturgeon

The Chesapeake Bay DPS includes the following: all anadromous Atlantic sturgeons that are spawned in the watersheds that drain into the Chesapeake Bay and into coastal waters from the Delaware-Maryland border on Fenwick Island to Cape Henry, VA. Within this range, Atlantic sturgeon historically spawned in the Susquehanna, Potomac, James, York, Rappahannock, and Nottoway Rivers (ASSRT, 2007). Based on the review by Oakley (2003), 100 percent of Atlantic sturgeon habitat is currently accessible in these rivers since most of the barriers to passage (i.e. dams) are located upriver of where spawning is expected to have historically occurred (ASSRT, 2007). Spawning still occurs in the James River, and the presence of juvenile and adult sturgeon in the York River suggests that spawning may occur there as well (Musick *et al.*, 1994; ASSRT, 2007; Greene, 2009). However, conclusive evidence of current spawning is only available for the James River. Atlantic sturgeon that are spawned elsewhere are known to use the Chesapeake Bay for other life functions, such as foraging and as juvenile nursery habitat prior to entering the marine system as subadults (Vladykov and Greeley, 1963; ASSRT, 2007; Wirgin *et al.*, 2007; Grunwald *et al.*, 2008).

Age to maturity for Chesapeake Bay DPS Atlantic sturgeon is unknown. However, Atlantic sturgeon riverine populations exhibit clinal variation with faster growth and earlier age to maturity for those that originate from southern waters, and slower growth and later age to maturity for those that originate from northern waters (75 FR 61872; October 6, 2010). Age at maturity is 5 to 19 years for Atlantic sturgeon originating from South Carolina rivers (Smith *et al.*, 1982) and 11 to 21 years for Atlantic sturgeon originating from the Hudson River (Young *et al.*, 1998). Therefore, age at maturity for Atlantic sturgeon of the Chesapeake Bay DPS likely falls within these values.

Several threats play a role in shaping the current status of Chesapeake Bay DPS Atlantic sturgeon. Historical records provide evidence of the large-scale commercial exploitation of Atlantic sturgeon from the James River and Chesapeake Bay in the 19th century (Hildebrand and Schroeder, 1928; Vladykov and Greeley, 1963; ASMFC, 1998; Secor, 2002; Bushnoe *et al.*, 2005; ASSRT, 2007) as well as subsistence fishing and attempts at commercial fisheries as early as the 17th century (Secor, 2002; Bushnoe *et al.*, 2005; ASSRT, 2007; Balazik *et al.*, 2010). Habitat disturbance caused by in-river work such as dredging for navigational purposes is thought to have reduced available spawning habitat in the James River (Holton and Walsh, 1995; Bushnoe *et al.*, 2005; ASSRT, 2007). At this time, we do not have information to quantify this loss of spawning habitat.

Decreased water quality also threatens Atlantic sturgeon of the Chesapeake Bay DPS, especially since the Chesapeake Bay system is vulnerable to the effects of nutrient enrichment due to a relatively low tidal exchange and flushing rate, large surface to volume ratio, and strong stratification during the spring and summer months (Pyzik *et al.*, 2004; ASMFC, 1998; ASSRT, 2007; EPA, 2008). These conditions contribute to reductions in dissolved oxygen levels throughout the Bay. The availability of nursery habitat, in particular, may be limited given the recurrent hypoxia (low dissolved oxygen) conditions within the Bay (Niklitschek and Secor, 2005; 2010). At this time we do not have sufficient information to quantify the extent that degraded water quality effects habitat or individuals in the James River or throughout the Chesapeake Bay.

Vessel strikes have been observed in the James River (ASSRT, 2007). Eleven Atlantic sturgeon were reported to have been struck by vessels from 2005 through 2007. Several of these were mature individuals. 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.

In the marine and coastal range of the Chesapeake Bay DPS from Canada to Florida, fisheries bycatch in federally and state managed fisheries poses a threat to the DPS, reducing survivorship of subadults and adults and potentially causing an overall reduction in the spawning population (Stein *et al.*, 2004; ASMFC, 2007; ASSRT, 2007).

Summary of the Chesapeake Bay DPS
Spawning for the Chesapeake Bay DPS is known to occur in only the James River. Spawning may be occurring in other rivers, such as the York, but has not been confirmed. There are anecdotal reports of increased sightings and captures of Atlantic sturgeon in the James River. However, this information has not been comprehensive enough to develop a population estimate for the James River or to provide sufficient evidence to confirm increased abundance. Some of the impact from the threats that facilitated the decline of the Chesapeake Bay 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). We do not currently have enough information about any life stage to establish a trend for this DPS.

Areas with persistent, degraded water quality, habitat impacts from dredging, continued bycatch in U.S. state and federally-managed fisheries, Canadian fisheries and vessel strikes remain significant threats to the Chesapeake Bay DPS of Atlantic sturgeon. Studies have shown that Atlantic sturgeon can only sustain low levels of bycatch mortality (Boreman, 1997; ASMFC, 2007; Kahnle *et al.*, 2007). The Chesapeake Bay DPS is currently at risk of extinction given (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 the potential for population recovery.

4.8.7 Carolina DPS of Atlantic sturgeon

The Carolina DPS includes all Atlantic sturgeon that spawn or are spawned in the watersheds (including all rivers and tributaries) from Albemarle Sound southward along the southern Virginia, North Carolina, and South Carolina coastal areas to Charleston Harbor. The marine range of Atlantic sturgeon from the Carolina DPS extends from the Hamilton Inlet, Labrador, Canada, to Cape Canaveral, Florida. Sturgeon are commonly captured 40 miles offshore (D. Fox, DSU, pers. comm.). Records providing fishery bycatch data by depth show the vast majority of Atlantic sturgeon bycatch via gillnets is observed in waters less than 50 meters deep (Stein et al. 2004, ASMFC 2007), but Atlantic sturgeon are recorded as bycatch out to 500 fathoms.

Rivers known to have current spawning populations within the range of the Carolina DPS include the Roanoke, Tar-Pamlico, Cape Fear, Waccamaw, and Pee Dee Rivers. We determined spawning was occurring if young-of-the-year (YOY) were observed, or mature adults were present, in freshwater portions of a system (Table 4). However, in some rivers, spawning by Atlantic sturgeon may not be contributing to population growth because of lack of suitable habitat and the presence of other stressors on juvenile survival and development. There may also be spawning populations in the Neuse, Santee and Cooper Rivers, though it is uncertain. Historically, both the Sampit and Ashley Rivers were documented to have spawning populations at one time. However, the spawning population in the Sampit River is believed to be extirpated and the current status of the spawning population in the Ashley River is unknown. Both rivers may be used as nursery habitat by young Atlantic sturgeon originating from other spawning populations. This represents our current knowledge of the river systems utilized by the Carolina DPS for specific life functions, such as spawning, nursery habitat, and foraging. However, fish from the Carolina DPS likely use other river systems than those listed here for their specific life functions.

River/Estuary	Spawning Population	Data
Roanoke River, VA/NC; Albemarle Sound, NC	Yes	collection of 15 YOY (1997-1998); single YOY (2005)
Tar-Pamlico River, NC; Pamlico Sound	Yes	one YOY (2005)
Neuse River, NC; Pamlico Sound	Unknown	
Cape Fear River, NC	Yes	upstream migration of adults in the fall, carcass of a ripe female upstream in mid-September (2006)
Waccamaw River, SC; Winyah Bay	Yes	age-1, potentially YOY (1980s)
Pee Dee River, SC; Winyah Bay	Yes	running ripe male in Great Pee Dee River (2003)
Sampit, SC; Winyah Bay	Extirpated	
Santee River, SC	Unknown	
Cooper River, SC	Unknown	
Ashley River, SC	Unknown	

Table 4. Major rivers, tributaries, and sounds within the range of the Carolina DPS and currently available data on the presence of an Atlantic sturgeon spawning population in each system.

The riverine spawning habitat of the Carolina DPS occurs within the Mid-Atlantic Coastal Plain ecoregion (TNC 2002a), which includes bottomland hardwood forests, swamps, and some of the world's most active coastal dunes, sounds, and estuaries. Natural fires, floods, and storms are so dominant in this region that the landscape changes very quickly. Rivers routinely change their courses and emerge from their banks. The primary threats to biological diversity in the Mid-Atlantic Coastal Plain, as listed by TNC are: global climate change and rising sea level; altered surface hydrology and landform alteration (e.g., flood-control and hydroelectric dams, interbasin transfers of water, drainage ditches, breached levees, artificial levees, dredged inlets and river channels, beach renourishment, and spoil deposition banks and piles); a regionally receding water table, probably resulting from both over-use and inadequate recharge; fire suppression; land fragmentation, mainly by highway development; land-use conversion (e.g., from forests to timber plantations, farms, golf courses, housing developments, and resorts); the invasion of exotic plants and animals; air and water pollution, mainly from agricultural activities including concentrated animal feed operations; and over-harvesting and poaching of species. Many of the Carolina DPS' spawning rivers, located in the Mid-Coastal Plain, originate in areas of marl. Waters draining calcareous, impervious surface materials such as marl are: (1) likely to be alkaline; (2) dominated by surface run-off; (3) have little groundwater connection; and, (4) are seasonally ephemeral.

Historical landings data indicate that between 7,000 and 10,500 adult female Atlantic sturgeon were present in North Carolina prior to 1890 (Armstrong and Hightower 2002, Secor 2002). Secor (2002) estimates that 8,000 adult females were present in South Carolina during that same time-frame. Reductions from the commercial fishery and ongoing threats have drastically reduced the numbers of Atlantic sturgeon within the Carolina DPS. Currently, the Atlantic sturgeon spawning population in at least one river system within the Carolina DPS has been extirpated, with a potential extirpation in an additional system. The abundances of the remaining river populations within the DPS, each estimated to have fewer than 300 spawning adults, is estimated to be less than 3 percent of what they were historically (ASSRT 2007).

Threats

The Carolina DPS was listed as endangered under the ESA as a result of a combination of habitat curtailment and modification, overutilization (i.e, being taken as bycatch) in commercial fisheries, and the inadequacy of regulatory mechanisms in ameliorating these impacts and threats.

The modification and curtailment of Atlantic sturgeon habitat resulting from dams, dredging, and degraded water quality is contributing to the status of the Carolina DPS. Dams have curtailed Atlantic sturgeon spawning and juvenile developmental habitat by blocking over 60 percent of the historical sturgeon habitat upstream of the dams in the Cape Fear and Santee-Cooper River systems. Water quality (velocity, temperature, and dissolved oxygen (DO)) downstream of these dams, as well as on the Roanoke River, has been reduced, which modifies and curtails the extent of spawning and nursery habitat for the Carolina DPS. Dredging in spawning and nursery grounds modifies the quality of the habitat and is further curtailing the extent of available habitat in the Cape Fear and Cooper Rivers, where Atlantic sturgeon habitat has already been modified and curtailed by the presence of dams. Reductions in water quality from terrestrial activities have modified habitat utilized by the Carolina DPS. In the Pamlico and Neuse systems, nutrient-loading and seasonal anoxia are occurring, associated in part with concentrated animal feeding operations (CAFOs). Heavy industrial development and CAFOs have degraded water quality in the Cape Fear River. Water quality in the Waccamaw and Pee Dee rivers have been affected by industrialization and riverine sediment samples contain high levels of various toxins, including dioxins. Additional stressors arising from water allocation and climate change threaten to exacerbate water quality problems that are already present throughout the range of the Carolina

DPS. Twenty interbasin water transfers in existence prior to 1993, averaging 66.5 million gallons per day (mgd), were authorized at their maximum levels without being subjected to an evaluation for certification by North Carolina Department of Environmental and Natural Resources or other resource agencies. Since the 1993 legislation requiring certificates for transfers, almost 170 mgd of interbasin water withdrawals have been authorized, with an additional 60 mgd pending certification. The removal of large amounts of water from the system will alter flows, temperature, and DO. Existing water allocation issues will likely be compounded by population growth and potentially climate change. Climate change is also predicted to elevate water temperatures and exacerbate nutrient-loading, pollution inputs, and lower DO, all of which are current stressors to the Carolina DPS.

Overutilization of Atlantic sturgeon from directed fishing caused initial severe declines in Atlantic sturgeon populations in the Southeast, from which they have never rebounded. Further, continued overutilization of Atlantic sturgeon as bycatch in commercial fisheries is an ongoing impact to the Carolina DPS. Little data exists on bycatch in the Southeast and high levels of bycatch underreporting are suspected. Further, a total population abundance for the DPS is not available, and it is therefore not possible to calculate the percentage of the DPS subject to bycatch mortality based on the available bycatch mortality rates for individual fisheries. However, fisheries known to incidentally catch Atlantic sturgeon occur throughout the marine range of the species and in some riverine waters as well. Because Atlantic sturgeon mix extensively in marine waters and may access multiple river systems, they are subject to being caught in multiple fisheries throughout their range. In addition, stress or injury to Atlantic sturgeon taken as bycatch but released alive may result in increased susceptibility to other threats, such as poor water quality (e.g., exposure to toxins and low DO). This may result in reduced ability to perform major life functions, such as foraging and spawning, or even post-capture mortality.

As a wide-ranging anadromous species, Carolina DPS Atlantic sturgeon are subject to numerous Federal (U.S. and Canadian), state and provincial, and inter-jurisdictional laws, regulations, and agency activities. While these mechanisms have addressed impacts to Atlantic sturgeon through directed fisheries, there are currently no mechanisms in place to address the significant risk posed to Atlantic sturgeon from commercial bycatch. Though statutory and regulatory mechanisms exist that authorize reducing the impact of dams on riverine and anadromous species, such as Atlantic sturgeon, and their habitat, these mechanisms have proven inadequate for preventing dams from blocking access to habitat upstream and degrading habitat downstream. Further, water quality continues to be a problem in the Carolina DPS, even with existing controls on some pollution sources. Current regulatory regimes are not necessarily effective in controlling water allocation issues (e.g., no restrictions on interbasin water transfers in South Carolina, the lack of ability to regulate non-point source pollution, etc.)

The recovery of Atlantic sturgeon along the Atlantic Coast, especially in areas where habitat is limited and water quality is severely degraded, will require improvements in the following areas: (1) elimination of barriers to spawning habitat either through dam removal, breaching, or installation of successful fish passage facilities; (2) operation of water control structures to provide appropriate flows, especially during spawning season; (3) imposition of dredging restrictions including seasonal moratoriums and avoidance of spawning/nursery habitat; and, (4) mitigation of water quality parameters that are restricting sturgeon use of a river (i.e., DO). Additional data regarding sturgeon use of riverine and estuarine environments is needed.

The concept of a viable population able to adapt to changing environmental conditions is critical to Atlantic sturgeon, and the low population numbers of every river population in the Carolina DPS put them in danger of extinction throughout their range; none of the populations are large or stable enough to provide with any level of certainty for continued existence of Atlantic sturgeon in this part of its range. Although the largest impact that caused the precipitous decline of the species has been curtailed (directed fishing), the population sizes within the Carolina DPS have remained relatively constant at greatly reduced levels (approximately 3 percent of historical population sizes) for 100 years. Small numbers of individuals resulting from drastic reductions in populations, such as occurred with Atlantic sturgeon due to the commercial fishery, can remove the buffer against natural demographic and environmental variability provided by large populations (Berry, 1971; Shaffer, 1981; Soulé, 1980). Recovery of depleted populations is an inherently slow process for a late-maturing species such as Atlantic sturgeon, and they continue to face a variety of other threats that contribute to their risk of extinction. While a long life-span also allows multiple opportunities to contribute to future generations, it also results increases the timeframe over which exposure to the multitude of threats facing the Carolina DPS can occur.

The viability of the Carolina DPS depends on having multiple self-sustaining riverine spawning populations and maintaining suitable habitat to support the various life functions (spawning, feeding, growth) of Atlantic sturgeon populations. Because a DPS is a group of populations, the stability, viability, and persistence of individual populations affects the persistence and viability of the larger DPS. The loss of any population within a DPS will result in: (1) a long-term gap in the range of the DPS that is unlikely to be recolonized; (2) loss of reproducing individuals; (3) loss of genetic biodiversity; (4) potential loss of unique haplotypes; (5) potential loss of adaptive traits; and (6) reduction in total number. The loss of a population will negatively impact the persistence and viability of the DPS as a whole, as fewer than two individuals per generation spawn outside their natal rivers (Secor and Waldman 1999). The persistence of individual populations, and in turn the DPS, depends on successful spawning and rearing within the freshwater habitat, the immigration into marine habitats to grow, and then the return of adults to natal rivers to spawn.

Summary of the Status of the Carolina DPS of Atlantic Sturgeon
In summary, the Carolina DPS is estimated to number less than 3 percent of its historic population size. There are estimated to be less than 300 spawning adults per year (total of both sexes) in each of the major river systems occupied by the DPS in which spawning still occurs, whose freshwater range occurs in the watersheds (including all rivers and tributaries) from Albemarle Sound southward along the southern Virginia, North Carolina, and South Carolina coastal areas to Charleston Harbor. Recovery of depleted populations is an inherently slow process for a late-maturing species such as Atlantic sturgeon. While a long life-span also allows multiple opportunities to contribute to future generations, this is hampered within the Carolina DPS by habitat alteration and bycatch. This DPS was severely depleted by past directed commercial fishing, and faces ongoing impacts and threats from habitat alteration or

inaccessibility, bycatch, and the inadequacy of existing regulatory mechanisms to address and reduce habitat alterations and bycatch that have prevented river populations from rebounding and will prevent their recovery.

The presence of dams has resulted in the loss of over 60 percent of the historical sturgeon habitat on the Cape Fear River and in the Santee-Cooper system. Dams are contributing to the status of the Carolina DPS by curtailing the extent of available spawning habitat and further modifying the remaining habitat downstream by affecting water quality parameters (such as depth, temperature, velocity, and DO) that are important to sturgeon. Dredging is also contributing to the status of the Carolina DPS by modifying Atlantic sturgeon spawning and nursery habitat. Habitat modifications through reductions in water quality are contributing to the status of the Carolina DPS due to nutrient-loading, seasonal anoxia, and contaminated sediments. Interbasin water transfers and climate change threaten to exacerbate existing water quality issues. Bycatch is also a current threat to the Carolina DPS that is contributing to its status. Fisheries known to incidentally catch Atlantic sturgeon occur throughout the marine range of the species and in some riverine waters as well. Because Atlantic sturgeon mix extensively in marine waters and may utilize multiple river systems for nursery and foraging habitat in addition to their natal spawning river, they are subject to being caught in multiple fisheries throughout their range. In addition to direct mortality, stress or injury to Atlantic sturgeon taken as bycatch but released alive may result in increased susceptibility to other threats, such as poor water quality (e.g., exposure to toxins). This may result in reduced ability to perform major life functions, such as foraging and spawning, or even post-capture mortality. While many of the threats to the Carolina DPS have been ameliorated or reduced due to the existing regulatory mechanisms, such as the moratorium on directed fisheries for Atlantic sturgeon, bycatch is currently not being addressed through existing mechanisms. Further, access to habitat and water quality continues to be a problem even with NMFS' authority under the Federal Power Act to recommend fish passsage and existing controls on some pollution sources. The inadequacy of regulatory mechanisms to control bycatch and habitat alterations is contributing to the status of the Carolina DPS.

4.8.8 South Atlantic DPS of Atlantic sturgeon

The South Atlantic DPS includes all Atlantic sturgeon that spawn or are spawned in the watersheds (including all rivers and tributaries) of the Ashepoo, Combahee, and Edisto Rivers (ACE) Basin southward along the South Carolina, Georgia, and Florida coastal areas to the St. Johns River, Florida. The marine range of Atlantic sturgeon from the South Atlantic DPS extends from the Hamilton Inlet, Labrador, Canada, to Cape Canaveral, Florida.

Rivers known to have current spawning populations within the range of the South Atlantic DPS include the Combahee, Edisto, Savannah, Ogeechee, Altamaha, and Satilla Rivers. We determined spawning was occurring if young-of-the-year (YOY) were observed, or mature adults were present, in freshwater portions of a system (Table 5). However, in some rivers, spawning by Atlantic sturgeon may not be contributing to population growth because of lack of suitable habitat and the presence of other stressors on juvenile survival and development. Historically, both the Broad-Coosawatchie and St. Marys Rivers were documented to have spawning populations at one time; there is also evidence that spawning may have occurred in the St. Johns

River or one of its tributaries. However, the spawning population in the St. Marys River, as well as any historical spawning population present in the St. Johns, is believed to be extirpated, and the status of the spawning population in the Broad-Coosawatchie is unknown. Both the St. Marys and St. Johns Rivers are used as nursery habitat by young Atlantic sturgeon originating from other spawning populations. The use of the Broad-Coosawatchie by sturgeon from other spawning populations is unknown at this time. The presence of historical and current spawning populations in the Ashepoo River has not been documented; however, this river may currently be used for nursery habitat by young Atlantic sturgeon originating from other spawning populations. This represents our current knowledge of the river systems utilized by the South Atlantic DPS for specific life functions, such as spawning, nursery habitat, and foraging. However, fish from the South Atlantic DPS likely use other river systems than those listed here for their specific life functions.

River/Estuary	**Spawning Population**	**Data**
ACE (Ashepoo, Combahee, and Edisto Rivers) Basin, SC; St. Helena Sound	Yes	1,331 YOY (1994-2001); gravid female and running ripe male in the Edisto (1997); 39 spawning adults (1998)
Broad-Coosawhatchie Rivers, SC; Port Royal Sound	Unknown	
Savannah River, SC/GA	Yes	22 YOY (1999-2006); running ripe male (1997)
Ogeechee River, GA	Yes	age-1 captures, but high inter-annual variability (1991-1998); 17 YOY (2003); 9 YOY (2004)
Altamaha River, GA	Yes	74 captured/308 estimated spawning adults (2004); 139 captured/378 estimated spawning adults (2005)
Satilla River, GA	Yes	4 YOY and spawning adults (1995-1996)
St. Marys River, GA/FL	Extirpated	
St. Johns River, FL	Extirpated	

Table 5. Major rivers, tributaries, and sounds within the range of the South Atlantic DPS and currently available data on the presence of an Atlantic sturgeon spawning population in each system.

The riverine spawning habitat of the South Atlantic DPS occurs within the South Atlantic Coastal Plain ecoregion (TNC 2002b), which includes fall-line sandhills, rolling longleaf pine uplands, wet pine flatwoods, isolated depression wetlands, small streams, large river systems, and estuaries. Other ecological systems in the ecoregion include maritime forests on barrier islands, pitcher plant seepage bogs and Altamaha grit (sandstone) outcrops. Other ecological systems in the ecoregion include maritime forests on barrier islands, pitcher plant seepage bogs and Altamaha grit (sandstone) outcrops. The primary threats to biological diversity in the South Atlantic Coastal Plain listed by TNC are intensive silvicultural practices, including conversion of natural forests to highly managed pine monocultures and the clear-cutting of bottomland hardwood forests. Changes in water quality and quantity, caused by hydrologic alterations (impoundments, groundwater withdrawal, and ditching), and point and nonpoint pollution, are threatening the aquatic systems. Development is a growing threat, especially in coastal areas. Agricultural conversion, fire regime alteration, and the introduction of nonnative species are additional threats to the ecoregion's diversity. The South Atlantic DPS' spawning rivers, located in the South Atlantic Coastal Plain, are primarily of two types: brownwater (with headwaters north of the Fall Line, silt-laden) and blackwater (with headwaters in the coastal plain, stained by tannic acids).

Secor (2002) estimates that 8,000 adult females were present in South Carolina prior to 1890. Prior to the collapse of the fishery in the late 1800s, the sturgeon fishery was the third largest fishery in Georgia. Secor (2002) estimated from U.S. Fish Commission landing reports that approximately 11,000 spawning females were likely present in the state prior to 1890. Reductions from the commercial fishery and ongoing threats have drastically reduced the numbers of Atlantic sturgeon within the South Atlantic DPS. Currently, the Atlantic sturgeon spawning population in at least two river systems within the South Atlantic DPS has been extirpated. The Altamaha River population of Atlantic sturgeon, with an estimated 343 adults spawning annually, is believed to be the largest population in the Southeast, yet is estimated to be only 6 percent of its historical population size. The abundances of the remaining river populations within the DPS, each estimated to have fewer than 300 spawning adults, is estimated to be less than 1 percent of what they were historically (ASSRT 2007).

Threats

The South Atlantic DPS was listed as endangered under the ESA as a result of a combination of habitat curtailment and modification, overutilization (i.e, being taken as bycatch) in commercial fisheries, and the inadequacy of regulatory mechanisms in ameliorating these impacts and threats.

The modification and curtailment of Atlantic sturgeon habitat resulting from dredging and degraded water quality is contributing to the status of the South Atlantic DPS. Dredging is a present threat to the South Atlantic DPS and is contributing to their status by modifying the quality and availability of Atlantic sturgeon habitat. Maintenance dredging is currently modifying Atlantic sturgeon nursery habitat in the Savannah River and modeling indicates that the proposed deepening of the navigation channel will result in reduced DO and upriver movement of the salt wedge, curtailing spawning habitat. Dredging is also modifying nursery and foraging habitat in the St. Johns Rivers. Reductions in water quality from terrestrial activities have modified habitat utilized by the South Atlantic DPS. Low DO is modifying sturgeon habitat in the Savannah due to dredging, and non-point source inputs are causing low DO in the Ogeechee River and in the St. Marys River, which completely eliminates juvenile nursery habitat in summer. Low DO has also been observed in the St. Johns River in the summer. Sturgeon are more sensitive to low DO and the negative (metabolic, growth, and feeding) effects caused by low DO increase when water temperatures are concurrently high, as they are within the range of the South Atlantic DPS. Additional stressors arising from water allocation and climate change threaten to exacerbate water quality problems that are already present throughout the range of the South Atlantic DPS. Large withdrawals of over 240 million gallons per day mgd of water occur in the Savannah River for power generation and municipal uses. However, users withdrawing less than 100,000 gallons per day (gpd) are not required to get permits, so actual water withdrawals from the Savannah and other rivers within the range of the South Atlantic DPS are likely much higher. The removal of large amounts of water from the system will alter flows, temperature, and DO. Water shortages and "water wars" are already occurring in the rivers occupied by the South Atlantic DPS and will likely be compounded in the future by population growth and potentially by climate change. Climate change is also predicted to elevate water temperatures and exacerbate nutrient-loading, pollution inputs, and lower DO, all of which are current stressors to the South Atlantic DPS.

Overutilization of Atlantic sturgeon from directed fishing caused initial severe declines in Atlantic sturgeon populations in the Southeast, from which they have never rebounded. Further, continued overutilization of Atlantic sturgeon as bycatch in commercial fisheries is an ongoing impact to the South Atlantic DPS. The loss of large subadults and adults as a result of bycatch impacts Atlantic sturgeon populations because they are a long-lived species, have an older age at maturity, have lower maximum fecundity values, and a large percentage of egg production occurs later in life. Little data exists on bycatch in the Southeast and high levels of bycatch underreporting are suspected. Further, a total population abundance for the DPS is not available, and it is therefore not possible to calculate the percentage of the DPS subject to bycatch mortality based on the available bycatch mortality rates for individual fisheries. However, fisheries known to incidentally catch Atlantic sturgeon occur throughout the marine range of the species and in some riverine waters as well. Because Atlantic sturgeon mix extensively in marine waters and may access multiple river systems, they are subject to being caught in multiple fisheries throughout their range. In addition, stress or injury to Atlantic sturgeon taken as bycatch but released alive may result in increased susceptibility to other threats, such as poor water quality (e.g., exposure to toxins and low DO). This may result in reduced ability to perform major life functions, such as foraging and spawning, or even post-capture mortality.

As a wide-ranging anadromous species, Atlantic sturgeon are subject to numerous Federal (U.S. and Canadian), state and provincial, and inter-jurisdictional laws, regulations, and agency activities. While these mechanisms have addressed impacts to Atlantic sturgeon through directed fisheries, there are currently no mechanisms in place to address the significant risk posed to Atlantic sturgeon from commercial bycatch. Though statutory and regulatory mechanisms exist that authorize reducing the impact of dams on riverine and anadromous species, such as Atlantic sturgeon, and their habitat, these mechanisms have proven inadequate for preventing dams from blocking access to habitat upstream and degrading habitat downstream. Further, water quality continues to be a problem in the South Atlantic DPS, even with existing controls on some pollution sources. Current regulatory regimes are not necessarily effective in controlling water allocation issues (e.g., no permit requirements for water withdrawals under 100,000 gpd in Georgia, no restrictions on interbasin water transfers in South Carolina, the lack of ability to regulate non-point source pollution.)

The recovery of Atlantic sturgeon along the Atlantic Coast, especially in areas where habitat is limited and water quality is severely degraded, will require improvements in the following areas: (1) elimination of barriers to spawning habitat either through dam removal, breaching, or installation of successful fish passage facilities; (2) operation of water control structures to provide appropriate flows, especially during spawning season; (3) imposition of dredging restrictions including seasonal moratoriums and avoidance of spawning/nursery habitat; and, (4) mitigation of water quality parameters that are restricting sturgeon use of a river (i.e., DO). Additional data regarding sturgeon use of riverine and estuarine environments is needed.

A viable population able to adapt to changing environmental conditions is critical to Atlantic sturgeon, and the low population numbers of every river population in the South Atlantic DPS put them in danger of extinction throughout their range; none of the populations are large or stable enough to provide with any level of certainty for continued existence of Atlantic sturgeon in this part of its range. Although the largest impact that caused the precipitous decline of the species has been curtailed (directed fishing), the population sizes within the South Atlantic DPS have remained relatively constant at greatly reduced levels (approximately 6 percent of historical population sizes in the Altamaha River, and 1 percent of historical population sizes in the remainder of the DPS) for 100 years. Small numbers of individuals resulting from drastic reductions in populations, such as occurred with Atlantic sturgeon due to the commercial fishery, can remove the buffer against natural demographic and environmental variability provided by large populations (Berry, 1971; Shaffer, 1981; Soulé, 1980). Recovery of depleted populations is an inherently slow process for a late-maturing species such as Atlantic sturgeon, and they continue to face a variety of other threats that contribute to their risk of extinction. While a long life-span also allows multiple opportunities to contribute to future generations, it also results increases the timeframe over which exposure to the multitude of threats facing the South Atlantic DPS can occur.

Summary of the Status of the South Atlantic DPS of Atlantic Sturgeon

The South Atlantic DPS is estimated to number fewer than 6 percent of its historical population size, with all river populations except the Altamaha estimated to be less than 1 percent of historical abundance. There are an estimated 343 spawning adults per year in the Altamaha and less than 300 spawning adults per year (total of both sexes) in each of the other major river systems occupied by the DPS in which spawning still occurs, whose freshwater range occurs in the watersheds (including all rivers and tributaries) of the ACE Basin southward along the South Carolina, Georgia, and Florida coastal areas to the St. Johns River, Florida. Recovery of depleted populations is an inherently slow process for a late-maturing species such as Atlantic sturgeon. Their late age at maturity provides more opportunities for individuals to be removed from the population before reproducing. While a long life-span also allows multiple opportunities to contribute to future generations, this is hampered within the South Atlantic DPS by habitat alteration, bycatch, and from the inadequacy of existing regulatory mechanisms to address and reduce habitat alterations and bycatch.

Dredging is contributing to the status of the South Atlantic DPS by modifying spawning, nursery, and foraging habitat. Habitat modifications through reductions in water quality are also contributing to the status of the South Atlantic DPS through reductions in DO, particularly during times of high water temperatures, which increase the detrimental effects on Atlantic sturgeon habitat. Interbasin water transfers and climate change threaten to exacerbate existing water quality issues. Bycatch is also a current impact to the South Atlantic DPS that is contributing to its status. Fisheries known to incidentally catch Atlantic sturgeon occur throughout the marine range of the species and in some riverine waters as well. Because Atlantic sturgeon mix extensively in marine waters and may utilize multiple river systems for nursery and foraging habitat in addition to their natal spawning river, they are subject to being caught in multiple fisheries throughout their range. In addition to direct mortality, stress or injury to Atlantic sturgeon taken as bycatch but released alive may result in increased susceptibility to other threats, such as poor water quality (e.g., exposure to toxins). This may result in reduced ability to perform major life functions, such as foraging and spawning, or even post-capture mortality. While many of the threats to the South Atlantic DPS have been ameliorated or reduced due to the existing regulatory mechanisms, such as the moratorium on directed fisheries for Atlantic sturgeon, bycatch is currently not being addressed through existing mechanisms. Further, access to habitat and water quality continues to be a problem even with NMFS' authority under the Federal Power Act to recommend fish passsage and existing controls on some pollution sources. There is a lack of regulation for some large water withdrawals, which threatens sturgeon habitat. Current regulatory regimes do not require a permit for water withdrawals under 100,000 gpd in Georgia and there are no restrictions on interbasin water transfers in South Carolina. Data required to evaluate water allocation issues are either very weak, in terms of determining the precise amounts of water currently being used, or non-existent, in terms of our knowledge of water supplies available for use under historical hydrologic conditions in the region. Existing water allocation issues will likely be compounded by population growth, drought, and potentially climate change. The inadequacy of regulatory mechanisms to control bycatch and habitat alterations is contributing to the status of the South Atlantic DPS.

4.9 Shortnose Sturgeon

Shortnose sturgeon are benthic fish that mainly occupy the deep channel sections of large rivers. They feed on a variety of benthic and epibenthic invertebrates including mollusks, crustaceans (amphipods, isopods), insects, and oligochaete worms (Vladykov and Greeley 1963; Dadswell 1979 *in* NMFS 1998). Shortnose sturgeon have similar lengths at maturity (45-55 cm fork length) throughout their range, but, because sturgeon in southern rivers grow faster than those in northern rivers, southern sturgeon mature at younger ages (Dadswell et al. 1984). Shortnose sturgeon are long-lived (30-40 years) and, particularly in the northern extent of their range, mature at late ages. In the north, males reach maturity at 5 to 10 years, while females mature between 7 and 13 years. Based on limited data, females spawn every three to five years while males spawn approximately every two years. The spawning period is estimated to last from a few days to several weeks. Spawning begins from late winter/early spring (southern rivers) to mid to late spring (northern rivers)[8] when the freshwater temperatures increase to 8-9ºC. Several published reports have presented the problems facing long-lived species that delay sexual maturity (Crouse et al. 1987; Crowder et al. 1994; Crouse 1999). In general, these reports

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[8] 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.

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 and a mean of 11,568 eggs/kg body weight (Dadswell et al. 1984).

At hatching, shortnose sturgeon are blackish-colored, 7-11mm long and resemble tadpoles (Buckley and Kynard 1981). In 9-12 days, the yolk sac is absorbed and the sturgeon develops into larvae which are about 15mm total length (TL; Buckley and Kynard 1981). Sturgeon larvae are believed to begin downstream migrations at about 20mm TL. Dispersal rates differ at least regionally, laboratory studies on Connecticut River larvae indicated dispersal peaked 7-12 days after hatching in comparison to Savannah River larvae that had longer dispersal rates with multiple, prolonged peaks, and a low level of downstream movement that continued throughout the entire larval and early juvenile period (Parker 2007). Synder (1988) and Parker (2007) considered individuals to be juvenile when they reached 57mm TL. Laboratory studies demonstrated that larvae from the Connecticut River made this transformation on day 40 while Savannah River fish made this transition on day 41 and 42 (Parker 2007).

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

In populations that have free access to the total length of a river (e.g., no dams within the species' range in a river: Saint John, Kennebec, Altamaha, Savannah, Delaware and Merrimack

Rivers), spawning areas are located at the farthest upstream reach of the river (NMFS 1998). In the northern extent of their range, shortnose sturgeon exhibit three distinct movement patterns. These migratory movements are associated with spawning, feeding, and overwintering activities. In spring, as water temperatures reach between 7-9.7ºC (44.6-49.5°F), pre-spawning shortnose sturgeon move from overwintering grounds to spawning areas. Spawning occurs from mid/late March to mid/late May depending upon location and water temperature. Sturgeon spawn in upper, freshwater areas and feed and overwinter in both fresh and saline habitats. Shortnose sturgeon spawning migrations are characterized by rapid, directed and often extensive upstream movement (NMFS 1998).

Shortnose sturgeon are believed to spawn at discrete sites within their natal river (Kieffer and Kynard 1996). In the Merrimack River, males returned to only one reach during a four year telemetry study (Kieffer and Kynard 1996). Squires (1982) found that during the three years of the study in the Androscoggin River, adults returned to a 1-km reach below the Brunswick Dam and Kieffer and Kynard (1996) found that adults spawned within a 2-km reach in the Connecticut River for three consecutive years. Spawning occurs over channel habitats containing gravel, rubble, or rock-cobble substrates (Dadswell et al. 1984; NMFS 1998). Additional environmental conditions associated with spawning activity include decreasing river discharge following the peak spring freshet, water temperatures ranging from 8 - 15º (46.4-59°F), and bottom water velocities of 0.4 to 0.8 m/sec (Dadswell et al. 1984; Hall et al. 1991, Kieffer and Kynard 1996, NMFS 1998). For northern shortnose sturgeon, the temperature range for spawning is 6.5-18.0ºC (Kieffer and Kynard in press). Eggs are separate when spawned but become adhesive within approximately 20 minutes of fertilization (Dadswell et al. 1984). Between 8° (46.4°F) and 12°C (53.6°F), eggs generally hatch after approximately 13 days. The larvae are photonegative, remaining on the bottom for several days. Buckley and Kynard (1981) found week old larvae to be photonegative and form aggregations with other larvae in concealment.

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

Juvenile shortnose sturgeon generally move upstream in spring and summer and move back downstream in fall and winter; however, these movements usually occur in the region above the saltwater/freshwater interface (Dadswell et al. 1984; Hall et al. 1991). Non-spawning movements include wandering movements in summer and winter (Dadswell et al. 1984; Buckley and Kynard 1985; O'Herron et al. 1993). Kieffer and Kynard (1993) reported that post-spawning migrations were correlated with increasing spring water temperature and river discharge. Adult sturgeon occurring in freshwater or freshwater/tidal reaches of rivers in summer and winter often occupy only a few short reaches of the total length (Buckley and Kynard 1985). Summer concentration areas in southern rivers are cool, deep, thermal refugia, where adult and juvenile shortnose sturgeon congregate (Flourney et al. 1992; Rogers et al. 1994; Rogers and Weber 1995; Weber 1996).

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

The temperature preference for shortnose sturgeon is not known (Dadswell et al. 1984) but shortnose sturgeon have been found in waters with temperatures as low as 2 to 3ºC (35.6-37.4°F) (Dadswell et al. 1984) and as high as 34ºC (93.2°F) (Heidt and Gilbert 1978). However, water temperatures above 28ºC (82.4°F) are thought to adversely affect shortnose sturgeon. In the Altamaha River, water temperatures of 28-30ºC (82.4-86°F) during summer months create unsuitable conditions and shortnose sturgeon are found in deep cool water refuges. Dissolved oxygen (DO) also seems to play a role in temperature tolerance, with increased stress levels at higher temperatures with low DO versus the ability to withstand higher temperatures with elevated DO (Niklitchek 2001).

Shortnose sturgeon are known to occur at a wide range of depths. A minimum depth of 0.6m (approximately 2 feet) is necessary for the unimpeded swimming by adults. Shortnose sturgeon are known to occur at depths of up to 30m (98.4 ft) but are generally found in waters less than 20m (65.5 ft) (Dadswell et al. 1984; Dadswell 1979). Shortnose sturgeon have also demonstrated tolerance to a wide range of salinities. Shortnose sturgeon have been documented in freshwater (Taubert 1980; Taubert and Dadswell 1980) and in waters with salinity of 30 parts-per-thousand (ppt) (Holland and Yeverton 1973; 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); however, shortnose sturgeon forage on vegetated mudflats and over shellfish beds in shallower waters when suitable forage is present.

Status and Trends of Shortnose Sturgeon Rangewide

Shortnose sturgeon were listed as endangered on March 11, 1967 (32 FR 4001), and the species remained on the endangered species list with the enactment of the ESA in 1973. Although the original listing notice did not cite reasons for listing the species, a 1973 Resource Publication, issued by the US Department of the Interior, stated that shortnose sturgeon were “in peril…gone in most of the rivers of its former range [but] probably not as yet extinct” (USDOI 1973). Pollution and overfishing, including bycatch in the shad fishery, were listed as principal reasons for the species’ decline. In the late nineteenth and early twentieth centuries, shortnose sturgeon commonly were taken in a commercial fishery for the closely related and commercially valuable

Atlantic sturgeon (*Acipenser oxyrinchus*). More than a century of extensive fishing for sturgeon contributed to the decline of shortnose sturgeon along the east coast. Heavy industrial development during the twentieth century in rivers inhabited by sturgeon impaired water quality and impeded these species' recovery; possibly resulting in substantially reduced abundance of shortnose sturgeon populations within portions of the species' ranges (e.g., southernmost rivers of the species range: Santilla, St. Marys and St. Johns Rivers). A shortnose sturgeon recovery plan was published in December 1998 to promote the conservation and recovery of the species (see NMFS 1998). Shortnose sturgeon are listed as "vulnerable" on the IUCN Red List.

Although shortnose sturgeon are listed as endangered range-wide, in the 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)[9] of shortnose sturgeon under the ESA. Although genetic information within and among shortnose sturgeon occurring in different river systems is largely unknown, life history studies indicate that shortnose sturgeon populations from different river systems are substantially reproductively isolated (Kynard 1997) and, therefore, should be considered discrete. The 1998 Recovery Plan indicates that while genetic information may reveal that interbreeding does not occur between rivers that drain into a common estuary, at this time, such river systems are considered a single population compromised of breeding subpopulations (NMFS 1998).

Studies conducted since the issuance of the Recovery Plan have provided evidence that suggests that years of isolation between populations of shortnose sturgeon have led to morphological and genetic variation. Walsh et al. (2001) examined morphological and genetic variation of shortnose sturgeon in three rivers (Kennebec, Androscoggin, and Hudson). The study found that the Hudson River shortnose sturgeon population differed markedly from the other two rivers for most morphological features (total length, fork length, head and snout length, mouth width, 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

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[9] 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.

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

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

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

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

Historically, shortnose sturgeon are believed to have inhabited nearly all major rivers and estuaries along nearly the entire east coast of North America. The range extended from the St John River in New Brunswick, Canada to the Indian River in Florida. Today, only 19 populations remain ranging from the St. Johns River, Florida (possibly extirpated from this system) to the Saint John River in New Brunswick, Canada. Shortnose sturgeon are large, long lived fish species. The present range of shortnose sturgeon is disjunct, with northern populations separated from southern populations by a distance of about 400 km. Population sizes vary across the species' range. From available estimates, the smallest populations occur in the Cape Fear (~8 adults; Moser and Ross 1995) in the south and Merrimack and Penobscot rivers in the north (~ several hundred to several thousand adults depending on population estimates used; M. Kieffer, United States Geological Survey, personal communication; Dionne 2010), while the largest populations are found in the Saint John (~18, 000; Dadswell 1979) and Hudson Rivers (~61,000; Bain et al. 1998). As indicated in Kynard 1996, adult abundance is less than the minimum estimated viable population abundance of 1000 adults for 5 of 11 surveyed northern populations and all natural southern populations. Kynard 1996 indicates that all aspects of the species' life history indicate that shortnose sturgeon should be abundant in most rivers. As such, the expected abundance of adults in northern and north-central populations should be thousands to tens of thousands of adults. Expected abundance in southern rivers is uncertain, but large rivers should likely have thousands of adults. The only river systems likely supporting populations of these sizes are the St John, Hudson and possibly the Delaware and the Kennebec, making the continued success of shortnose sturgeon in these rivers critical to the species as a whole. While no reliable estimate of the size of either the total species population rangewide, or the shortnose sturgeon population in the Northeastern United States exists, it is clearly below the size that could be supported if the threats to shortnose sturgeon were removed.

Threats to shortnose sturgeon recovery rangewide

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

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

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

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

Contaminant analysis was conducted on two shortnose sturgeon from the Delaware River in the fall of 2002. Muscle, liver, and gonad tissue were analyzed for contaminants (ERC 2002). Sixteen metals, two semivolatile compounds, three organochlorine pesticides, one PCB Aroclor, as well as polychlorinated dibenzo-p-dioxins (PCDDs), and polychlorinated dibenzofurans (PCDFs) were detected in one or more of the tissue samples. Levels of aluminum, cadmium, PCDDs, PCDFs, PCBs, DDE (an organochlorine pesticide) were detected in the "adverse affect" range. It is of particular concern that of the above chemicals, PCDDs, DDE, PCBs and cadmium, were detected as these have been identified as endocrine disrupting chemicals. Contaminant analysis conducted in 2003 on tissues from a shortnose sturgeon from the

Kennebec River revealed the presence of fourteen metals, one semivolatile compound, one PCB Aroclor, Polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) in one or more of the tissue samples. Of these chemicals, cadmium and zinc were detected at concentrations above an adverse effect concentration reported for fish in the literature (ERC 2003). While no directed studies of chemical contamination in shortnose sturgeon have been undertaken, it is evident that the heavy industrialization of the rivers where shortnose sturgeon are found is likely adversely affecting this species.

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

Pulp mill, silvicultural, agricultural, and sewer discharges, as well as a combination of non-point source discharges, which contain elevated temperatures or high biological demand, can reduce dissolved oxygen levels. Shortnose sturgeon are known to be adversely affected by dissolved oxygen levels below 5 mg/L. Shortnose sturgeon may be less tolerant of low dissolved oxygen levels in high ambient water temperatures and show signs of stress in water temperatures higher than 28ºC (82.4°F) (Flourney et al. 1992). At these temperatures, concomitant low levels of dissolved oxygen may be lethal.

5.0 CLIMATE CHANGE

The discussion below presents background information on global climate change and information on past and predicted future effects of global climate change throughout the range of the listed species considered here. Additionally, we present the available information on predicted effects of climate change in the action area and how listed sea turtles and sturgeon may be affected by those predicted environmental changes over the life of the proposed action (i.e., five years). Climate change is relevant to the Status of the Species, Environmental Baseline and Cumulative Effects sections of this Opinion; rather than include partial discussion in several sections of this Opinion, we are synthesizing this information into one discussion. Consideration of effects of the proposed action in light of predicted changes in environmental conditions due to anticipated climate change are included in the Effects of the Action section below (section 8.0 below).

5.1 Background Information on Global climate change

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

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

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

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

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

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

5.2 Species Specific Information on Climate Change Effects

5.2.1 Loggerhead Sea Turtles

The most recent Recovery Plan for loggerhead sea turtles as well as the 2009 Status Review Report identifies global climate change as a threat to loggerhead sea turtles. However, trying to assess the likely effects of climate change on loggerhead sea turtles is extremely difficult given the uncertainty in all climate change models and the difficulty in determining the likely rate of temperature increases and the scope and scale of any accompanying habitat effects. Additionally, no significant climate change-related impacts to loggerhead sea turtle populations have been observed to date. Over the long-term, climate change related impacts are expected to influence biological trajectories on a century scale (Parmesan and Yohe 2003). As noted in the 2009 Status Review (Conant *et al.* 2009), impacts from global climate change induced by human activities are likely to become more apparent in future years (IPCC 2007). Climate change related increasing temperatures, sea level rise, changes in ocean productivity, and increased frequency of storm events may affect loggerhead sea turtles.

Increasing temperatures are expected to result in increased polar melting and changes in precipitation which may lead to rising sea levels (Titus and Narayanan 1995 in Conant *et al.* 2009), which could result in increased erosion rates along nesting beaches. Sea level rise could result in the inundation of nesting sites and decrease available nesting habitat (Daniels *et al.* 1993; Fish *et al.* 2005; Baker *et al.* 2006). The BRT noted that the loss of habitat as a result of climate change could be accelerated due to a combination of other environmental and oceanographic changes such as an increase in the frequency of storms and/or changes in prevailing currents, both of which could lead to increased beach loss via erosion (Antonelis *et al.* 2006; Baker *et al.* 2006; both in Conant *et al.* 2009). Along developed coastlines, and especially in areas where erosion control structures have been constructed to limit shoreline movement, rising sea levels may cause severe effects on nesting females and their eggs as nesting females may deposit eggs seaward of the erosion control structures potentially subjecting them to repeated tidal inundation. However, if global temperatures increase and there is a range shift northwards, beaches not currently used for nesting may become available for loggerhead sea turtles, which may offset some loss of accessibility to beaches in the southern portions of the range.

Climate change has the potential to result in changes at nesting beaches that may affect loggerhead sex ratios. Loggerhead sea turtles exhibit temperature-dependent sex determination. Rapidly increasing global temperatures may result in warmer incubation temperatures and highly female-biased sex ratios (*e.g.*, Glen and Mrosovsky 2004; Hawkes *et al.* 2009); however, to the extent that nesting can occur at beaches further north where sand temperatures are not as warm, these effects may be partially offset. The BRT specifically identified climate change as a threat to loggerhead sea turtles in the neritic/oceanic zone where climate change may result in future trophic changes, thus impacting loggerhead prey abundance and/or distribution. In the threats matrix analysis, climate change was considered for oceanic juveniles and adults and eggs/hatchlings. The report states that for oceanic juveniles and adults, "although the effect of trophic level change from…climate change…is unknown it is believed to be very low.” For eggs/hatchlings the report states that total mortality from anthropogenic causes, including sea level rise resulting from climate change, is believed to be low relative to the entire life stage. However, only limited data are available on past trends related to climate effects on loggerhead sea turtles; current scientific methods are not able to reliably predict the future magnitude of climate change, associated impacts, whether and to what extent some impacts will offset others, or the adaptive capacity of this species.

However, Van Houtan and Halley (2011) recently developed climate based models to investigate loggerhead nesting (considering juvenile recruitment and breeding remigration) in the North Pacific and Northwest Atlantic. These models found that climate conditions/oceanographic influences explain loggerhead nesting variability, with climate models alone explaining an average 60% (range 18%-88%) of the observed nesting changes over the past several decades. In terms of future nesting projections, modeled climate data show a future positive trend for Florida nesting, with increases through 2040 as a result of the Atlantic Multidecadal Oscillation signal.

5.2.2 Kemp’s Ridley Sea Turtles

The recovery plan for Kemp’s ridley sea turtles (NMFS *et al.* 2011) identifies climate change as a threat; however, as with the other species discussed above, no significant climate change-related impacts to Kemp’s ridley sea turtles have been observed to date. Atmospheric warming could cause habitat alteration which may change food resources such as crabs and other invertebrates. It may increase hurricane activity, leading to an increase in debris in nearshore and offshore waters, which may result in an increase in entanglement, ingestion, or drowning. In addition, increased hurricane activity may cause damage to nesting beaches or inundate nests with sea water. Atmospheric warming may change convergence zones, currents and other oceanographic features that are relevant to Kemp's ridleys, as well as change rain regimes and levels of nearshore runoff.

Considering that the Kemp’s ridley has temperature-dependent sex determination (Wibbels 2003) and the vast majority of the nesting range is restricted to the State of Tamaulipas, Mexico, global warming could potentially shift population sex ratios towards females and thus change the reproductive ecology of this species. A female bias is presumed to increase egg production (assuming that the availability of males does not become a limiting factor) (Coyne and Landry 2007) and increase the rate of recovery; however, it is unknown at what point the percentage of males may become insufficient to facilitate maximum fertilization rates in a population. If males become a limiting factor in the reproductive ecology of the Kemp's ridley, then reproductive output in the population could decrease (Coyne 2000). Low numbers of males could also result in the loss of genetic diversity within a population; however, there is currently no evidence that this is a problem in the Kemp's ridley population (NMFS *et al.* 2011). Models (Davenport 1997, Hulin and Guillon 2007, Hawkes *et al.* 2007, all referenced in NMFS *et al.* 2011) predict very long-term reductions in fertility in sea turtles due to climate change, but due to the relatively long life cycle of sea turtles, reductions may not be seen until 30 to 50 years in the future.

Another potential impact from global climate change is sea level rise, which may result in increased beach erosion at nesting sites. Beach erosion may be accelerated due to a combination of other environmental and oceanographic changes such as an increase in the frequency of storms and/or changes in prevailing currents. In the case of the Kemp's ridley where most of the critical nesting beaches are undeveloped, beaches may shift landward and still be available for nesting. The Padre Island National Seashore (PAIS) shoreline is accreting, unlike much of the Texas coast, and with nesting increasing and the sand temperatures slightly cooler than at Rancho Nuevo, PAIS could become an increasingly important source of males for the population.

5.2.3 Green Sea Turtles

The five year status review for green sea turtles (NMFS and USFWS 2007d) notes that global climate change is affecting green sea turtles and is likely to continue to be a threat. There is an increasing female bias in the sex ratio of green turtle hatchlings. While this is partly attributable to imperfect egg hatchery practices, global climate change is also implicated as a likely cause. This is because warmer sand temperatures at nesting beaches are likely to result in the production of more female embryos. At least one nesting site, Ascension Island, has had an increase in mean sand temperature in recent years (Hays *et al.* 2003 in NMFS and USFWS 2007d). Climate change may also affect nesting beaches through sea level rise, which may reduce the availability of nesting habitat and increase the risk of nest inundation. Loss of appropriate nesting habitat may also be accelerated by a combination of other environmental and oceanographic changes, such as an increase in the frequency of storms and/or changes in prevailing currents, both of which could lead to increased beach loss via erosion. Oceanic changes related to rising water temperatures could result in changes in the abundance and distribution of the primary food sources of green sea turtles, which in turn could result in changes in behavior and distribution of this species. Seagrass habitats may suffer from decreased productivity and/or increased stress due to sea level rise, as well as salinity and temperature changes (Short and Neckles 1999; Duarte 2002).

As noted above, the increasing female bias in green sea turtle hatchlings is thought to be at least partially linked to increases in temperatures at nesting beaches. However, at this time, we do not know how much of this bias is due to hatchery practice and how much is due to increased sand temperature. Because we do not have information to predict the extent and rate to which sand temperatures at the nesting beaches used by green sea turtles may increase in the short-term future, we cannot predict the extent of any future bias. Also, we do not know to what extent to which green sea turtles may be able to cope with this change by selecting cooler areas of the beach or shifting their nesting distribution to other beaches at which increases in sand temperature may not be experienced.

5.2.4 Leatherback sea turtles

Global climate change has been identified as a factor that may affect leatherback habitat and biology (NMFS and USFWS 2007b); however, no significant climate change related impacts to leatherback sea turtle populations have been observed to date. Over the long term, climate change related impacts will likely influence biological trajectories in the future on a century scale (Parmesan and Yohe 2003). Changes in marine systems associated with rising water temperatures, changes in ice cover, salinity, oxygen levels and circulation including shifts in ranges and changes in algal, plankton, and fish abundance could affect leatherback prey distribution and abundance. Climate change is expected to expand foraging habitats into higher latitude waters and some concern has been noted that increasing temperatures may increase the female:male sex ratio of hatchlings on some beaches (Morosovsky *et al.* 1984 and Hawkes *et al.* 2007 in NMFS and USFWS 2007b). However, due to the tendency of leatherbacks to have individual nest placement preferences and deposit some clutches in the cooler tide zone of beaches, the effects of long-term climate on sex ratios may be mitigated (Kamel and Mrosovsky 2004 in NMFS and USFWS 2007b).

Additional potential effects of climate change on leatherbacks include range expansion and changes in migration routes as increasing ocean temperatures shift range-limiting isotherms north (Robinson *et al.* 2008). Leatherbacks have expanded their range in the Atlantic north by 330 km in the last 17 years as warming has caused the northerly migration of the 15°C sea surface temperature (SST) isotherm, the lower limit of thermal tolerance for leatherbacks (McMahon and Hays 2006). Leatherbacks are speculated to be the best able to cope with climate change of all the sea turtle species due to their wide geographic distribution and relatively weak beach fidelity. Leatherback sea turtles may be most affected by any changes in the distribution of their primary jellyfish prey, which may affect leatherback distribution and foraging behavior (NMFS and USFWS 2007b). Jellyfish populations may increase due to ocean warming and other factors (Brodeur *et al.* 1999; Attrill *et al.* 2007; Richardson *et al.* 2009). However, any increase in jellyfish populations may or may not impact leatherbacks as there is no evidence that any leatherback populations are currently food-limited.

Increasing temperatures are expected to result in increased polar melting and changes in precipitation which may lead to rising sea levels (Titus and Narayanan 1995 in Conant *et al.* 2009), which could result in increased erosion rates along nesting beaches. Sea level rise could result in the inundation of nesting sites and decrease available nesting habitat (Fish *et al.* 2005). This effect would potentially be accelerated due to a combination of other environmental and oceanographic changes such as an increase in the frequency of storms and/or changes in prevailing currents. While there is a reasonable degree of certainty that climate change related effects will be experienced globally (*e.g.*, rising temperatures and changes in precipitation patterns), due to a lack of scientific data, the specific effects of climate change on this species are not quantifiable at this time (Hawkes *et al.* 2009).

5.2.5 Atlantic sturgeon

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

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

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

5.2.6 Shortnose sturgeon

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

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

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

5.3 Effects of Climate Change in the Action Area to Atlantic and shortnose sturgeon

As there is significant uncertainty in the rate and timing of change as well as the effect of any changes that may be experienced in the action area due to climate change, it is difficult to predict the impact of these changes on shortnose and Atlantic sturgeon, particularly over the short term (i.e., the five year period considered here).

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

In the action area, it is possible that changing seasonal temperature regimes could result in changes in the timing of seasonal migrations through the area as sturgeon move to spawning and overwintering grounds. There could be shifts in the timing of spawning; presumably, if water temperatures warm earlier in the spring, and water temperature is a primary spawning cue, spawning migrations and spawning events could occur earlier in the year. However, because spawning is not triggered solely by water temperature, but also by day length (which would not be affected by climate change) and river flow (which could be affected by climate change), it is not possible to predict how any change in water temperature or river flow alone will affect the seasonal movements of sturgeon through the action area.

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

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

Normal surface water temperatures in the action area can be as high as 28°C at some times and in some areas during the summer months; temperatures in deeper waters and near the bottom are cooler. A predicted increase in water temperature of 3-4°C within 100 years is expected to result in temperatures approaching the preferred temperature of shortnose and Atlantic sturgeon (28°C) on more days and/or in larger areas. However, over the next five years, any increase in water temperatures is expected to be very small. While over time warming water temperatures could result in shifts in the distribution of sturgeon out of certain areas during the warmer months, we do not expect these type of large scale changes in the next five years.

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

5.4 Effects of Climate Change in the Action Area on Sea Turtles

As there is significant uncertainty in the rate and timing of change as well as the effect of any changes that may be experienced in the action area due to climate change, it is difficult to predict the impact of these changes on sea turtles; however, we have considered the available information to consider likely impacts to these species in the action area.

Sea turtles are most likely to be affected by climate change due to increasing sand temperatures at nesting beaches which in turn would result in increased female: male sex ratio among hatchlings, sea level rise which could result in a reduction in available nesting beach habitat, increased risk of nest inundation, changes in the abundance and distribution of forage species which could result in changes in the foraging behavior and distribution of sea turtle species, and changes in water temperature which could possibly lead to a northward shift in their range.

Over the time period considered in this Opinion, any increase in sea surface temperatures attributable to global climate change is expected to be very small. It is unlikely to be enough of a change to contribute to shifts in the range or distribution of sea turtles. Theoretically, we expect that as waters in the action area warm, more sea turtles could be present or sea turtles could be present for longer periods of time. However, if temperature affected the distribution of sea turtle forage in a way that decreased forage in the action area, sea turtles may be less likely to occur in the action area. The nesting range of some sea turtle species may shift northward. Nesting in Virginia and further northward is relatively rare, but a small number of loggerhead nests are laid on Virginia Beach and other ocean facing beaches each year. The maximum number of nests laid in Virginia in a particular year was nine. As of the end of July 2012, seven loggerhead nests have been recorded and one Kemp's ridley nest (at Dam Neck); the first time a Kemp's ridley nest has ever been documented in Virginia and the furthest north this species has ever been documented to nest. It is important to consider that in order for nesting to be successful in the mid-Atlantic, fall and winter temperatures need to be warm enough to support the successful rearing of eggs and sea temperatures must be warm enough for hatchlings to survive when they enter the water. Predicted increases in water temperatures over the next five years are not great enough to allow successful rearing of sea turtle eggs in the action area or the survival of hatchlings that enter the water outside of the summer months. Therefore, it is unlikely that over the time period considered here, that there would be an increase in nesting activity in the action area or that hatchlings would be present in the action area.

6.0 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 Opinion includes the effects of several activities that may affect the survival and recovery of the listed species in the action area.

6.1 Federal Actions that have Undergone 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 action area. Each of those consultations sought to develop ways of reducing the probability of adverse impacts of the action on listed species.

6.1.1 Authorization of Fisheries through Fishery Management Plans

NMFS authorizes the operation of several fisheries in the action area under the authority of the Magnuson-Stevens Fishery Conservation Act and through Fishery Management Plans and their implementing regulations. Commercial and recreational fisheries in the action area employ gear that is known to harass, injure, and/or kill sea turtles and Atlantic sturgeon. In the Northeast Region (Maine through Virginia), formal ESA section 7 consultations have been conducted on the American lobster, Atlantic bluefish, Atlantic mackerel/squid/ butterfish, Atlantic sea scallop, monkfish, northeast multispecies, red crab, spiny dogfish, summer flounder/scup/black sea bass, and tilefish fisheries. These consultations have considered effects to loggerhead, green, Kemp's ridley and leatherback sea turtles. We have completed Biological Opinions on the operations of these fisheries. In each of these Opinions, we concluded that the ongoing action was likely to adversely affect but was not likely to jeopardize the continued existence of any sea turtle species. Each of these Opinions included an incidental take statement (ITS) exempting a certain amount of lethal and/or non-lethal take resulting from interactions with the fishery. These ITSs are summarized in the table below. Further, in each Opinion, we concluded that the potential for interactions (*i.e.*, vessel strikes) between sea turtles and fishing vessels was extremely low and similarly that any effects to sea turtle prey and/or habitat would be insignificant and discountable. We have also determined that the Atlantic herring and surf clam/ocean quahog fisheries do not adversely affect any species of listed sea turtles.

In addition to these consultations, NMFS has conducted a formal consultation on the pelagic longline component of the Atlantic highly migratory species FMP. Portions of this fishery occur within the action area. In a June 1, 2004 Opinion, NMFS concluded that the ongoing action was likely to adversely affect but was not likely to jeopardize the continued existence of loggerhead, Kemp's ridley or green sea turtles but was likely to jeopardize the continued existence of leatherback sea turtles. This Opinion included a Reasonable and Prudent Alternative that when implemented would modify operations of the fishery in a way that would remove jeopardy. This fishery is currently operated in a manner that is consistent with the RPA. The RPA included an ITS which is reflected in the table below. Unless specifically noted, all numbers denote an annual number of captures that may be lethal or non-lethal.

Table 6. Information on Fisheries Opinions conducted by NMFS NERO and SERO for federally managed fisheries that operate in the action area

FMP	**Date of Most Recent**	**Loggerhead**	**Kemp's ridley**	**Green**	**Leatherback**

	Opinion				
American lobster	August 3, 2012	1	0	0	5
Atlantic bluefish	October 29, 2010	82 (34 lethal)	4	5	4
Monkfish	October 29, 2010	173 (70 lethal)	4	5	4
Multispecies	October 29, 2010	46 in trawls (21 lethal)	4	5	4
Skate	October 29, 2010	39 (17 lethal)	4	5	4
Spiny dogfish	October 29, 2010	2	4	5	4
Mackerel/squid/butterfish	October 29, 2010	62 (25 lethal)	2	2	2
Summer flounder/scup/black sea bass	October 29, 2010	205 (85 lethal)	4	5	6
Shark fisheries as managed under the Consolidated HMS FMP	May 20, 2008	679 (349 lethal) every 3 years	2 (1 lethal) every 3 years	2 (1 lethal) every 3 years	74 (47 lethal) every 3 years
Atlantic sea scallop	July 12, 2012	2012: 301 (195 lethal); 2013 and beyond: 301 (115 lethal)	3	2	2
Coastal migratory pelagic	August 13, 2007	33 every 3 years	4 every 3 years	14 every 3 years	2 every 3 years
Pelagic longline under the HMS FMP (per the RPA)	June 1, 2004	1,905 (339 lethal) every 3 years	*105 (18 lethal) every 3 years	*105 (18 lethal) every 3 years	1764 (252 lethal) every 3 years

**combination of 105 (18 lethal) Kemp's ridley, green, hawksbill, or Olive ridley*

We are in the process of reinitiating consultations that consider fisheries actions that may affect Atlantic sturgeon. Sturgeon originating from the four DPSs considered in this consultation are known to be captured and killed in fisheries operated in the action area. At the time of this writing, no Opinions considering effects of federally authorized fisheries on any DPS of Atlantic sturgeon have been completed. As noted in the Status of the Species section above, the NEFSC prepared a bycatch estimate for Atlantic sturgeon captured in sink gillnet and otter trawl fisheries operated from Maine through Virginia. This estimate indicates that, based on data from 2006-2010, annually, an average of 3,118 Atlantic sturgeon are captured in these fisheries with 1,569 in sink gillnet and 1,548 in otter trawls. The mortality rate in sink gillnets is estimated at approximately 20% and the mortality rate in otter trawls is estimated at 5%. Based on this estimate, a total of 391 Atlantic sturgeon are estimated to be killed annually in these fisheries that are prosecuted in the action area. We are currently in the process of determining the effects of this annual loss to each of the DPSs. At this time, there is no bycatch estimate for fisheries that are regulated by NMFS SERO. Any of these fisheries that operate with sink gillnets or otter trawls are likely to interact with Atlantic sturgeon and be an additional source of mortality in the action area. Also, as noted above, NMFS SERO has reinitiated the consultation for shrimp trawling; consultation on the smooth dogfish fishery is also currently being conducted by SERO in coordination with NMFS HMS.

6.1.2 Hopper Dredging

The construction and maintenance of federal navigation channels and sand mining ("borrow") areas have also been identified as sources of sea turtle mortality. Atlantic sturgeon may also be killed during hopper dredging operations, although this is rare. All hopper dredging projects are authorized or carried out by the U.S. Army Corps of Engineers. In the action area, these projects are under the jurisdiction of the districts within the North Atlantic Division. Hopper dredging projects in this area have resulted in the recorded mortality of approximately 87 loggerheads, 4 greens, 9 Kemp's ridleys and 4 unidentified hard shell turtles since observer records began in 1993. Nearly all of these interactions resulted in the death of the turtle. To date, nearly all of these interactions have occurred in nearshore coastal waters with very few interactions in the open ocean. Similarly, few interactions between hopper dredges and Atlantic sturgeon have been observed, with just 3 records documenting interactions between hopper dredges and Atlantic sturgeon in the action area (2 in Virginia near the Chesapeake Bay entrance, and one in New York Bight). We have completed several ESA Section 7 consultations with the Corps to consider effects of these hopper dredging projects on listed sea turtles. Many of these consultations will be reinitiated to consider effects to Atlantic sturgeon. The table below provides information on Biological Opinions considering dredging projects in the action area and the associated ITS for sea turtles (unless otherwise noted, take estimates are per dredge cycle):

Table 7. Information on Consultations conducted by NMFS for dredging projects that occur in the action area

Project	Date of Opinion	Loggerhead	Kemp's ridley	Green	Leatherback	Notes
Long Island NY to Manasquan NJ Beach Nourishment	12/15/1995	5 turtles total: combination of any species				
Sandy Hook Channel Dredging	6/10/1996	2	1	2	1	2 loggerheads/green inclusive; and 1 Kemp's/leatherback
ACOE	11/26/199	4	1	1	0	Annual Estimate

Philadelphia District Dredging	6					
Ambrose Channel, NJ Sand Mining	10/11/2002	2	1	1	1	1 leatherback OR Kemp's
Delaware River Deepening	07/17/2009	20 sea turtles total over the life of the project: no more than 2 Kemp's the remainder loggerhead		0	0	

6.1.3 Nuclear Generating Stations

Salem and Hope Creek – Delaware River

PSEG Nuclear operates two nuclear power plants pursuant to licenses issued by the US Nuclear Regulatory Commission (NRC). These facilities are the Salem and Hope Creek Generating Stations (Salem and HCGS), which are located on adjacent sites within a 740-acre parcel of property at the southern end of Artificial Island in Lower Alloways Creek Township, Salem County, New Jersey. Consultation pursuant to Section 7 of the ESA between NRC and NMFS on the effects of the operation of these facilities has been ongoing since 1979. A Biological Opinion was issued by NMFS in April 1980 in which NMFS concluded that the ongoing operation of the facilities was not likely to jeopardize the continued existence of shortnose sturgeon. Consultation was reinitiated in 1988 due to the documentation of impingement of sea turtles at the Salem facility. An Opinion was issued on January 2, 1991 in which NMFS concluded that the ongoing operation was not likely to jeopardize shortnose sturgeon, Kemp's ridley, green or loggerhead sea turtles. Consultation was reinitiated in 1992 due to the number of sea turtle impingements at the Salem intake exceeding the number exempted in the 1991 Incidental Take Statement. A new Opinion was issued on August 4, 1992. Consultation was again reinitiated in January 1993 when the number of sea turtle impingements exceeded the 1992 ITS with an Opinion issued on May 14, 1993. In 1998 the NRC requested that NMFS modify the Reasonable and Prudent Measures and Terms and Conditions of the ITS, and, specifically, remove a sea turtle study requirement. NMFS responded to this request in a letter dated January 21, 1999. Accompanying this letter was a revised ITS which served to amend the May 14, 1993 Opinion. The 1999 ITS exempts the annual take (capture at intake with injury or mortality) of 5 shortnose sturgeon, 30 loggerhead sea turtles, 5 green sea turtles, and 5 Kemp's ridleys. With the exception of 1991 and 1992, when 23 and 10 sea turtles were captured at the intakes, the actual level of take has been far lower than the exempted level. Inclusive of 1991 and 1992, for the period between 1979 and 1992, a total of 2 green, 23 Kemp's ridley and 60 loggerheads have been captured at the intakes. Since monitoring of the intakes was initiated in 1978, 18 shortnose sturgeon have been recovered from the Salem intakes. No shortnose sturgeon or sea turtles have been observed at the Hope Creek intakes. No sea turtles have been captured at Salem since 2001. Two Atlantic sturgeon, both previously dead, have been observed at the Salem intakes; none have been observed at the Hope Creek intakes. Consultation was reinitiated in 2011; we are currently in the process of preparing an updated Biological Opinion considering effects of ongoing operations on sea turtles and Atlantic sturgeon.

Indian Point – Hudson River

IP1 operated from 1962 through October 1974. IP2 and IP3 have been operational since 1973 and 1975, respectively. Since 1963, shortnose and Atlantic sturgeon in the Hudson River have been exposed to effects of this facility. Eggs and early larvae would be the only life stages of sturgeon small enough to be vulnerable to entrainment at the Indian Point intakes (openings in the wedge wire screens are 6mm x 12.5 mm (0.25 inches by 0.5 inches); eggs are small enough to pass through these openings but are not expected to occur in the immediate vicinity of the Indian Point site.

Studies to evaluate the effects of entrainment at IP2 and IP3 occurred from the early 1970s through 1987; with intense daily sampling during the spring of 1981-1987. As reported by the Nuclear Regulatory Commission (NRC) in its Final Environmental Impact Statement considering the proposed relicensing of IP2 and IP3 (NRC 2011), entrainment monitoring reports list no shortnose or Atlantic sturgeon eggs or larvae at IP2 or IP3. Given what is known about these life stages (i.e., no eggs expected to be present in the action area; larvae only expected to be found in the deep channel area away from the intakes) and the intensity of the past monitoring, it is reasonable to assume that this past monitoring provides an accurate assessment of past entrainment of sturgeon early life stages. Based on this, it is unlikely that any entrainment of sturgeon eggs and larvae occurred historically.

NMFS has no information on any monitoring for impingement that may have occurred at the IP1 intakes. Therefore, we are unable to determine whether any monitoring did occur at the IP1 intakes and whether shortnose or Atlantic sturgeon were recorded as impinged at IP1 intakes. Despite this lack of data, given that the IP1 intake is located between the IP2 and IP3 intakes and operates in a similar manner, it is reasonable to assume that some number of shortnose and Atlantic sturgeon were impinged at the IP1 intakes during the time that IP1 was operational. However, based on the information available to NMFS, we are unable to make a quantitative assessment of the likely number of shortnose and Atlantic sturgeon impinged at IP1 during the period in which it was operational.

The impingement of shortnose and Atlantic sturgeon at IP2 and IP3 has been documented (NRC 2011). Impingement monitoring occurred from 1974-1990, and during this time period, 21 shortnose sturgeon were observed impinged at IP2. For Unit 3, 11 impinged shortnose sturgeon were recorded. At Unit 2, 251 Atlantic sturgeon were observed as impinged during this time period, with an annual range of 0-118 individuals (peak number in 1975); at Unit 3, 266 Atlantic sturgeon were observed as impinged, with an annual range of 0-153 individuals (peak in 1976). No monitoring of the intakes for impingement has occurred since 1990.

While models of the current thermal plume are available, it is not clear whether this model accurately represents past conditions associated with the thermal plume. As no information on past thermal conditions are available and no monitoring was done historically to determine if the thermal plume was affecting shortnose or Atlantic sturgeon or their prey, it is not possible to estimate past effects associated with the discharge of heated effluent from the Indian Point facility. No information is available on any past impacts to shortnose sturgeon prey due to impingement or entrainment or exposure to the thermal plume. This is because no monitoring of sturgeon prey in the action area has occurred.

The Indian Point facility may be relicensed in the future; if so, it could operate until 2033 and 2035. NRC is currently considering Entergy's application for a new operating license. NRC's proposed action was the subject of a section 7 consultation with NMFS that concluded in October 2011. In our Biological Opinion, we considered the effects of the continued operation of the facility from the time a new license is issued (2013 and 2015 for Units 2 and 3 respectively) through the 20 year extended operating period (2033 and 2035) on shortnose sturgeon. We determined that the proposed action was likely to adversely affect, but not likely to jeopardize, the continued existence of shortnose sturgeon. As explained in the "Effects of the Action" section of that Opinion, an average of 5 shortnose sturgeon per year are likely to be impinged at Unit 2 during the extended operating period, with a total of no more than 104 shortnose sturgeon over the 20 year period (dead or alive). Additionally, over the 20 year operating period, an additional 6 shortnose sturgeon (dead or alive) are likely to be impinged at the Unit 1 intakes which will provide service water for the operation of Unit 2. At Unit 3, an average of 3 shortnose sturgeon are likely to be impinged per year during the extended operating period, with a total of no more than 58 shortnose sturgeon (dead or alive) taken as a result of the operation of Unit 3 over the 20 year period. This level of take was exempted through an Incidental Take Statement that applies only to the period when the facility operates under a new operating license (September 28, 2013 through September 28, 2033 for Units 1 and 2; December 12, 2015 through December 12, 2035 for Unit 3). It is likely that the operation of Indian Point continues to cause the impingement, and possible mortality, of some number of individual Atlantic sturgeon in the Hudson River; on May 16, 2012, NRC requested reinitiation of the 2011 consultation to consider Atlantic sturgeon. This consultation is currently ongoing.

Tappan Zee Bridge Replacement

The U.S. Federal Highway Authority (FHWA), the New York Department of Transportation (DOT), the New York State Thruway Authority (NYSTA) are planning to replace the existing Tappan Zee Bridge. A Record of Decision was signed in September 2012 and construction may start as soon as Fall 2012. Construction is expected to take 5 years. We issued a Biological Opinion to FHWA, as the lead Federal agency, in June 2012. This Opinion concluded that the proposed bridge replacement project may adversely affect but was not likely to jeopardize the continued existence of shortnose sturgeon or any DPS of Atlantic sturgeon. The ITS included with the Opinion exempts the lethal take of 2 shortnose sturgeon and 2 Atlantic sturgeon (from the Gulf of Maine, New York Bight or Chesapeake Bay DPS), as well as the capture and injury of shortnose and Atlantic sturgeon from the Gulf of Maine, New York Bight and Chesapeake Bay DPS. Injury and mortality may occur as a result of exposure to underwater noise from pile driving or capture in the dredge bucket. FHWA carried out a pile installation demonstration project in spring 2012 and no injured or dead sturgeon were observed.

6.2 Non-federally regulated fisheries

Like federally authorized fisheries, Atlantic sturgeon and sea turtles may be vulnerable to capture, injury and mortality in fisheries occurring in state waters. The action area includes state waters from Maine to Virginia, with the exception of Vermont and West Virginia. Information on the number of Atlantic sturgeon captured or killed in state fisheries is extremely limited and as such, efforts are currently underway to obtain more information on the numbers of Atlantic sturgeon captured and killed in state water fisheries.

Atlantic sturgeon are taken incidentally to the operation of fisheries targeting other anadromous species along the East Coast. Very little is known about the level of listed species take in fisheries that operate strictly in state waters and at this time we are not able to quantify the number of interactions between Atlantic sturgeon or sea turtles and state authorized commercial or recreational fisheries operating in the action area.

Atlantic croaker fishery

An Atlantic croaker fishery using trawl and gillnet gear also occurs within the action area and turtle takes have been observed in the fishery. The average annual bycatch of loggerhead sea turtles in bottom otter trawl gear used in the Atlantic croaker fishery was estimated to be 70 loggerhead sea turtles (Warden 2011). Additional information on sea turtle interactions with gillnet gear, including gillnet gear used in the Atlantic croaker fishery, has also been recently published by Murray (2009a, 2009b). The average annual bycatch of loggerhead sea turtles in gillnet gear used in the Atlantic croaker fishery, based on VTR data from 2002-2006, was estimated to be 11 per year with a 95% CI of 3-20 (Murray 2009b). A quantitative assessment of the number of Atlantic sturgeon captured in the croaker fishery is not available. Mortality rates of Atlantic sturgeon in commercial trawls has been estimated at 5%. A review of the NEFOP observer database indicates that from 2006-2010, 60 Atlantic sturgeon (out of a total of 726 observed interactions) were captured during observed trips where the trip target was identified as croaker. This represents a minimum number of Atlantic sturgeon captured in the croaker fishery during this time period as it only considers observed trips.

Weakfish fishery

The weakfish fishery occurs in both state and Federal waters but the majority of commercially and recreationally caught weakfish are caught in state waters (ASMFC 2002). The dominant commercial gears include gill nets, pound nets, haul seines, and trawls, with the majority of landings occurring in the fall and winter months (ASMFC 2002). Weakfish landings were dominated by the trawl fishery through the mid-1980s after which gill net landings began to account for most weakfish landed (ASMFC 2002). North Carolina has accounted for the majority of the annual landings since 1972 while Virginia ranks second, followed by New Jersey (ASMFC 2002). As described in section 3.1.1, sea turtle bycatch in the weakfish fishery has occurred (Warden 2011; Murray 2009a, 2009b). The average annual bycatch of loggerhead sea turtles in bottom otter trawl gear used in the weakfish fishery was estimated to be 1 loggerhead sea turtle (Warden 2011). Additional information on sea turtle interactions with gillnet gear, including gillnet gear used in the weakfish fishery, has also been recently published by Murray (2009a, 2009b). The average annual bycatch of loggerhead sea turtles in gillnet gear used in the weakfish fishery, based on VTR data from 2002-2006, was estimated to be one (1) per year with a 95% CI of 0-1 (Murray 2009b). A quantitative assessment of the number of Atlantic sturgeon captured in the weakfish fishery is not available. Mortality rates of Atlantic sturgeon in commercial trawls has been estimated at 5%. A review of the NEFOP observer database indicates that from 2006-2010, 36 Atlantic sturgeon (out of a total of 726 observed interactions) were captured during observed trips where the trip target was identified as weakfish. This represents a minimum number of Atlantic sturgeon captured in the weakfish fishery during this time period as it only considers observed trips.

Whelk fishery

A whelk fishery using pot/trap gear is known to occur in several parts of the action area, including waters off of Maine, Connecticut, Massachusetts, Delaware, Maryland, and Virginia. Landings data for Delaware suggests that the greatest effort in the whelk fishery for waters off of that state occurs in the months of July and October; times when sea turtles are present. Whelk pots, which unlike lobster traps are not fully enclosed, have been suggested as a potential source of entrapment for loggerhead sea turtles that may be enticed to enter the trap to get the bait or whelks caught in the trap (Mansfield *et al.*2001). Leatherback and loggerhead sea turtles as well as right, humpback, and fin whales are known to become entangled in lines associated with trap/pot gear used in several fisheries including lobster, whelk, and crab species (NMFS SEFSC 2001; Dwyer *et al.*2002: NMFS 2007a). Whelk pots are not known to interact with Atlantic sturgeon

Crab fisheries

Various crab fisheries, such as horseshoe crab and blue crab, also occur in Federal and state waters. Atlantic sturgeon are not known to be captured in crab pot gear. The crab fisheries may have detrimental impacts on sea turtles beyond entanglement in the fishing gear itself. Loggerheads are known to prey on crab species, including horseshoe and blue crabs. In a study of the diet of loggerhead sea turtles in Virginia waters from 1983-2002, Seney and Musick (2007) found a shift in the diet of loggerheads in the area from horseshoe and blue crabs to fish, particularly menhaden and Atlantic croaker. The authors suggested that a decline in the crab species have resulted in the shift and loggerheads are likely foraging on fish captured in fishing nets or on discarded fishery bycatch (Seney and Musick 2007). The physiological impacts of this shift are uncertain although it was suggested as a possible explanation for the declines in loggerhead abundance noted by Mansfield (2006). Other studies have detected seasonal declines in loggerhead abundance coincident with seasonal declines of horseshoe and blue crabs in the same area (Maier *et al.*2005). While there is no evidence of a decline in horseshoe crab abundance in the Southeast during the period 1995-2003, declines were evident in some parts of the Mid-Atlantic (ASMFC 2004; Eyler *et al.*2007). Given the variety of loggerheads prey items (Dodd 1988; Burke *et al.*1993; Bjorndal 1997; Morreale and Standora 1998) and the differences in regional abundance of horseshoe crabs and other prey items (ASMFC 2004; Eyler *et al.*2007), a direct correlation between loggerhead sea turtle abundance and horseshoe crab and blue crab availability cannot be made at this time. Nevertheless, the decline in loggerhead abundance in Virginia waters (Mansfield 2006), and possibly Long Island waters (Morreale *et al.*2005), commensurate with noted declines in the abundance of horseshoe crab and other crab species raises concerns that crab fisheries may be impacting the forage base for loggerheads in some areas of their range.

American lobster trap fishery
An American lobster trap fishery also occurs in state waters of New England and the Mid-Atlantic and is managed under the ASMFC's ISFMP. Like the Federal waters component of the fishery, the state waters fishery has also been identified as a source of gear causing injuries to and mortality of loggerhead and leatherback sea turtles as a result of entanglement in vertical buoy lines of the pot/trap gear. Between 2002 and 2008, the lobster trap fishery in state waters was verified as the fishery involved in at least 27 leatherback entanglements in the Northeast Region. All entanglements involved the vertical line of the gear. These verified/confirmed entanglements occurred in Maine, Massachusetts, and Rhode Island state waters from June through October (Northeast Region STDN database). Atlantic sturgeon are not known to interact with lobster trap gear.

Incidental captures of loggerheads in fish traps have also been reported from several Atlantic coast states (Shoop and Ruckdeschel 1989; W. Teas, pers. comm.). Long haul seines and channel nets are also known to incidentally capture loggerheads and other sea turtles in sounds and other inshore waters along the U.S. Atlantic coast, although no lethal takes have been reported (NMFS SEFSC 2001). No information on interactions between Atlantic sturgeon and fish traps, long haul seines or channel nets is currently available; however, depending on where this gear is set and the mesh size, the potential exists for Atlantic sturgeon to be entangled or captured in this gear.

Observations of state recreational fisheries have shown that loggerhead, leatherback, and green sea turtles are known to bite baited hooks, and loggerheads frequently ingest the hooks. Hooked sea turtles have been reported by the public fishing from boats, piers, beaches, banks, and jetties, and from commercial fishermen fishing for snapper, grouper, and sharks with both single rigs and bottom longlines (NMFS SEFSC 2001). A summary of known impacts of hook-and-line captures on loggerhead sea turtles can be found in the TEWG (1998, 2000, 2009) reports. Atlantic sturgeon have been observed captured in hook and line gear; the number of interactions that occur is unknown. While most Atlantic sturgeon are likely to be released alive, we currently have no information on post-release survival.

6.3 Vessel Activity and Military Operations

Potential sources of adverse effects to sea turtles from Federal vessel operations in the action area include operations of the U.S. Navy (USN), U.S. Coast Guard (USCG), Environmental Protection Agency (EPA), Army Corps of Engineers (ACOE), and NOAA to name a few. NMFS has previously conducted formal consultations with the USN, USCG, and NOAA on their vessel-based operations. NMFS has also conducted section 7 consultations with the Minerals Management Service (MMS) (now known as the Bureau of Ocean Energy Management (BOEM)), Federal Energy Regulatory Commission (FERC), and Maritime Administration (MARAD) on vessel traffic related to energy projects in the Northeast Region and has implemented conservation measures. Through the section 7 process, where applicable, NMFS has and will continue to establish conservation measures for all these agency vessel operations to avoid or minimize adverse effects to listed species. We are currently in the process of determining if any of these activities may affect Atlantic sturgeon and if any existing section 7 consultations on these actions need to be reinitiated. To date, ocean going vessels and military activities have not been identified as significant threats to Atlantic sturgeon. However, the possibility exists for interactions between vessels and Atlantic sturgeon in the marine environment. Because of a lack of information on the effects of these activities on Atlantic sturgeon, the discussion below focuses on sea turtles.

Although consultations on individual USN and USCG activities have been completed, only one formal consultation on overall military activities in all of the Atlantic has been completed at this time. In June 2009, NMFS prepared an Opinion on USN activities in each of their four training range complexes along the U.S. Atlantic coast—Northeast, Virginia Capes, Cherry Point, and Jacksonville (NMFS 2009d). In addition, the following Opinions for the USN (NMFS 1996, 1997a, 2008c, 2009e) and USCG (NMFS 1995, 1998c) contain details on the scope of vessel operations for these agencies and the conservation measures that are being implemented as standard operating procedures. In the U.S. Atlantic, the operation of USCG boats and cutters is estimated to take no more than one individual sea turtle, of any species, per year (NMFS 1995).

Similarly, operations of vessels by other Federal agencies within the action area (NOAA, EPA, and ACOE) may adversely affect sea turtles. However, vessel activities of those agencies are often limited in scope, as they operate a limited number of vessels or are engaged in research/ operational activities that are unlikely to contribute a large amount of risk. From 2009 on, NOAA research vessels conducting fisheries surveys for the NEFSC are estimated to take no more than nine sea turtles per year (eight alive, one dead). This includes up to seven loggerheads as well as an additional loggerhead, leatherback, Kemp's ridley, or green sea turtle per year during bottom trawl surveys and one loggerhead, leatherback, Kemp's ridley, or green sea turtle per year during scallop dredge surveys (NMFS 2007c).

6.4 Other Activities

6.4.1 Maritime Industry

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

6.4.2 Pollution

Anthropogenic sources of marine pollution, while difficult to attribute to a specific Federal, state, local, or private action, may affect sea turtles and Atlantic sturgeon in the action area. Sources of pollutants in the action area include atmospheric loading of pollutants such as PCBs; storm water runoff from coastal towns, cities, and villages; runoff into rivers emptying into bays; groundwater discharges; sewage treatment plant effluents; and oil spills. The pathological effects of oil spills on sea turtles have been documented in several laboratory studies (Vargo *et al.*1986).

Nutrient loading from land-based sources, such as coastal communities and agricultural operations, is known to stimulate plankton blooms in closed or semi-closed estuarine systems. The effect to larger embayments is unknown. Contaminants could degrade habitat if pollution and other factors reduce the food available to marine animals.

6.4.3 Coastal development

Beachfront development, lighting, and beach erosion control all are ongoing activities along the Mid- and South Atlantic coastlines of the U.S. These activities potentially reduce or degrade sea turtle nesting habitats or interfere with hatchling movement to sea. Nocturnal human activities along nesting beaches may also discourage sea turtles from nesting sites. The extent to which these activities reduce sea turtle nesting and hatchling production is unknown. However, more and more coastal counties are adopting stringent protective measures to protect hatchling sea turtles from the disorienting effects of beach lighting. Coastal development may also impact Atlantic sturgeon if it disturbs or degrades foraging habitats or otherwise affects the ability of sturgeon to use coastal habitats.

6.5 Reducing Threats to ESA-listed Sea Turtles

Numerous efforts are ongoing to reduce threats to listed sea turtles. Below, we detail efforts that are ongoing within the action area. The majority of these activities are related to regulations that have been implemented to reduce the potential for incidental mortality of sea turtles from commercial fisheries. These include sea turtle release gear requirements for Atlantic HMS; TED requirements for Southeast shrimp trawl fishery and the southern part of the summer flounder trawl fishery; mesh size restrictions in the North Carolina gillnet fishery and Virginia’s gillnet and pound net fisheries; modified leader requirements in the Virginia Chesapeake Bay pound net fishery; area closures in the North Carolina gillnet fishery; and gear modifications in the Atlantic sea scallop dredge fishery. In addition to regulations, outreach programs have been established and data on sea turtle interactions and strandings are collected. The summaries below discuss all of these measures in more detail.

6.5.1 Use of a Chain-Mat Modified Scallop Dredge in the Mid-Atlantic

In response to the observed capture of sea turtles in scallop dredge gear, including serious injuries and sea turtle mortality as a result of capture, NMFS proposed a modification to scallop dredge gear (70 FR 30660, May 27, 2005). The rule was finalized as proposed (71 FR 50361, August 25, 2006) and required federally permitted scallop vessels fishing with dredge gear to modify their gear by adding an arrangement of horizontal and vertical chains (hereafter referred to as a “chain mat”) between the sweep and the cutting bar when fishing in Mid-Atlantic waters south of 41°9’N from the shoreline to the outer boundary of the EEZ during the period of May 1-November 30 each year. The requirement was subsequently modified by emergency rule on November 15, 2006 (71 FR 66466), and by a final rule published on April 8, 2008 (73 FR 18984). On May 5, 2009, NMFS proposed additional minor modifications to the regulations on how chain mats are configured (74 FR 20667). In general, the chain mat gear modification is expected to reduce the severity of some sea turtle interactions with scallop dredge gear. However, this modification is not expected to reduce the overall number of sea turtle interactions with scallop dredge gear.

6.5.2 Sea Turtle Handling and Resuscitation Techniques

NMFS has developed and published as a final rule in the *Federal Register* (66 FR 67495, December 31, 2001) sea turtle handling and resuscitation techniques for sea turtles that are incidentally caught during scientific research or fishing activities. Persons participating in fishing activities or scientific research are required to handle and resuscitate (as necessary) sea turtles as prescribed in the final rule. These measures help to prevent mortality of hard-shelled turtles caught in fishing or scientific research gear.

6.5.3 Sea Turtle Entanglements and Rehabilitation

A final rule (70 FR 42508) published on July 25, 2005, allows any agent or employee of NMFS, the USFWS, the U.S. Coast Guard, or any other Federal land or water management agency, or any agent or employee of a state agency responsible for fish and wildlife, when acting in the course of his or her official duties, to take endangered sea turtles encountered in the marine environment if such taking is necessary to aid a sick, injured, or entangled endangered sea turtle, or dispose of a dead endangered sea turtle, or salvage a dead endangered sea turtle that may be useful for scientific or educational purposes. NMFS already affords the same protection to sea turtles listed as threatened under the ESA (50 CFR 223.206(b)).

6.5.4 Education and Outreach Activities

Education and outreach activities do not directly reduce the threats to ESA-listed sea turtles. However, education and outreach are a means of better informing the public of steps that can be taken to reduce impacts to sea turtles (*i.e.*, reducing light pollution in the vicinity of nesting beaches) and increasing communication between affected user groups (*e.g.*, the fishing community). For the HMS fishery, NMFS has been active in public outreach to educate fishermen regarding sea turtle handling and resuscitation techniques. For example, NMFS has conducted workshops with longline fishermen to discuss bycatch issues including protected species, and to educate them regarding handling and release guidelines. NMFS intends to continue these outreach efforts in an attempt to increase the survival of protected species through education on proper release techniques.

6.5.5 Sea Turtle Stranding and Salvage Network (STSSN)

As is the case with education and outreach, the STSSN does not directly reduce the threats to sea turtles. However, the extensive network of STSSN participants along the Atlantic and Gulf of Mexico coasts not only collects data on dead sea turtles, but also rescues and rehabilitates live stranded turtles. Data collected by the STSSN are used to monitor stranding levels and identify areas where unusual or elevated mortality is occurring. These data are also used to monitor incidence of disease, study toxicology and contaminants, and conduct genetic studies to determine population structure. All of the states that participate in the STSSN tag live turtles when encountered (either via the stranding network through incidental takes or in-water studies). Tagging studies help provide an understanding of sea turtle movements, longevity, and reproductive patterns, all of which contribute to our ability to reach recovery goals for the species.

6.6 Reducing Threats to Atlantic sturgeon

Several conservation actions aimed at reducing threats to Atlantic sturgeon are currently ongoing. In the near future, NMFS will be convening a recovery team and will be drafting a recovery plan which will outline recovery goals and criteria and steps necessary to recover all Atlantic sturgeon DPSs. Numerous research activities are underway, involving NMFS and other Federal, State and academic partners, to obtain more information on the distribution and abundance of Atlantic sturgeon throughout their range, including in the action area. Efforts are also underway to better understand threats faced by the DPSs and ways to minimize these threats, including bycatch and water quality, and to develop population estimates for each DPS. Fishing gear research is underway to design fishing gear that minimizes interactions with Atlantic sturgeon while maximizing retention of targeted fish species. Several states are in the process of preparing ESA Section 10 Habitat Conservation Plans aimed at minimizing the effects of state fisheries on Atlantic sturgeon.

7.0 EFFECTS OF THE ACTION

As discussed in the *Description of the Proposed Action*, the proposed Federal action is the FWS funding of 86 fish surveys carried out by 11 States and DC. FWS provides funds on a five-year cycle. Sea turtles and sturgeon could be affected by the proposed actions in a number of ways. This includes: (1) capture in sampling gear; (2) interactions with the research vessels; (3) effects to prey; and (4) effects to habitat. The analysis will be organized along these topics.

7.1 Studies that have no historic interactions with listed species

Of the 86 activities considered in this consultation, 84 have been ongoing for several years. Of these 84 studies, interactions with NMFS listed species (Atlantic or shortnose sturgeon or sea turtles) have occurred during only 22. Because none of the 62 activities where no interactions have occurred will be modified in a way that increases the risk of future interactions, it is reasonable to anticipate that there will be no more interactions. Therefore, we do not anticipate that any sea turtles or sturgeon will be captured, injured or killed during the activities listed in Table 8. Two of the studies to be carried out by the State of Rhode Island are new (Narragansett Bay Adult Winter Flounder Monitoring and Assessment and Narragansett Bay Ventless Pot, Multi-species Monitoring and Assessment Program).

Shortnose sturgeon and sea turtles do not occur in the area where the Narragansett Bay winter flounder study will occur. Atlantic sturgeon could occasionally be present in these areas, but given the time of year when this survey will take place, the type of gear and the location, it is extremely unlikely that any Atlantic sturgeon will be captured during this study. The Ventless pot study will be carried out with fish pots targeting black sea bass. Shortnose sturgeon do not occur in the area where this study will take place. While sea turtles are occasionally present in

Narragansett Bay, the low number of sea turtles in this area combined with the small amount of sampling gear makes interactions unlikely. Atlantic sturgeon are not known to interact with fish pots. Based on this analysis, we do not anticipate any interactions between RI's Narragansett Bay Ventless Pot survey and NMFS listed species. :

Table 8.

State	Survey	Gear	Historical Time Period	Historical Total Effort	Atlantic Sturgeon	Shortnose Sturgeon	Sea Turtles	Marine Mammals
ME	Striped Bass Acoustic Telemetry Study	Hook and line	2007-2011	N/A	0	0	0	0
NH	Anadromous Alosid Restoration and Evaluation	Fishway trap	1972-2011	N/A	0	0	0	0
NH	Estuarine Survey of Juvenile Finfish	Beach seine (30.5m)	1997-2011	1,530 hauls	0	0	0	0
MA	Fish Community Assessments	Boat electrofishing, Gill net, Beach seine	2003-2011	N/A	0	0	0	0
MA	Essex Dam Fish Passage Facility Evaluation	Fishway trap	1982-2011	N/A	0	0	0	0
MA	Winter Founder Year Class Strength Survey	Beach seine (6m)	1976-2011	1,687 hauls	0	0	0	0
MA	Cooperative Striped Bass Tagging Study	Hook and line	1991-2011	N/A	0	0	0	0
MA	Massachusetts Large Pelagics Research Project	Hook and line	1988-2011	N/A	0	0	0	0
MA	Striped Bass Acoustic Telemetry Study	Hook and line	2008-2011	N/A	0	0	0	0
MA	Monitoring Spawning Behavior and Movement of Atlantic Cod - Hook and line	Hook and line	2009-2011	N/A	0	0	0	0
MA	Monitoring Spawning Behavior and Movement of Atlantic Cod - Long line	Long line	Starting 2012	N/A	0	0	0	0
MA	Population and Spawning Habitat Monitoring for Rainbow Smelt	Fyke net	1988-2011	N/A	0	0	0	0

MA	Monitoring of Biological Parameters and Habitat Characteristics for River Herring and American Shad	Dip net	1984-2011	N/A	0	0	0	0
MA	Restoration of American Shad in the Charles River	Boat electrofishing	2006-2011	N/A	0	0	0	0
MA	River Herring Trap and Transfer	Beach seine	1984-2011	N/A	0	0	0	0
NH	Monitoring of Rainbow Smelt Spawning Activity	Fyke Net	2007-2012	N/A	0	0	0	0
RI	Seasonal Fishery Assessment in Rhode Island and Block Island Sound	Bottom trawl (12.1m)	1977-May 2012	3,015 tows	0	0	0	0
RI	Narragansett Bay Monthly Fish Assessment	Bottom trawl (12.1m)	1990-May 2012	2,896 tows	0	0	0	0
RI	Young-of-the-Year Survey of Selected Rhode Island Coastal Ponds and Embayments	Beach seine	1994-May 2012	1,674 hauls	0	0	0	0
RI	Juvenile Marine Finfish Survey	Beach seine	1988-May 2012	2,070 hauls	0	0	0	0
RI	Abundance and Distribution of Blue Crab	Crab traps	Starting 2012	N/A	0	0	0	0
CT	Estuarine Seine Survey	Beach seine (7.6m)	1988-2011	2,313 hauls (w/o 2011)	0	0	0	0
CT	Inshore Survey	Beach seine (15.2m)	2008-2011	3,076 hauls (w/o 2011)	0	0	0	0
NY	Long Island Sound Trap Survey	Fish traps	2007-2011	N/A	0	0	0	0
NY	Western Long Island Sound Seine Survey	Beach seine (61m, 152m)	1984-2011	4,538 hauls	0	0	0	0

NY	Young-of-the-Year American Eel Survey	Fyke net	2000-2011	700 sets	0	0	0	0
NY	Artificial Reef Monitoring	Fish traps	2007-2009	N/A	0	0	0	0
NY	Alosine Juvenile Abundance Survey	Beach seine (30.5m)	1980-2011	6,072 hauls	0	0	0	0
NJ	Delaware River Juvenile American Shad Outmigration	Haul seine (91m)	1986-2011	N/A	0	0	0	0
NJ	Relative Abundance of Selected Finfish Species in Delaware Bay	Bottom trawl (4.9m)	1991-2011	1,552 tows	0	0	0	0
PA	Estimate of Black Bass Population Density	Boat electrofishing	1982-2011	361 hours	0	0	0	0
PA	Long Term Fish Population Monitoring and Management Technique Evaluations	Boat electrofishing	1995-2011	155 hours	0	0	0	0
DE	Atlantic Menhaden Young of the Year Survey	Mid-water trawl (1.5m)	2002-2011	N/A	0	0	0	0
MD	Tidal Largemouth Bass Survey	Boat electrofishing	1999-2011	N/A	0	0	0	0
MD	Tidal Potomac River Blue Catfish Survey	Boat electrofishing	2008-2011	N/A	0	0	0	0
MD	Coastal Bays Fisheries Investigations Beach Seine Survey	Beach seine (15.2m, 30m)	1972-2011	1,196 hauls	0	0	0	0
MD	Submerged Aquatic Vegetation Beach Seining Program	Beach seine (15.2m)	Starting 2012	N/A	0	0	0	0
MD	Summer Juvenile American and Hickory Shad Seine Survey	Beach seine (61m)	2004-2011	1,683 hauls	0	0	0	0
MD	Spring Adult American and Hickory Shad Electrofishing Survey	Boat electrofishing	2001-2011	586 runs	0	0	0	0
MD	Spring American Shad Gill Net Brood Stock Collection	Gill net	2002-2011	908 sets	0	0	0	0

MD	Spring Hickory Shad Electrofishing Brood Stock Collection	Boat electrofishing	2005-2011	56 days	0	0	0	0
MD	Upper Chesapeake Bay Winter Trawl Survey	Bottom trawl (7.6m)	1999-2011	1,021 tows	0	0	0	0
MD	Fishery Independent Choptank River Fyke Net Survey	Fyke net	1989-2011	5,682 days	0	0	0	0
MD	Juvenile Trawl and Seine Survey	Bottom trawl (4.9m), Beach seine (30.5m)	2005-2011	N/A	0	0	0	0
MD	Juvenile Striped Bass Seine Survey	Beach seine (30.5m)	1957-2011	9,772 hauls	0	0	0	0
MD	Marine and Estuarine Finfish Ecological and Habitat Investigations	Bottom trawl (4.9m), Beach seine (30.5m)	1957-2011	N/A	0	0	0	0
MD	Mycobacteriosis in Striped Bass Resident to Chesapeake Bay	Hook and line, Pound net, Beach seine	2003-2011	N/A	0	0	0	0
DC	Fish Population Surveys - Electrofishing	Boat electrofishing	1990-2011	605 hours	0	0	0	0
DC	Fish Population Surveys - Seining	Beach seine (30.5m)	1990-2011	1,181 hauls	0	0	0	0
DC	Fish Tagging Surveys	Boat electrofishing	1999-2011	62 hours	0	0	0	0
DC	Push Net Survey	Push net	2005-2011	480 pushes	0	0	0	0
DC	American Eel Studies	Backpack electrofishing and fish pots	2008-2011	N/A	0	0	0	0
DC	Fish Passage on Rock Creek	Backpack and boat electrofishing	2006-2011	30 hours	0	0	0	0
DC	American Shad Stock Enhancement	Gill net	2006-2011	51 hours	0	0	0	0

VA	Tidal River Fish Community Monitoring	Boat electrofishing	1990-2011	125 hours	0	0	0	0
VA	Tidal River Fish Catfish Surveys	Boat electrofishing	1993-2011	499 hours	0	0	0	0
VA	American Shad Restoration - Gill Netting	Gill net	1994-2011	8,840 sets	0	0	0	0
VA	American Shad Restoration - Electrofishing	Boat electrofishing	1994-2011	311 hours	0	0	0	0
VA	Northern Snakehead Monitoring in Virginia	Boat electrofishing	2004-2011	N/A	0	0	0	0
VA	American Shad Monitoring Program - Fyke Netting	Fyke net	Started 2011	N/A	0	0	0	0
VA	Juvenile Striped Bass Beach Seine Survey	Beach seine (30.5m)	1967-2011	8,908 hauls	0	0	0	0

7.2 Studies that have had past interactions

Interactions with listed species have occurred in 22 of the activities considered here. As explained above, these are the only activities in which we anticipate future interactions. These activities are:

State	Survey	Location	Gear	Historical Time Period	Historical Total Effort	Atlantic Sturgeon	Shortnose Sturgeon	Sea Turtles
ME	Juvenile Striped Bass and Alosine Beach Seine Survey	Kennebec, Androscoggin and Penobscot estuaries	Beach seine (17m)	1979-2011	2,972 hauls	0	3	0
ME	Maine-New Hampshire Inshore Trawl Survey	Coastal Maine and New Hampshire	Bottom trawl (17.3m)	2000-2011	2,152 tows	21	0	0
MA	Westfield River Fish Passage Facility Evaluation	Westfield River	Fishway trap	1997-2011	N/A	0	1	0
MA	Fishery Resource Assessment	Coastal Massachusetts	Bottom trawl (11.8m)	1978-2011	6,255 tows	1	0	0
CT	Long Island Sound Trawl	Long Island Sound	Bottom trawl	1984-2011	5,994 tows	431	0	1

	Survey		(9.1m)					
NY	New York Small Mesh Survey	Peconic Bay	Bottom trawl (4.9m)	1987-2011	9,337 tows	0	0	2
NY	Spawning Stock Survey of American Shad, River Herring and Striped Bass	Hudson River	Haul seine (152m, 305m)	1983-2011	1,715 hauls	0	3	0
NY	Striped Bass Electrofishing	Hudson River	Boat electrofishing	1989-2011	N/A	0	33	0
NY	Striped Bass Juvenile Abundance Survey	Hudson River	Beach seine (71m)	1979-2011	4,687 hauls	2	1	0
NY	American Shad Spawning Habitat Studies	Hudson River	Gill net	2009-2011	94 sets	1	0	0
NJ	New Jersey Ocean Trawl Survey	Coastal New Jersey	Bottom trawl (25m)	1988-2011	4,361 tows	322	0	10
NJ	Cooperative Striped Bass Tagging in Delaware Bay	Delaware Bay	Gill net	1989-2011	3,290 sets	55	0	0
NJ	Delaware River Juvenile Striped Bass Seine Survey	Delaware River	Beach seine (30.5m)	1980-2011	6,278 hauls	0	1	0
DE	Delaware River Striped Bass Spawning Stock Assessment	Delaware River	Boat electrofishing	1991-2011	350 hours	0	1	0
DE	Bottom Trawl Sampling of Adult Groundfish in Delaware Bay	Coastal waters of Delaware	Bottom trawl (9.3m)	1966-2011	2,525 tows	41	3	15
DE	Bottom Trawl Sampling of Juvenile Fishes in Delaware's Estuaries	Delaware estuaries	Bottom trawl (4.9m)	1980-2011	10,358 tows	7	4	3
MD	Coastal Bays Fisheries Investigations Trawl Survey	Coastal bays of Maryland	Bottom trawl (4.9m)	1972-2011	3,945 tows	0	0	1

MD	Submerged Aquatic Vegetation Beach Seining Program	Coastal bays of Maryland	Beach seine (15.2m)	Starting 2012	N/A	0	0	0
VA	American Shad Monitoring Program - Gill Netting	York, James and Rappahannock rivers	Gill net	1998-2011	23,760 hours	229	0	0
VA	Juvenile Fish Trawl Survey	Chesapeake Bay	Bottom trawl (9.1m)	1955-2011	40,575 tows	48	0	2
VA	Chesapeake Bay Multispecies Monitoring and Assessment Program	Chesapeake Bay	Bottom trawl (13.7m)	2002-2011	3,669 tows	4	0	1
VA	Striped Bass Spawning Stock Assessment - Gill Netting	James and Rappahannock rivers	Gill net	1991-2011	N/A	3	0	0

These activities fall into several broad categories: beach seines, bottom trawls, fish passage facilities (fishway trap), haul seine, boat electrofishing, and gill net. The analysis below is organized by gear type.

7.3 Beach and Haul Seine

Capture of sturgeon in beach and haul seines is rare. We are aware of many nearshore seine studies that occur annually in rivers and coastal waters where sturgeon are present with very few observations of sturgeon recorded. Three beach seine studies carried out with grant funds have captured shortnose and/or Atlantic sturgeon. Additionally, New York's haul seine study targeting juvenile American shad, river herring, and striped bass has encountered shortnose sturgeon. While this study uses seines that are set by boat, they are hauled in by hand on the beach, making it similar to the other beach seine studies considered here.

Maine DMR's study targeting alosines and striped bass in the Kennebec, Androscoggin and Penobscot estuaries has been ongoing since 1979. Over 2,792 beach seine hauls have been conducted and only three shortnose sturgeon have been captured. There have been no interactions with Atlantic sturgeon or sea turtles.

The Delaware River juvenile striped bass beach seine survey has been ongoing since 1980. Over 6,278 beach seine hauls have been conducted with the capture of one shortnose sturgeon. Similarly, the Hudson River striped bass beach seine survey has been ongoing since 1979. NY has completed 4,687 hauls and captured just one shortnose sturgeon and two Atlantic sturgeon.

The type of habitat where beach seining occurs somewhat overlaps with preferred sturgeon habitat; however, shortnose and Atlantic sturgeon are a benthic species typically found in deeper river channels near the bottom. Shortnose and Atlantic sturgeon also 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, there is a low likelihood of an encounter with a sturgeon. This is consistent with the low number of encounters that have occurred in the Maine, Delaware and New York studies noted above. In the future, we anticipate that no more than three shortnose will be captured in Maine DMR beach seine surveys during any five-year grant period. We also expect that no more than one shortnose sturgeon will be captured in the New Jersey Delaware River juvenile striped bass beach seine survey every five years and that no more than two Atlantic sturgeon and four shortnose sturgeon will be captured every five years in beach and haul seine studies carried out by New York. This is consistent with past capture rates.

The New York beach seine survey occurs in the Hudson River. Mixed stock analysis for the Hudson River indicates that the majority of Atlantic sturgeon in the river are likely to originate from the New York Bight DPS (92%), with 6% originating from the Gulf of Maine DPS and 2% from the Chesapeake Bay DPS. These percentages are based on genetic sampling of individuals (n=39) captured within the Hudson River and therefore, represent the best available information on the likely genetic makeup of individuals occurring in that area. Based on this, we anticipate that the two Atlantic sturgeon captured in the New York seine surveys are most likely to originate from the New York Bight DPS. However, it is possible that they may be from the Gulf of Maine or Chesapeake Bay DPS.

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 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.

Beach seine net sampling involves sets of up to 15 minutes. This will cause 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, we expect the level of stress to be low enough to result in no long term physiological effects, behavioral change or changes to normal migratory behaviors.

In summary, we anticipate the following captures of sturgeon and sea turtles in beach and haul seine surveys during a 5-year grant period:

Survey	No. of Shortnose Sturgeon	No. of Atlantic sturgeon
Maine beach seine	3	0
Delaware beach seine	1	0
New York beach and haul	4	1 NYB DPS; and 1 GOM or CB DPS

7.4 Bottom Trawl

The potential for capture of sea turtles and Atlantic sturgeon in bottom otter trawl gear is well established (see for example, Lutcavage *et al.*1997, Henwood and Stuntz 1987, NRC 1990, ASSRT 2007). Here, we establish the expected number of sea turtles and sturgeon that will be captured in the various trawl surveys.

Background Information on Sea Turtle interaction with trawl gear

Sea turtles forcibly submerged in any type of restrictive gear can eventually suffer fatal consequences from prolonged anoxia and/or seawater infiltration of the lung (Lutcavage *et al.*1997). A study examining the relationship between tow time and sea turtle mortality in the shrimp trawl fishery showed that mortality was strongly dependent on trawling duration, with the proportion of dead or comatose sea turtles rising from 0% for the first 50 minutes of capture to 70% after 90 minutes of capture (Henwood and Stuntz 1987). However, metabolic changes that can impair a sea turtle's ability to function can occur within minutes of a forced submergence. While most voluntary dives appear to be aerobic, showing little if any increases in blood lactate and only minor changes in acid-base status, the story is quite different in forcibly submerged sea turtles, where oxygen stores are rapidly consumed, anaerobic glycolysis is activated, and acid-base balance is disturbed, sometimes to lethal levels (Lutcavage and Lutz 1997). Forced submergence of Kemp's ridley sea turtles in shrimp trawls resulted in an acid-base imbalance after just a few minutes (times that were within the normal dive times for the species) (Stabenau *et al.*1991). Conversely, recovery times for acid-base levels to return to normal may be prolonged. Henwood and Stuntz (1987) found that it took as long as 20 hours for the acid-base levels of loggerhead sea turtles to return to normal after capture in shrimp trawls for less than 30 minutes. This effect is expected to be worse for sea turtles that are recaptured before metabolic levels have returned to normal.

Following the recommendations of the NRC to reexamine the association between tow times and sea turtle deaths, the data set used by Henwood and Stuntz (1987) was updated and re-analyzed (Epperly *et al.*2002; Sasso and Epperly 2006). Seasonal differences in the likelihood of mortality for sea turtles caught in trawl gear were apparent. For example, the observed mortality exceeded 1% after 10 minutes of towing in the winter (defined in Sasso and Epperly (2006) as the months of December-February), while the observed mortality did not exceed 1% until after 50 minutes in the summer (defined as March-November; Sasso and Epperly 2006). In general, tows of short duration (<10 minutes) in either season have little effect on the likelihood of mortality for sea turtles caught in the trawl gear and would likely achieve a negligible mortality rate (defined by the NRC as <1%). Intermediate tow times (10-200 minutes in summer and 10-150 minutes in winter) result in a rapid escalation of mortality, and eventually reach a plateau of high mortality, but will not equal 100%, as a sea turtle caught within the last hour of a long tow will likely survive (Epperly *et al.*2002; Sasso and Epperly 2006). However, in both seasons, a rapid escalation in the mortality rate did not occur until after 50 minutes (Sasso and Epperly 2006) as had been found by Henwood and Stuntz (1987). Although the data used in the reanalysis were specific to bottom otter trawl gear in the U.S. south Atlantic and Gulf of Mexico shrimp fisheries, the authors considered the findings to be applicable to the impacts of forced submergence in general (Sasso and Epperly 2006).

Sea turtle behaviors may influence the likelihood of them being captured in bottom trawl gear. Video footage recorded by the NMFS, Southeast Fisheries Science Center (SEFSC), Pascagoula Laboratory indicated that sea turtles will keep swimming in front of an advancing shrimp trawl, rather than deviating to the side, until they become fatigued and are caught by the trawl or the trawl is hauled up (NMFS 2002a). Sea turtles have also been observed to dive to the bottom and hunker down when alarmed by loud noise or gear (Memo to the File, L. Lankshear, December 4, 2007), which could place them in the path of bottom gear such as a bottom otter trawl. With respect to oceanographic features, a review of the data associated with the 11 sea turtles captured by the scallop dredge fishery in 2001 concluded that the sea turtles appeared to have been near the shelf/slope front (D. Mountain, pers. comm.).

There are very few reports of sea turtles dying during research trawls. Based on the analysis by Sasso and Epperly (2006) and Epperly *et al.*(2002) as well as information on captured sea turtles from past state trawl surveys, the NEAMAP and NEFSC trawl surveys, as well as the NEFSC FSB observer program, tow times less than 30 minutes will likely eliminate the risk of death from forced submergence for sea turtles caught in the bottom otter trawl survey gear.

During spring and fall bottom otter trawl surveys conducted by the NEFSC from 1963-2009, a total of 71 loggerhead sea turtles were observed captured. Only one of the 71 loggerheads suffered injuries (cracks to the carapace) causing death (Wendy Teas, SEFSC, pers. comm. to Linda Despres, NEFSC, 2007). All others were alive and returned to the water unharmed. The one leatherback sea turtle captured in the NEFSC trawl survey was released alive and uninjured. NEFSC trawl survey tows are approximately 30 minutes in duration. All sea turtles captured in the NEAMAP surveys as well as the other trawl surveys considered in this Opinion have also been released alive and uninjured.

Background Information on Atlantic Sturgeon and Trawl gear

Atlantic sturgeon captured in trawl gear as bycatch of commercial fishing operations have a mortality rate of approximately 5% (based on information in the NEFOP database). Short tow duration and careful handling of any sturgeon once on deck is likely to result in a very low potential for mortality. None of the hundreds of Atlantic sturgeon captured in past state ocean trawl surveys have had any evidence of injury and there have been no recorded mortalities. The NEFSC surveys have recorded the capture of 110 Atlantic sturgeon since 1972; the NEAMAP survey has captured 102 Atlantic sturgeon since 2007. To date, there have been no recorded injuries or mortalities. In the Hudson River, a trawl survey that incidentally captures shortnose and Atlantic sturgeon has been ongoing since the late 1970s. To date, no injuries or mortalities of any sturgeon have been recorded.

7.4.1 Coastal Maine and New Hampshire Bottom Trawl Survey

The Maine-New Hampshire Inshore Trawl Survey is a stratified random survey with a fixed component. The inshore area sampled includes four depth strata: 5-20 fathoms, 21-35 fathoms, 36-55 fathoms, and >56 fathoms out to approximately the 12-mile limit, and five longitudinal regions based on oceanographic, geologic, and biological features. Together, 20 separate strata exist. A target of 115 stations is selected for sampling in each survey resulting in a sampling density of 1 station for every 40 NM^2.

As illustrated in the table below, a total of 21 Atlantic sturgeon have been captured and released alive in 21 tows out of a total of 2,152 total tows made by this survey from 2000 to 2011.

Year	# of tows	# of tows with Atlantic Sturgeon	Month Caught
2000	78	1	Oct
2001	186	1	Sep
2002	175	3	1-May; 2-Oct
2003	179	2	May
2004	190	1	Oct
2005	158	1	May
2006	194	2	1-May; 1-Oct
2007	195	2	May
2008	191	2	2-Sep
2009	204	3	1-May; 2-Oct
2010	202	1	1-Oct
2011	200	2	1-May; 1-Oct
Total	**2,152**	**21**	

Table 9. Capture of Atlantic sturgeon in the ME/NH Bottom Trawl Survey

Atlantic sturgeon have been caught in approximately 1% of the tows since the survey began. The annual catch rate has been low, ranging from 1-3, with no more than two sturgeon caught per month. There has been an average of two Atlantic sturgeon captured per year. Based on this long term average, we would expect no more than 10 Atlantic sturgeon to be captured in any five year grant period. Based on the mixed stock analysis (using results from the NEFOP database because we do not have site-specific analysis), we expect that: 49% of the captured Atlantic sturgeon will originate from the NYB DPS (5 individuals), 20% from the SA DPS (2 individuals), 14% from the CB DPS (1 individual), 11% from the GOM DPS (1 individual) and 4% from Carolina DPS (1 individual). Given the short duration of the tows (less than 30 minutes), we do not anticipate the mortality of any Atlantic sturgeon captured in this trawl survey.

7.4.2 Massachusetts Coastal Bottom Trawl Survey

The objective of this survey is to collect, analyze, and summarize bottom trawl data for fishery management purposes. This survey occurs statewide in coastal/ territorial waters and is conducted in 3-week time spans during the months of May and September. The survey utilizes a stratified random sampling design consisting of 23 sampling strata based on six depth zones (< 30', 31-60', 61-90', 91-120', 120-180', and > 180') and five geographic regions (Massachusetts Bay north to the Merrimack River, Cape Cod Bay, waters south and east of Cape Cod and Nantucket, Nantucket Sound, and Vineyard Sound/ Buzzards Bay). At each station, the standard tow is 20 minutes at an average speed of 2.5 kts with a 3:1 scope. Vessel services are provided by the Northeast Fisheries Science Center, NOAA R/V GLORIA MICHELLE (65' LOA, 355 hp); this vessel has been chartered since 1982.

The catch from each tow is manually sorted, and weights, numbers, and length-frequencies are recorded by species. Large catches, which are impractical to completely process are subsampled by weight or volume and expanded to represent the entire sample. Routine collections and observations include scale/otolith samples, sex, and maturity stage. Bottom water temperatures are recorded at each station.

The bottom trawl survey has been conducted for 33 consecutive years. During that time, sixty-two cruises have been undertaken which have completed over 5,200 stations representing over 1,700 hours of bottom trawling time. To date, one Atlantic sturgeon has been captured and was released alive. This individual was captured in Cape Cod Bay in May 1986. No shortnose sturgeon, sea turtles or marine mammals have been encountered.

Because future surveys will follow identical protocols to the past and operate in the same areas, it is reasonable to anticipate similar catch levels as in the past. Based on this, we expect that no more than one Atlantic sturgeon will be captured during the spring or fall MDMF survey each year for a total of five over the five-year grant period. Based on the mixed stock analysis (using results from the NEFOP database because we do not have site-specific analysis), we expect that: 49% of the captured Atlantic sturgeon will originate from the NYB DPS, 20% from the SA DPS, 14% from the CB DPS, 11% from the GOM DPS and 4% from Carolina DPS. Therefore, we expect the capture of 3 individuals from the NYB DPS, 1 from the SA DPS and 1 from either the GOM, CB or Carolina DPS.

The short duration of the tow and careful handling of any sturgeon once on deck is likely to result in a low potential for mortality. None of the Atlantic sturgeon captured in similar surveys (see 6.4.1) have had any evidence of injury and there have been no recorded mortalities. Based on this information, we expect that all Atlantic sturgeon captured in future MDMF surveys will be alive and will be released uninjured.

7.4.3 Connecticut's Long Island Sound Trawl survey

7.4.3.1 Capture in trawl gear – sea turtles

The potential for capture of sea turtles in bottom otter trawl gear is well established (see for example, Lutcavage *et al*. 1997, Henwood and Stuntz 1987, NRC 1990). Here, we establish the expected number of sea turtles that will be captured in the LISTS. The survey takes place in April, May, June, September and October.

To date, only one sea turtle has been captured in the LIST survey since it began in 1984. One loggerhead sea turtle was observed in the Hempstead Harbor (NY) area of western Long Island Sound on September 12, 1989. CT reports that this capture occurred during a major hypoxia event. The dissolved oxygen level at that site was 0.3 mg/l and little else was observed in that sample (a few crabs and lobster and less than 20 fish). The turtle was a fairly small individual (estimated at approximately 40 pounds) and was released in good condition.

Because sea turtles are known to occur in Long Island Sound and are known to be vulnerable to capture in otter trawl gear, we expect that future surveys will capture sea turtles. Based on the capture of only one sea turtle during the LIST survey to date, we expect that no more than one sea turtle will be captured each year that the survey occurs. Thus, we expect up to five sea turtles to be captured in any five-year grant period. While the one capture was of a loggerhead, we know that Kemp's ridley, green and leatherback sea turtles occur in the action area and are vulnerable to capture in trawl gear. Because these species have been captured in trawl gear operating in nearby areas in similar surveys (*i.e.*, the NEAMAP surveys carried out by VIMS), we anticipate that future CT surveys could capture leatherback, Kemp's ridley or green sea turtles. Because of this, we expect that the one turtle captured annually is most likely to be a loggerhead, but could also be leatherback, Kemp's ridley or green sea turtle. Over a five-year grant period, we expect the capture or no more than five sea turtles, with one likely to be a Kemp's ridley, leatherback or green sea turtle and the remainder likely to be loggerheads. Based on past results and the short duration of the tows, we do not anticipate that any of the sea turtles captured during the CT surveys will be injured or killed.

7.4.3.2 Capture in trawl gear – Atlantic sturgeon

Since 1984, the CT DEEP has conducted 5,994 tows in Long Island Sound for the LIST survey. A total of 431 Atlantic sturgeon have been captured in 144 LIS Trawl Survey tows since May 1994, yielding an overall encounter rate of 2.4% of LIST tows. There have been no known mortalities of sturgeon encountered in the history of the survey.

The fall period (September-October) accounted for 64.3% of sturgeon captured during 2,110 tows. Spring sampling (April-June) accounted for 27.2% of the expanded sturgeon catch in 3,043 tows. The summer and winter sampling no longer occurs. The frequency of LISTS tows that encounter Atlantic sturgeon (percent of positive tows) is similar in the spring and fall periods, varying from 0.0%-6.3% in the spring and from 0.0% to 7.5% in the fall. Sturgeon ranged from 54 to 213 cm FL. Up to 47 Atlantic sturgeon have been captured in a single tow with no injuries observed.

Because CT has recorded all captures of Atlantic sturgeon, we have information that allows us to predict future interactions. The maximum number of captures in a given year is 60 (range of 1-60, mean of 15.6 captures per year).

Table 10. Standardized Captures of Atlantic Sturgeon in CT LIST survey 1984-2011

Year	**Spring (April – June)**	**Summer (July – August)**	**Fall (September – October)**	**Winter (November)**	**Annual Total**
1984	3	5	3	0	11
1985	0	1	1	1	3
1986	0	0	4	2	6
1987	1	2	3	0	6
1988	2	4	0	1	7
1989	1	2	2	8	13
1990	1	0	3	5	9
1991	2	-	1	-	3
1992	8	-	22	-	30
1993	3	-	57	-	58
1994	7	-	53	-	60
1995	3	-	3	-	6
1996	2	-	1	-	3
1997	2	-	3	-	5
1998	14	-	3	-	17
1999	27	--	12	-	39
2000	4	-	3	-	7
2001	3	-	15	-	18
2002	10	-	8	-	18
2003	0	-	23	6	29
2004	0	-	8	-	8
2005	6	-	3	-	9
2006	8	--	13	-	21
2007	5	-	13	-	18
2008	2	-	5	-	7
2009	1	-	17	-	18
2010	1	-	-	-	1
2011	3	-	2	-	3

Total	**322**	**14**	**281**	**23**	**437**

An average of 40 samples have been taken on each of 157 monthly cruises since May 1984. The mathematical average is about three Atlantic sturgeon per survey or about 0.07 sturgeon per sample; for the spring period the average is 4.25 sturgeon/year and during the fall it is 10.4 sturgeon/year.

In a five-year grant period, there will be 25 surveys (April, May, June, September and October in each of five years) with approximately 1,000 samples. Using the average capture rate per sample (1,000 samples x 0.07 sturgeon/sample) we anticipate the capture of 70 Atlantic sturgeon during this time. Using the average capture rate per monthly survey (25 surveys x three sturgeon), we would anticipate the capture of 75 Atlantic sturgeon. Using the average capture per season we anticipate 74 captures. However, it is important to consider that in some years the number of captures has been very high (60 individuals). The greatest number of Atlantic sturgeon captured in any five-year period was 160 individuals (1990-1994). Because these surveys will follow identical protocols to the past and operate in the same areas, it is reasonable to anticipate similar catch levels in future years. Based on this, we anticipate that no more than 160 Atlantic sturgeon will be captured during any five-year grant period.

Based on the mixed stock analysis available for Long Island Sound, we expect that 79% of the captured Atlantic sturgeon will originate from the NYB DPS (126 individuals), 10% from the SA DPS (16 individuals), 7% from the CB DPS (11 individuals), 4% from the GOM DPS (6 individuals), and 0.5% from the Carolina DPS (1 individual).

The short duration of the tow and careful handling of any sturgeon once on deck is likely to result in a low potential for mortality. None of the 437 Atlantic sturgeon captured in past CT LIST surveys have had any evidence of injury and there have been no recorded mortalities. The NEFSC surveys have recorded the capture of 110 Atlantic sturgeon since 1972; the NEAMAP survey has captured 102 Atlantic sturgeon since 2007. To date, there have been no recorded injuries or mortalities. In the Hudson River, a trawl survey that incidentally captures shortnose and Atlantic sturgeon has been ongoing since the late 1970s. To date, no injuries or mortalities of any sturgeon have been recorded. Similarly, no injuries or mortalities of Atlantic sturgeon captured in the NJ ocean trawl surveys have been recorded. Based on this information, we expect that all Atlantic sturgeon captured in the CT LIST surveys will be alive and will be released uninjured.

7.4.4 New York Peconic Bay Small Mesh Survey

The New York Small Mesh Trawl Survey is used for long-term monitoring and assessment of annual recruitment of important marine finfish species in New York waters. A semi-balloon shrimp trawl is towed for 10 minutes. Since the inception of this project in 1987 a total of 9,337 sample tows have been completed in the Peconic Bay study area with two sea turtles captured (see Figure 3 below for capture locations). Both turtles were released from the net alive and uninjured. There have been no interactions with shortnose or Atlantic sturgeon during this survey.

Figure 3. Sampling grid and turtle catch data for the New York State Small Mesh Trawl Survey.

Based on past captures, we anticipate the capture of no more than two sea turtles during any five-year grant period. We expect that these individuals would be loggerheads, Kemp's ridley or green sea turtles. Given the short tow times, we do not anticipate any mortalities.

7.4.5 New Jersey Ocean Trawl Survey

7.4.5.1 Capture in trawl gear – sea turtles

Here, we establish the expected number of sea turtles that will be captured in the NJ ocean trawl surveys. As noted above, these surveys take place in January, April, June, August and October.

The table below provides information on all sea turtles captured in past NJ trawl surveys conducted since the program began in 1989 (n=10, 9 loggerheads, 1 leatherback).

Table 11. Captures of Sea Turtles in NJ Ocean Trawl Survey 1989-2012

Year	Month	Species	Weight (kg)	Alive	Injured
1991	August	*loggerhead*	80	YES	NO
1993	June	*loggerhead*	19.87	YES	NO
1993	June	*loggerhead*	28.32	YES	NO
2002	October	*loggerhead*	30	YES	NO
2005	June	*loggerhead*	NA	YES	NO
2005	August	*leatherback*	227.27	YES	NO

2005	August	*loggerhead*	160	YES	NO
2007	October	*loggerhead*	19.78	YES	NO
2009	August	*loggerhead*	117.22	YES	NO
2011	June	*loggerhead*	41.93	YES	NO
2012	October	*Kemp's ridley*	3.71	YES	NO

This study has been ongoing for 24 years; the mathematical average capture of sea turtles per year is 0.46 turtles/year. The number of sea turtles captured is highly variable from year to year, with most years having zero captures; however in 2005, three turtles were captured. The capture of sea turtles has become more frequent since 2002, as compared to the 1980s or 1990s. Applying the annual average over the complete time series, we would expect two sea turtles to be captured during any five-year grant period. However, the capture rate is higher in more recent years. The capture of three sea turtles in 2005 suggests that future interaction rates could be as high as 3 sea turtles per year. The maximum number of sea turtles captured in any particular survey has been two (August 2005), with no more than one sea turtle captured in all other surveys. No sea turtles have been captured in the January or April surveys which is consistent with our knowledge of the seasonal distribution of sea turtles in the action area. Based on our analysis of the existing capture data, we expect that an average of one sea turtle will be captured during each survey in June, August, and October, with no captures anticipated in January or April. Therefore, in any five year grant period, we anticipate the capture of no more than 15 sea turtles.

With the exception of one capture of a leatherback in 2005, all other captures of sea turtles in the ocean trawl survey have been loggerheads. However, we know that Kemp's ridley and green sea turtles occur in the action area and are vulnerable to capture in trawl gear. Because these species have been captured in trawl gear operating in nearby areas in similar surveys (*i.e.*, the NEAMAP surveys carried out by VIMS), we anticipate that future NJ surveys could capture Kemp's ridley or green sea turtles. Based on past interactions, we anticipate that the majority of the 15 captured sea turtles will be loggerheads, with no more than 5 leatherback, Kemp's ridley or green sea turtles.

Tows for the NJ marine trawl surveys will be 20 minutes in duration. Based on the analysis by Sasso and Epperly (2006) and Epperly *et al.*(2002) discussed in Section 6.4.1 above, as well as information on captured sea turtles from past NJ trawl surveys, the NEAMAP and NEFSC trawl surveys, as well as the NEFSC FSB observer program, a 20-minute tow time for the bottom otter trawl gear to be used in the survey will likely eliminate the risk of death from forced submergence for sea turtles caught in the bottom otter trawl survey gear. We do not anticipate any mortalities of captured sea turtles.

7.4.5.2 Capture in trawl gear – Atlantic sturgeon

NJ has recorded all sturgeon interactions since 1988. This information allows us to predict future interactions. To date, a total of 322 Atlantic sturgeon captures have been recorded, with an average encounter rate of 3.4% (*i.e.*, the percent of trawl samples that captured an Atlantic sturgeon) with a maximum of 35 captures in a given year (range of 0-35, mean of 13.4 captures per year).

Table 12. Captures of Atlantic Sturgeon in NJ Ocean Trawl 1988-2011

Year	**No. Sturgeon Caught**	**Total Samples**	**Samples with Sturgeon**
1988	2	68	2
1989	33	193	13
1990	15	171	10
1991	25	189	7
1992	27	191	8
1993	10	187	3
1994	0	186	0
1995	6	188	3
1996	3	189	3
1997	12	187	3
1998	1	188	1
1999	11	186	6
2000	1	186	1
2001	4	186	3
2002	5	188	5
2003	16	188	10
2004	23	187	8
2005	18	186	10
2006	35	186	10
2007	24	187	12
2008	26	186	12
2009	12	186	7
2010	10	186	9
2011	3	186	3
2012	3	186	3
Total	**325**	**4,547**	**152**

Because these surveys will follow identical protocols to the past and operate in the same areas, it is reasonable to anticipate similar catch levels in these years. Surveys take place five times per year. The mathematical average is 13 Atlantic sturgeon per year or about 0.07 sturgeon per sample. We have considered whether this average has changed over time. From 1989-1999, 143 Atlantic sturgeon were caught in 2,055 samples, with an average of 0.07 Atlantic sturgeon per sample. From 2000-2012, 182 Atlantic sturgeon were captured in 2,424 samples, with an average of 0.075 Atlantic sturgeon per sample. While the number of captures is highly variable from year to year, the average per sample is consistent over time. Therefore, it is reasonable to consider that surveys carried out in a future five-year period will result in the same average capture of Atlantic sturgeon. During a five-year grant period, there will be twenty five surveys with approximately 930 samples. Using the average capture rate per sample (0.07), we anticipate the capture of 65 Atlantic sturgeon during this time. Using the average capture rate per year (13), we would also anticipate the capture of 65 Atlantic sturgeon. The highest average of sturgeon captures for any consecutive five-year period is 25 captures/year during 2004-2008. Using this rate, we would anticipate a total of 125 captures during a five year grant period. Because the capture rate has a high level of interannual variability, it is reasonable to use the highest five year average to predict future interaactions. Therefore, we anticipate that no more than 125 Atlantic sturgeon will be captured during a five year grant period.

Based on the mixed stock analysis (using results from the NEFOP database because we do not have site-specific analysis), we expect that 49% of the captured Atlantic sturgeon will originate from the NYB DPS (62 individuals), 20% from the SA DPS (25 individuals), 14% from the CB DPS (19 individuals), 11% from the GOM DPS (14 individuals) and 4% from Carolina DPS (5 individuals).

The short duration of the tow and careful handling of any sturgeon once on deck is likely to result in a low potential for mortality. None of the 325 Atlantic sturgeon captured in past NJ ocean trawl surveys have had any evidence of injury and there have been no recorded mortalities. The NEFSC surveys have recorded the capture of 110 Atlantic sturgeon since 1972; the NEAMAP survey has captured 102 Atlantic sturgeon since 2007. To date, there have been no recorded injuries or mortalities. In the Hudson River, a trawl survey that incidentally captures shortnose and Atlantic sturgeon has been ongoing since the late 1970s. To date, no injuries or mortalities of any sturgeon have been recorded. Based on this information, we expect that all Atlantic sturgeon captured in the NJ ocean trawl surveys will be alive and will be released uninjured.

7.4.6 Delaware Estuary Bottom Trawl

The objective of this study is to monitor trends in abundance and distribution and to determine year-class strength for a selected group of finfish. Sampling is conducted monthly from April through October at 33 stations in the Delaware Bay and six stations in the Delaware River above the Chesapeake and Delaware Canal in 2011. Twelve stations were sampled monthly in the Indian River and Rehoboth Bays (Inland Bays). April sampling was missed in 2003 at station 22 in the Delaware Estuary and was permanently discontinued in July 2003 due to shoaling and draft considerations at the Mahon River entrance. Occasionally some stations have been missed due to extreme low water conditions or other navigational obstructions. The net used was a 4.9-m (16-foot) semi-balloon otter trawl. Sampling at each station consisted of a ten-minute trawl tow, usually made against the prevailing tide.

Since 1980, Delaware's 16-foot trawl survey has completed 8,317 bottom trawl samples in the Delaware Bay and River and Atlantic sturgeon occurred in seven of those samples (one sturgeon in each sample), a 0.08% occurrence rate. These fish were caught at river stations 92, 94 and 96 except for one fish that was caught at station 10 in the upper bay (Table 13). The captured Atlantic sturgeon were measured and quickly, yet gently returned to the water. There have been no mortalities associated with any of the seven Atlantic sturgeon caught during this survey. No Atlantic sturgeon were taken during any of the 2,041 tows conducted in Delaware's Inland Bays since 1986.

Four shortnose sturgeon have been collected during the survey with an occurrence rate of 0.05% (Table 14). All four were collected in the Delaware River at stations 92, 94 and 96. The shortnose sturgeon were all returned to the water alive. Two sea turtles were caught by this survey since 1980 (Table 15) with a 0.02% occurrence rate. Both sea turtles were loggerhead turtles. These turtles were taken in June and July. Since 1986, there have been no shortnose sturgeon taken in 2,041 tows in Delaware's Inland Bays. There was one (1) loggerhead turtle collected in the Inland Bays during 2002 (Table 16). The sea turtles caught during the survey were released alive and in good condition.

Table 14. Annual number caught, catch per tow (CPUE), geometric mean and number stations sampled for Atlantic sturgeon from 16-foot trawl sampling in the Delaware Bay and River.

Year	# Tows	Number Caught	CPUE	GEOMN
1980	195	-	-	-
1981	205	-	-	-
1982	241	-	-	-
1983	237	-	-	-
1984	244	-	-	-
1985	245	-	-	-
1986	240	-	-	-
1987	230	-	-	-
1988	237	-	-	-
1989	247	1	0.0040	0.0028
1990	199	1	0.0050	0.0035
1991	277	-	-	-
1992	277	-	-	-
1993	278	1	0.0036	0.0025
1994	280	-	-	-
1995	280	1	0.0036	0.0025
1996	280	-	-	-
1997	280	-	-	-
1998	280	-	-	-
1999	280	-	-	-
2000	267	-	-	-
2001	280	-	-	-
2002	280	-	-	-
2003	275	-	-	-
2004	273	-	-	-
2005	273	-	-	-
2006	273	1	0.0037	0.0025
2007	273	-	-	-
2008	273	-	-	-
2009	273	-	-	-
2010	272	1	0.0037	0.0026
2011	273	1	0.0037	0.0025

Table 15. Annual number caught, catch per tow (CPUE), geometric mean and number stations sampled for shortnose sturgeon from 16-foot trawl sampling in the Delaware Bay and River.

Year	# Tows	Number Caught	CPUE	GEOMN
1980	195	-	-	-
1981	205	-	-	-
1982	241	-	-	-
1983	237	-	-	-
1984	244	-	-	-
1985	245	-	-	-
1986	240	-	-	-
1987	230	-	-	-
1988	237	-	-	-
1989	247	-	-	-
1990	199	-	-	-
1991	277	-	-	-
1992	277	-	-	-
1993	278	-	-	-
1994	280	-	-	-
1995	280	-	-	-
1996	280	1	0.0036	0.0025
1997	280	-	-	-
1998	280	-	-	-
1999	280	-	-	-
2000	267	-	-	-
2001	280	-	-	-
2002	280	1	0.0036	0.0025
2003	275	-	-	-
2004	273	-	-	-
2005	273	-	-	-
2006	273	-	-	-
2007	273	-	-	-
2008	273	1	0.0037	0.0025
2009	273	-	-	-
2010	272	1	0.0037	0.0026
2011	273	-	-	-

Table 16. Annual number caught and number stations sampled for sea turtles from 16-foot trawl sampling in the Delaware Bay and River.

		Number caught	
Year	**# Tows**	**Loggerhead**	**Kemp's Ridley**
1980	195	-	-
1981	205	-	-
1982	241	-	-
1983	237	-	-
1984	244	-	-
1985	245	-	-
1986	240	-	-
1987	230	-	-
1988	237	-	-
1989	247	-	-
1990	199	-	-
1991	277	-	-
1992	277	-	-
1993	278	-	-
1994	280	-	-
1995	280	1	-
1996	280	-	-
1997	280	-	-
1998	280	-	-
1999	280	1	-
2000	267	-	-
2001	280	-	-
2002	280	-	-
2003	275	-	-
2004	273	-	-
2005	273	-	-
2006	273	-	-
2007	273	-	-
2008	273	-	-
2009	273	-	-
2010	272	-	-
2011	273	-	-

Table 17. Annual number caught and number stations sampled for sea turtles from 16-foot trawl sampling in the Delaware's Inland Bays.

		Number caught	
Year	# Tows	Loggerhead	Kemp's Ridley
1986	88	-	-
1987	62	-	-
1988	82	-	-
1989	81	-	-
1990	61	-	-
1991	68	-	-
1992	88	-	-
1993	84	-	-
1994	83	-	-
1995	82	-	-
1996	83	-	-
1997	84	-	-
1998	84	-	-
1999	83	-	-
2000	84	-	-
2001	78	-	-
2002	60	1	-
2003	72	-	-
2004	84	-	-
2005	84	-	-
2006	83	-	-
2007	83	-	-
2008	84	-	-
2009	48	-	-
2010	84	-	-
2011	84	-	-

Based on past capture rates, we anticipate the annual capture of no more than two sea turtles (one in Inland Bays and one in Delaware Bay/River) in any five-year grant period. The majority of these sea turtles are expected to be loggerheads; however, it is possible that Kemp's ridley, green or leatherback sea turtles could also be captured. We anticipate that one of the turtles captured will be a loggerhead and the other will be a Kemp's ridley, green or leatherback. We also anticipate the capture of no more than one shortnose sturgeon and one Atlantic sturgeon annually. As such, in a five-year grant period, we anticipate the capture of up to 5 sea turtles (4 loggerheads and one Kemp's ridley, green or leatherback), five shortnose sturgeon and five Atlantic sturgeon.

Based on mixed-stock analysis, we have determined that Atlantic sturgeon in the project area likely originate from the five DPSs at the following frequencies: NYB 58%; Chesapeake Bay 18%; South Atlantic 17%; Gulf of Maine 7%; and Carolina 0.5%. These percentages are largely based on genetic sampling of individuals (n=105) sampled in directed research targeting Atlantic sturgeon along the Delaware Coast, just south of Delaware Bay. This is the closest sampling effort (geographically) to the action area for which mixed stock analysis results are available. Because the genetic composition of the mixed stock changes with distance from the rivers of origin, it is appropriate to use mixed stock analysis results from the nearest sampling location. Therefore, this represents the best available information on the likely genetic makeup of individuals occurring in the action area. We also considered information on the genetic makeup of individuals captured within the Delaware River. However, we only have information on the assignment of these individuals to the river of origin and do not have a mixed stock analysis for these samples. The river assignments are very similar to the mixed stock analysis results for the Delaware Coastal sampling, with the Hudson/Delaware accounting for 55-61% of the fish, James River accounting for 17-18%, South Atlantic 17-18%, and Gulf of Maine 9-11%. The range in assignments considers the slightly different percentages calculated by treating each sample individually versus treating each fish individually (some fish were captured in more than one of the years during the three year study). Carolina DPS origin fish are only occasionally detected in samples taken in the Northeast and are not detected in either the Delaware Coast or in-river samples noted above. However, mixed stock analysis from some sampling efforts (e.g., Long Island Sound, n=275), indicates that approximately 0.5% of the fish sampled were Carolina DPS origin. Additionally, 4% of Atlantic sturgeon sampled in the NEFOP program were Carolina DPS origin. Because any Carolina origin sturgeon that were sampled in Long Island Sound could have swam through the action area on their way between Long Island Sound and their rivers of origin, it is reasonable to expect that 0.5% of the Atlantic sturgeon captured in the action area could originate from the Carolina DPS. Based on this analysis, of the 5 anticipated Atlantic sturgeon captures, we expect 3 to originate from the New York Bight DPS, 1 from the Chesapeake Bay DPS and one from either the Gulf of Maine, South Atlantic or Carolina DPS.

Given the short tow times (10 minutes or less), we do not anticipate any injury or mortality of any captured sturgeon or sea turtles. All captured turtles and sturgeon are expected to be returned to the water alive.

7.4.7 Delaware Bay Groundfish Bottom Trawl

To date, Delaware's 30-foot trawl survey has completed 2,525 bottom trawl samples (20-minute tows) and Atlantic sturgeon occurred in 36 of those samples, a 1.4% occurrence rate. A total of 41 Atlantic sturgeon have been collected during this survey (Table 18). The captured Atlantic sturgeon were measured and quickly, yet gently returned to the water. There have been no mortalities associated with any of 41 Atlantic sturgeon caught during this survey.

Three shortnose sturgeon have been collected during the survey with an occurrence rate of 0.12% (Table 19). The shortnose sturgeon were all returned to the water alive. A total of 15 sea turtles have been collected during this survey since 1980 (Table 20) with a 0.6% occurrence rate. Eleven of the sea turtles collected were loggerhead turtles, the remaining three turtles were Kemp's Ridley turtles. Eight of the turtles were taken in July and the remaining three were taken in June (2), August (3) and September (2). All sea turtles caught during the survey were released alive and in good condition.

Table 18. Annual number caught, mean number per nautical mile (No./nm), weight of catch, mean weight per nautical mile (Kg./nm) and number stations sampled for Atlantic sturgeon from 30-foot trawl sampling in the Delaware Bay.

YEAR	# Tows	Number Caught	Weight (Kg)	No./nm	Kg./nm
1966	56	2	-	0.03	-
1967	75	-	-	-	-
1968	40	-	-	-	-
1969	42	-	-	-	-
1970	35	-	-	-	-
1971	39	-	-	-	-
1979	99	12	61.65	0.14	0.70
1980	93	2	10.95	0.02	0.12
1981	98	2	9.6	0.03	0.11
1982	40	-	-	-	-
1983	38	-	-	-	-
1984	45	-	-	-	-
1990	61	3	6.1	0.05	0.11
1991	71	-	-	-	-
1992	89	-	-	-	-
1993	83	-	-	-	-
1994	71	1	13.88	0.01	0.20
1995	88	2	4.64	0.02	0.04
1996	76	3	17.68	0.03	0.21
1997	89	-	-	-	-
1998	80	-	-	-	-
1999	87	1	3.4	0.01	0.04
2000	90	2	15.25	0.02	0.16
2001	90	1	0	0.01	-
2002	68	-	-	-	-
2003	63	-	-	-	-
2004	90	-	-	-	-
2005	90	-	-	-	-
2006	89	1	2.32	0.01	0.03
2007	90	-	-	-	-
2008	90	1	5.52	0.01	0.06

2009	90	-	-	-	-
2010	90	-	-	-	-
2011	90	8	72.37	0.09	0.81

Table 19. Annual number caught, mean number per nautical mile (No./nm), weight of catch, mean weight per nautical mile (Kg./nm) and number stations sampled for shortnose sturgeon from 30-foot trawl sampling in the Delaware Bay.

YEAR	**# Tows**	**Number Caught**	**Weight (Kg)**	**No./nm**	**Kg./nm**
1966	56	.	.	.	.
1967	75	.	.	.	.
1968	40	.	.	.	.
1969	42	.	.	.	.
1970	35	.	.	.	.
1971	39	.	.	.	.
1979	99	.	.	.	.
1980	93	.	.	.	.
1981	98	.	.	.	.
1982	40	.	.	.	.
1983	38	.	.	.	.
1984	45	.	.	.	.
1990	61	.	.	.	.
1991	71	1	3.94	0.01	0.02
1992	89	.	.	.	.
1993	83	.	.	.	.
1994	71	.	.	.	.
1995	88	.	.	.	.
1996	76	.	.	.	.
1997	89	.	.	.	.
1998	80	.	.	.	.
1999	87	.	.	.	.
2000	90	.	.	.	.
2001	90	.	.	.	.
2002	68	.	.	.	.
2003	63	.	.	.	.
2004	90	.	.	.	.
2005	90	.	.	.	.
2006	89	1	2.04	0.01	0.05
2007	90	.	.	.	.
2008	90	.	.	.	.
2009	90	1	1.63	0.01	0.02

2010	90	.	.	.	.
2011	90	.	.	.	.

Table 20. Annual number caught and number stations sampled for loggerhead turtles from 30-foot trawl sampling in the Delaware Bay.

		Number caught	
Year	**# Tows**	**Loggerhead**	**Kemp's Ridley**
1966	56	-	-
1967	75	-	-
1968	40	-	-
1969	42	-	-
1970	35	-	-
1971	39	-	-
1979	99	-	-
1980	93	-	-
1981	98	-	-
1982	40	-	-
1983	38	-	-
1984	45	-	-
1990	61	-	-
1991	71	-	-
1992	89	-	-
1993	83	-	-
1994	71	-	-
1995	88	1	-
1996	76	1	-
1997	89	-	-
1998	80	-	2
1999	87	1	1
2000	90	2	-
2001	90	-	-
2002	68	-	-
2003	63	-	-
2004	90	-	-
2005	90	-	-
2006	90	4	-
2007	90	-	-
2008	90	2	-
2009	90	1	-

2010	90	-	-
2011	90	-	-

The number of Atlantic sturgeon captured in this survey is highly variable, ranging from 0-12 with typical years having a catch of 3 or less and most years a catch of zero. The long-term annual average is 1.2 sturgeon/year. Given the high interannual variability in captures, we have considered the possibility that catches in the future will be as high as the maximum number captured in any consecutive five-year period (16). As such, we expect that no more than 16 Atlantic sturgeon will be captured in any five-year grant period. Based on mixed-stock analysis (see Section 6.4.6), we have determined that Atlantic sturgeon in the project area likely originate from the five DPSs at the following frequencies: NYB 58%; Chesapeake Bay 18%; South Atlantic 17%; Gulf of Maine 7%; and Carolina 0.5%. Therefore, we anticipate the capture of 9 individuals from the New York Bight DPS, 3 from the Chesapeake Bay DPS, 3 from the South Atlantic DPS, and 1 from the Gulf of Maine or Carolina DPS.

The number of sea turtles captured has been variable, ranging from 0-4 per year. The highest number of captures in any consecutive five-year period was seven (2006-2010). Both loggerheads and Kemp's ridleys have been captured in this survey, with a ratio of 4:1 loggerheads to Kemp's ridleys. Based on past captures, in any future five-year period we expect the capture of no more than seven sea turtles. We expect the majority of these turtles will be loggerheads. We expect that 2 will be Kemp's ridleys and given the known occurrence of green and leatherback sea turtles in Delaware Bay, there could also be a capture of a green or leatherback. Therefore, we anticipate the capture of 4 loggerheads, 2 Kemp's ridley and 1 green or leatherback. Given the short tow time, we do not anticipate any mortality.

Very few shortnose sturgeon have been captured in the past, with no more than 1 capture per year. As such, we expect no more than five captures in future five-year grant periods.
Given the short tow times (10 minutes or less), we do not anticipate any injury or mortality. All captured turtles and sturgeon are expected to be returned to the water alive.

7.4.8 Maryland Coastal Bays Fisheries Investigations Trawl Survey

The Maryland Department of Natural Resources (MDNR) Fisheries Service has conducted the Coastal Bays Fisheries Investigations (CBFI) Trawl and Beach Seine Survey in Maryland's Coastal Bays since 1972, sampling with a standardized protocol since 1989. Trawl sampling was conducted at 20 fixed sites throughout Maryland's Coastal Bays on a monthly basis from April through October.

No Atlantic or shortnose sturgeon have been captured since the trawl survey began in 1972. Only one sea turtle has been encountered. A loggerhead turtle was captured trawling on October 5, 1976 in Isle of Wight Bay at False Channel (T007). Given the rarity of sea turtle captures during this study, we anticipate that no more than one sea turtle will be captured in the five-year grant period; while only a loggerhead has been captured in the past, we expect that future captures could be loggerhead, Kemp's ridley, green or leatherback sea turtles.

7.4.9 Virginia Chesapeake Bay MMAP

The ChesMMAP survey conducts five research cruises annually (March, May, July, September, November) throughout the main stem of Chesapeake Bay. During each cruise, up to 80 sites are sampled according to a stratified random design. At each sampling site, this gear is towed along the bottom for 20 minutes at approximately 3.0 knots and in the same general direction as the prevailing current. To date, there have been four Atlantic sturgeon captured and one loggerhead sea turtle. Information on these captures is detailed in the tables below:

Table 21. Atlantic sturgeon interactions:

STATION	DATE	Time	Depth (ft)	Latitude	Longitude	Fork Length (mm)
CM20050701070	01-Jul-05	1:45 PM	39	36.959	-76.084	708
CM20060501031	18-May-06	7:48 AM	41	38.327	-76.353	508
CM20101101061	02-Nov-10	3:49 PM	19	37.041	-76.200	1150
CM20110501061	26-May-11	12:53 PM	19	37.075	-76.236	550

Table 22. Turtle interactions:

STATION	DATE	Time	Depth (ft)	Latitude	Longitude	Curved Notch-to-Notch Length (mm)
CM20070701061	7/10/2007	12:16:00 PM	16	37.023	-76.226	1045

Given the rarity of sea turtle captures during this study, we anticipate that no more than one sea turtle will be captured in the five-year grant period. While only a loggerhead has been captured in the past, we expect that future captures could be loggerhead, Kemp’s ridley, green or leatherback sea turtles. Given the short duration of the tows (less than 30 minutes), we do not anticipate the mortality of any sea turtles captured in this trawl survey.

Given these past interaction rates with Atlantic sturgeon, we expect that future surveys will capture no more than one Atlantic sturgeon annually, for a total of no more than five Atlantic sturgeon during the five year grant period. Based on the mixed stock analysis (using results from the NEFOP database because we do not have site-specific analysis), we expect that: 49% of the captured Atlantic sturgeon will originate from the NYB DPS (3 individuals), 20% from the SA DPS (1 individual), with the remaining individual originating from the CB, GOM or Carolina DPS. Given the short duration of the tows (less than 30 minutes), we do not anticipate the mortality of any Atlantic sturgeon captured in this trawl survey.

7.4.10 Virginia Juvenile Fish

The juvenile fish trawl survey conducted by VIMS is the oldest continuing monitoring program (56 years) for marine and estuarine fishes in the United States. Five-minute tows occur in the Bay monthly except during January and March, when few target species are available. Past captures of Atlantic sturgeon and sea turtles are detailed below.

Table 23. Atlantic sturgeon interactions:

CRUISENO	STATION	Latitude	Longitude	Number	SZMEAN	SZMIN	SZMAX	Total Wgt	STADATE	RIVER
JA640701	3	37.11667	-76.6333	1	488	488	488		19640714	JA
JA720805	1	37.21667	-76.8333	3	113	100	129		19720810	JA
YK750109	15	37.535	-76.9533	1	129	129	129	10	19750129	PM
JA750203	4	37.35833	-77.3033	1	200	200	200	50	19750206	JA
YK760107	23	37.545	-76.8967	1	418	418	418	418	19760121	PM
YK760107	26	37.53667	-76.955	2	473.5	442	505	1550	19760121	PM
JA780608	5	37.235	-76.9417	1	112	112	112	7	19780630	JA
JA780608	8	37.23167	-76.9417	1	115	115	115	5	19780630	JA
JA790112	8	37.19833	-76.7767	1	380	380	380	210	19790122	JA
JA790702	5	37.075	-76.6067	2	464.5	459	470	1700	19790705	JA
JA790801	8	37.155	-76.6367	1	466	466	466		19790803	JA
JA791205	4	37.08833	-76.6383	2	506	502	510	1480	19791211	JA
JA791205	7	37.21	-76.6967	1	85	85	85	10	19791211	JA
JA800205	10	37.21	-76.6633	1	540	540	540	970	19800221	JA
JA800306	7	37.115	-76.6383	1	494	494	494	950	19800311	JA
JA801005	9	37.155	-76.6367	1	997	997	997	6300	19801008	JA
JA801005	12	37.21833	-76.89	1	340	340	340	290	19801008	JA
JA810108	7	37.19833	-76.7733	1	537	537	537	910	19810128	JA
JA810203	4	37.215	-76.8567	1	325	325	325	230	19810218	JA
JA810904	9	37.155	-76.6367	1	505	505	505	1130	19810918	JA
JA811103	7	37.075	-76.6067	1	610	610	610	1850	19811116	JA
JA811103	9	37.155	-76.6367	1	690	690	690	2000	19811116	JA
JA820201	4	37.215	-76.8667	1	535	535	535	980	19820202	JA
JA890801	9	37.207	-76.6532	1	645	645	645	2060	19890815	JA
YK970415	135	37.55217	-76.8615	1	161	161	161		19970415	YK
JA970425	19	37.19567	-76.7725	1	225	225	225		19970425	JA
JA971106	140	37.22983	-76.8227	1	438	438	438		19971106	JA
JA980112	15	37.18933	-76.6562	1	458	458	458		19980112	JA
JA980113	18	37.20583	-76.6847	1	394	394	394		19980113	JA
JA980113	21	37.183	-76.7312	1	453	453	453		19980113	JA
JA980608	20	37.19817	-76.7755	1	555	555	555		19980608	JA
JA980804	14	37.05183	-76.5875	2	547	527	567		19980804	JA
JA980922	135	37.18633	-76.7623	1	586	586	586		19980922	JA
JA981106	13	37.03483	-76.535	1	513	513	513		19981106	JA
JA990114	127	37.21117	-76.6602	1	580	580	580		19990114	JA
JA990204	23	37.1805	-76.7585	1	640	640	640		19990204	JA
JA991015	113	37.0215	-76.5085	1	810	810	810		19991015	JA
JA000411	13	37.00867	-76.479	1	810	810	810		20000411	JA
JA010404	23	37.18233	-76.756	1	582	582	582		20010404	JA
JA040315	20	37.20433	-76.7802	1	170	170	170		20040315	JA
JA050718	24	37.22283	-76.8055	2	345	342	348		20050718	JA
YK051103	135	37.551	-76.863	1	415	415	415		20051103	YK
JA051118	140	37.22983	-76.8237	1	466	466	466		20051118	JA
JA060120	127	37.20917	-76.6582	1	506	506	506		20060120	JA
YK111201	140	37.22983	-76.8227	1	133	133	133		20111201	YK
YK120106	140	37.22983	-76.8227	1	150	150	150		20120106	YK
YK120106	140	37.22983	-76.8227	1	141	141	141		20120106	YK
YK120106	140	37.22983	-76.8227	1	146	146	146		20120106	YK

There have been Atlantic sturgeon captures in 19 of the 56 years that the study has been ongoing, with captures ranging from 1-7 Atlantic sturgeon per year. The highest number of sturgeon caught in any five-year period was 17 (1978-1982). Given the high interannual variability in captures, we have considered the possibility that catches in the future will be as high as the maximum number captured in any consecutive five-year period (17). As such, we expect that no more than 17 Atlantic sturgeon will be captured in any five-year grant period. Based on the mixed stock analysis (using results from the NEFOP database because we do not have site-specific analysis), we expect that: 49% of the captured Atlantic sturgeon will originate from the NYB DPS, 20% from the SA DPS 14% from the CB DPS, 11% from the GOM DPS and 4% from Carolina DPS. Therefore, we anticipate the capture of 8 individuals from the New York Bight DPS, 3 from the South Atlantic DPS, 3 from the Chesapeake Bay DPS, 2 from the Gulf of Maine DPS and 1 from the Carolina DPS. Given the short duration of the tows (less than 30 minutes), we do not anticipate the mortality of any Atlantic sturgeon captured in this trawl survey.

Table 24. Turtle interactions:

1 Loggerhead - Cruise #: CL090610, station 12, CW= 650 mm, CL= 650 mm
1 Kemps Ridley – Cruise#: YK111005, station 5, CW = 400 mm

Only two sea turtles have been captured during the 56-year history of this study. Given the rarity of sea turtle captures during this study, we anticipate that no more than one sea turtle will be captured in the five-year grant period. Both Kemp's ridley and loggerhead sea turtles have been captured in the past. Given the known occurrence of green and leatherback seat turtles in Virginia waters, we anticipate that the sea turtle captured could be a loggerhead, Kemp's ridley, green or leatherback sea turtle. Given the short duration of the tows (less than 30 minutes), we do not anticipate the mortality of any sea turtles captured in this trawl survey.

7.5 Fish Passage Facilities

The State of Massachusetts monitors the West Springfield fish passage facility (a Denil ladder) located at the first dam on the Westfield River, a tributary to the Connecticut River. Monitoring occurs seasonally, during the spring (April - July) and fall (September - October) fish passage seasons when American shad, blueback herring, and Atlantic salmon are migrating.

The facility has been operational for 15 years. To date, one shortnose sturgeon has been observed in the fishway. During the summer of 2007, a shortnose sturgeon was observed swimming near the base of the ladder. Approximately 48 hours later the fish was observed in the fish trap at the top of the ladder. The fish was removed from the trap and returned to the river. No injuries were observed.

The use of Denil ladders by shortnose sturgeon is rare. Ladders are installed at several hydroelectric facilities in the Northeast where shortnose sturgeon are known to occur, including the Brunswick Dam on the Androscoggin River, Maine, and Cabot Station on the Connecticut River, Massachusetts. Despite extensive monitoring programs at both facilities, no shortnose sturgeon have ever been documented using either ladder. The only documented occurrence of a shortnose sturgeon using a Denil ladder is at the Westfield River project.

As evidenced by the occurrence of only shortnose sturgeon in the trap in 15 years, the capture of a shortnose sturgeon in a fish trap at the top of a Denil ladder is a rare event. Because of this, we anticipate that no more than one shortnose sturgeon will be captured in the fishtrap monitored by the State of Massachusetts in any five-year grant period. Given the intense monitoring of the fishway that occurs when it is open, any shortnose sturgeon in the ladder are expected to be seen.

Ultimately, these fish would be removed and placed back downstream of the ladder. While these fish may experience minor injuries such as abrasions due to contact with the concrete, no significant injuries or mortalities are anticipated. The State of Massachusetts will ensure that any shortnose sturgeon in the ladder or fishtrap is identified and safely removed. As such, any shortnose sturgeon caught in the Denil will not be allowed to pass upstream of the project where they could be permanently trapped or subject to injury or mortality while attempting to pass downstream of the project. Further, as response and removal from the ladder is anticipated to occur within 24 hours, any delay in carrying out normal behaviors will be temporary and not likely to result in the abandonment of spawning or any other fitness consequences for that individual.

No Atlantic sturgeon or sea turtles have been observed at the Westfield River fishtrap and given its location, no individuals from any of these species are anticipated to occur in the area.

7.6 Boat Electrofishing

Electrofishing entails passing an electric current in the water to capture or control fish. The electric current causes fish within the effective area of the electric field to become temporarily stunned or immobilized (referred to as electrotaxis) to facilitate capture by nets. Three electrofishing surveys have interacted with shortnose or Atlantic sturgeon. Given the freshwater location of these surveys, we do not anticipate sea turtles to be present and therefore, do not anticipate any future interactions with sea turtles.

The three studies considered here, New York Striped Bass Electrofishing in the Hudson River, Delaware Tidal Largemouth Bass Monitoring Program in the Nanticoke River, and Delaware River Striped Bass Spawning Stock Assessment in the Delaware River are described in sections 3.6.4, 3.91 and 3.9.3, respectively.

New York Study

The New York study targets striped bass in the spring (late April – early May), near Kingston, New York (River Miles 87-96). This study has been ongoing since 1989. To date, 33 shortnose sturgeon have been observed. These fish were observed stunned on the surface, captured and returned to the river with no apparent injury or mortality.

Table 25. Interactions with Sturgeon during NY Striped Bass Electrofishing Study in the Hudson River, 1989-2011.

	Electrofishing				
	Minutes of Fishing	Target Species		Sturgeon	
Years		American Shad	Striped Bass	Shortnose	Atlantic

1989	300	0	129	0	0
1990	199	0	549	0	0
1991	1284	5	344	0	0
1992	1730	41	402	0	0
1993	1707	29	556	0	0
1994	1148	0	256	0	0
1995	393	150	177	0	0
1996	1305	0	623	0	0
1997	a	0	152	0	0
1998	1008	0	388	0	0
1999	2044	31	606	0	0
2000	2031	2	641	0	0
2001	1970	0	877	0	0
2002	2324	28	733	0	0
2003	2225	0	776	0	0
2004	1760	1	867	0	0
2005	1683	0	740	0	0
2006	1064	1	470	22	0
2007	1215	0	429	3	0
2008	2508	0	1144	8	0
2009	b	0		b	b
2010	903	0	457	0	0
2011	890	13	172	0	0
Total	28,801	301	11,488	33	0

a. Not recorded

b. No sampling

In most years (19 of 22) that sampling has occurred, no interactions with sturgeon have been recorded. In the years when sturgeon were observed, the number of interactions ranged from 3-22. The long-term annual average is approximately two interactions per year. However, for the most recent five year period when sampling occurred (2011, 2010, 2008, 2007, 2006), the annual average was seven individuals. Using this annual average to predict future interactions, we would expect no more than 35 interactions with shortnose sturgeon in any five-year grant period. No interactions with Atlantic sturgeon have been recorded in the past; therefore, we do not anticipate any future interactions with Atlantic sturgeon. Sea turtles do not occur in the area being sampled; therefore, we do not anticipate any future interactions with any species of sea turtle.

Delaware – Largemouth Bass Study and Striped Bass Survey

Delaware samples largemouth bass in the freshwater portion of the Nanticoke River in the fall (September/October). Sampling was conducted annually between 1989 and 2004 but was conducted only bi-annually (even number years) beginning in 2006. Only one interaction with a sturgeon has occurred since the study began. In 2008, while sampling the portion of the Nanticoke River that is between the US Route 13 bridge and the Blades drawbridge, one Atlantic sturgeon was observed. It came partially out of the water while current was flowing. It was not stunned and was not collected but was estimated to be a sub-adult. That is the only sturgeon observed during the nineteen years of electrofishing within this system.

The striped bass survey is conducted in the lower Delaware River from the Delaware Memorial Bridge at rkm 110 to the mouth of Big Timber Creek, NJ at rkm 152. The survey, conducted since 1991 with over 350 hours of electrofishing time has not encountered an Atlantic sturgeon. On May 3, 2011, the survey encountered a shortnose sturgeon (778 mm FL, 993 mm TL),It experienced normal taxus from electrofishing gear and was netted and allowed to recover in the live well. It was then measured, examined for external tags and released after full recovery. The fish showed no signs of injury.

For the Delaware studies, interactions with sturgeon have been rare, with one shortnose and one Atlantic sturgeon observed since the studies began (1989 and 1991). Given the past interaction rate, during the five year grant period, we expect that no more than one shortnose and no more than one Atlantic sturgeon will be encountered during the largemouth bass (Nanticoke River) and striped bass (Delaware River) surveys. Atlantic sturgeon from all five DPSs could be present in the project area; therefore, the affected Atlantic sturgeon could be from any of the five DPSs.

Effects to exposed sturgeon

As explained above, in a given five-year grant period, we anticipate interactions with no more than 35 shortnose sturgeon in the NY survey and no more than one shortnose and one Atlantic sturgeon during the Delaware survey.

Electrofishing can cause mortality or injury to fish. Limited information is available regarding effects to sturgeon. Moser (2000) conducted limited laboratory experiments on the effects of electrofishing on shortnose sturgeon. Shortnose sturgeon were exposed to electrical current for up to 60 seconds at a time, four to five minutes a day. Despite this extensive level of exposure, no mortality occurred. Shortnose sturgeon recovered very quickly from exposures and no difference in growth was seen in control and exposed subjects suggesting that feeding behaviors were not affected. Sturgeon were initially more responsive to the electroshocking treatment than catfish; however, they recovered quickly and moved to avoid the stimulus. More sturgeon than catfish rolled onto their side or completely rolled upside-down within the first 15 seconds. They also exhibited more twitching, rigor and avoidance behaviors than did catfish. But, sturgeon generally recovered immediately after the experiment. Over 75% of the sturgeon recovered immediately, with maximum recovery times of 5 minutes. Sturgeon were exposed repeatedly over a 32 day period and no long term mortality was seen.

Electrofishing injury rates for shovelnose sturgeon (*Scaphirhynchus platorynchus)* were documented to be 0% according to Snyder (2003). Lab studies conducted on juvenile white sturgeon (*Acipenser transmontanus*) showed higher injury rates for pulsed DC current compared to DC current (68% vs. 10%) with no mortality (Holliman and Reynolds 2002). The available mortality data for sturgeon indicates that mortality resulting from exposure to electrofishing current is likely to be zero.

Based upon this information, of the shortnose and Atlantic sturgeon that are likely to be exposed to the electrofishing current (35 shortnose in New York, 1 shortnose and 1 Atlantic in Delaware), none are expected to experience mortality. Exposed sturgeon are likely to be stunned and may roll or twitch. The available information indicates that most sturgeon will recover immediately, with all exposed sturgeon recovering within 5 minutes. It is likely that most sturgeon will recover and swim away before they are netted.

As no sampling will occur during sturgeon spawning activities and any adults encountered during sampling will have time to recover prior to any subsequent spawning activities, no significant effects to spawning sturgeon are expected. Further, as recovery from exposure is expected to occur within five minutes, any delay in carrying out normal behaviors will be temporary and not likely to result in the abandonment of spawning or any other fitness consequences for that individual.

7.7 Gill Net

Five gill net surveys carried out by New York, New Jersey, Maryland and Virginia have captured Atlantic sturgeon. No interactions with shortnose sturgeon or sea turtles have been recorded in any of the gill net studies funded by USFWS.

7.7.1 New York American Shad Spawning Habitat Studies

NYDEC initiated this program in 2009. Drift gill nets are set for short periods of time in early spring (April – early May), south of Kingston. To date, one Atlantic sturgeon has been captured. This fish was captured in 2011 and released with no apparent injuries.

Table 26.

		Sturgeon	
Year	Net Sets	Shortnose	Atlantic
2009	22	0	0
2010	18	0	0
2011	27	0	1
2012	27	0	0
Total	94	0	1

Drift gill nets fish primarily at the surface. Sturgeon are benthic fish and are less likely to occur in the upper water column near the surface where the drift gill net fishes; therefore, the low number of encounters is consistent with our expectation that the interaction rate would be low. Based on past interactions, we expect no more than one Atlantic sturgeon will be captured during this study during each five year grant period. Atlantic sturgeon from all five DPSs could be present in the project area; therefore, the affected Atlantic sturgeon could be from any of the five DPSs. Gill net sets will be short. However, Atlantic sturgeon can be killed if entangled in gillnets. Mortality rates in commercial fisheries using gillnets are approximately 20%. Given the known vulnerability of Atlantic sturgeon to gillnets, it is possible that the captured Atlantic sturgeon may be killed.

7.7.2 NJ Striped Bass Gillnet Survey

The gillnet survey for striped bass has been ongoing since 1989. Gillnets are set in water depths of 6 to 12-feet in areas of lower Delaware Bay near Bidwell's Creek and Reeds Beach, New Jersey. Nets are 5-6" stretch mesh. The survey takes place from early March through early May. Since the mid-1990s, the survey has operated with drift gill nets rather than anchored gear; average soak time is about 30 minutes. Only one 600-foot net is set at a time and all nets are monitored/tended throughout the study.

Since 1989, 397 trips have occurred with 2,863 hours of sampling. No interactions with any sea turtles have occurred. Sea turtles are vulnerable to capture in gillnets; however, the location of the deployment makes interactions with these species unlikely. Because no captures of these species have occurred in this study in the past and there are no changes to the study proposed that would increase the potential for interactions, we do not anticipate any future interactions with any species of sea turtles in the striped bass gillnet survey.

year	# sets	# hours	# hours per set	# sb caught	# sturgeon caught	# sturgeon tagged
1989	87	112.0	1.3	493	0	0
1990	109	144.9	1.3	85	0	0
1991	71	88.6	1.2	329	0	0
1992	59	81.0	1.4	1,145	0	0
1993	74	94.4	1.3	1,258	0	0
1994	180	176.0	1.0	1,018	0	0
1995	171	178.1	1.0	2,166	0	0
1996	185	303.4	1.6	2,305	0	0
1997	263	284.8	1.1	601	2	0
1998	173	207.7	1.2	931	0	0
1999	152	146.5	1.0	2,353	0	0
2000	138	107.3	0.8	2,680	3	0
2001	174	132.1	0.8	2,943	1	0
2002	185	135.5	0.7	2,041	0	0
2003	163	74.9	0.5	2,847	2	0
2004	190	106.7	0.6	2,166	0	0

2005	205	149.5	0.7	1,418	33	1
2006	124	78.8	0.6	1,658	3	0
2007	114	53.8	0.5	1,252	3	0
2008	145	58.9	0.4	1,733	0	0
2009	110	42.4	0.4	2,443	1	1
2010	146	73.5	0.5	1,319	6	6
2011	72	32.5	0.5	873	1	1
Total	3,290	2,863.3	0.9	36,057	55	9

No Atlantic sturgeon were captured prior to 1997. Since then, 55 Atlantic sturgeon have been captured in the striped bass survey. With the exception of 2005 when 33 individuals were captured, the number of captures has been less than 6 per year. The average catch per unit effort of Atlantic sturgeon since 1989 is 0.17 sturgeon/set; since 1996 the average CPUE is 0.24 sturgeon/set (2,354 in this time period); considering only the last 10 years (2001-2011), the CPUE is 0.034 sturgeon/set (1,454 sets in this time period). Because the CPUE has changed over time, with could be related to either changes in the way the gear is deployed (anchored nets vs. drift nets) and/or changes in Atlantic sturgeon abundance or distribution, it is reasonable to apply the CPUE from the most recent time period (*i.e.*, the last 10 years) to predict future interactions with Atlantic sturgeon. The average number of sets per year since 2001 is 145; considering three years of sampling with this number of sets per year and the CPUE of 0.034 sturgeon per set, we would expect the capture of 25 Atlantic sturgeon in any five-year grant period, with an average of 5 captures per year. However, we must also consider that past observations suggest that there is the potential for some years to have higher levels of interactions (e.g., there were 10 captures in 2010 and 33 in 2005). The maximum number of interactions in any consecutive five-year period is 41 (2003-2007). Given the high level of interannual variability, we have considered that it is possible that the maximum number of Atlantic sturgeon caught in any three year period (41) could be captured in a future five-year period. Based on this, we anticipate that no more than 41 Atlantic sturgeon will be captured in any five-year grant period. Based on mixed-stock analysis (see Section 6.4.6), we have determined that Atlantic sturgeon in the project area likely originate from the five DPSs at the following frequencies: NYB 58%; Chesapeake Bay 18%; South Atlantic 17%; Gulf of Maine 7%; and Carolina 0.5%. Therefore, we anticipate the capture of 23 individuals from the New York Bight DPS, 7 from the Chesapeake Bay DPS, 7 from the South Atlantic DPS, 3 from the Gulf of Maine, and 1 from the Carolina DPS.

The short duration of the net sets, constant monitoring/tending of the gear and careful handling of any sturgeon once the net is hauled is likely to result in a low potential for mortality. None of the 55 Atlantic sturgeon captured in past gillnet surveys have had any evidence of injury and there have been no recorded mortalities. Information available from the NEFOP database suggests that mortality of Atlantic sturgeon in commercially fished sink gillnets is, on average, approximately 20%; however, mortality of sturgeon in gillnets set for fisheries research is much lower, on average around 1%. The duration of gillnet deployment is likely a primary factor in mortality rates. Based on the short duration of net sets (average of 30 minutes) and the constant observation/tending of the net, and past monitoring which indicates that no mortalities have occurred, we expect that the likelihood of an Atlantic sturgeon captured in future striped bass gillnet surveys suffering serious injury or mortality is very low (around 1% based on other research using gillnets to capture sturgeon); therefore, we expect that no more than one of the 41 Atlantic sturgeon will die; this individual could originate from any of the five DPSs. All other captured Atlantic sturgeon will be alive and will be released uninjured.

7.7.3 Maryland Spring Striped Bass Experimental Drift Gill Net Survey

Since 1985, MD DNR has used multi-panel experimental drift gill nets to monitor the Chesapeake Bay component of the Atlantic coast striped bass population. Multi-panel experimental drift gill nets were deployed in the Potomac River and in the Upper Chesapeake Bay in 2011. Gill nets are fished 6 days per week, weather permitting, from late March through May. Individual net panels were 150 feet long, and ranged from 8.0 to 11.5 feet deep depending on mesh size. The panels were constructed of multifilament nylon webbing in 3.0 - 10.0-inch stretch-mesh. In the Upper Bay, all 10 panels were tied together, end to end, to fish the entire suite of meshes simultaneously. In the Potomac River, because of the design of the fishing boat, the gang of panels was split in half, with two suites of panels (5 meshes tied together) fished simultaneously end to end. In both systems, all 10 panels were fished twice daily unless weather prohibited a second set. The order of panels within the suite of nets was randomized with gaps of 5 to 10 feet between each panel. Overall soak times for each panel ranged from 6 to 105 minutes.

Since 1985, a total of 2,287 gill net sampling days were conducted by MD DNR Striped Bass Program biologists. Only one Atlantic sturgeon was encountered in this survey during the entire time series of this project (1985 to present). The fish was captured in the Upper Chesapeake Bay sampling area, on May 3, 2001, at site 18 (off Betterton at the mouth of the Sassafras River) and was 943 mm TL. The fish was found to be in good condition and was released unharmed.

No shortnose sturgeon have been seen or captured during the entire time series of this project (1985 to present). Similarly, no sea turtles have been seen or sampled during the entire time series of this project (1985 to present).

Based on past interactions, we expect that no more than one Atlantic sturgeon will be captured during this study for each five year grant period. Atlantic sturgeon originating from all five of the DPSs occur in the Chesapeake Bay, given that, the individual captured could belong to any of the five DPSs. Given the variable soak times used in this survey, it is possible that this fish could be killed.

7.7.4 Virginia American Shad Monitoring Program - Gill Netting

To carry out this study, one staked gillnet (SGN), 900 feet (approximately 274 m) in length, is set on the York and James rivers and one SGN, 912 feet (approximately 277 m) in length, is set on the Rappahannock River. Locations of the sets are consistent over the time series and are as follows: lower James River near the James River Bridge at river mile 10; middle York River near Clay Bank at river mile 14; and middle Rappahannock River near the Rappahannock River bridge (at Tappahannock, Virginia) at river mile 36.

Each week during the American shad spawning run (typically late February to early May), nets are fished on two succeeding days (two 24-h sets). Catches of all other species are recorded and enumerated on log sheets by observers on each river and released. In 2009, VIMS American shad program personnel began tagging Atlantic sturgeons that were captured in good condition during this survey. All sturgeon are processed according to USFWS tagging protocols in the following manner: fork and total lengths (mm) are recorded, they are scanned for PIT tags. Fish without PIT tags present are tagged using T-Bar and PIT tags provided by the USFWS, fin clipped and then released alive (depending on specific circumstances, e.g., animal condition, only a subset of the above processing may take place).

Atlantic sturgeon have been captured in the staked gill nets used to monitor abundance of adult American shad in the James, York, and Rappahannock rivers. Since 1998, 191 Atlantic sturgeon have been captured during 987 trips, totaling approximately 23,760 hours of fishing. The total numbers of Atlantic sturgeon captured in this survey from 1998-2012, by year, were:

Year	Total Atlantic Sturgeon	James River	York / Rappahannock
1998	34	27	7
1999	24	22	2
2000	16	15	1
2001	8	7	1
2002	1	1	0
2003	3	3	0
2004	6	4	2
2005	26	22	4
2006	41	31	10
2007	30	22	8
2008	9	7	2
2009	7	6	1
2010	10	7	3
2011	10	9	1
2012	2	2	0

Most Atlantic sturgeon caught during this survey have been released alive and in good condition; past mortality is estimated at approximately 2% which is consistent with levels of mortality in gillnet studies that target Atlantic sturgeon. The long-term annual average is 15 Atlantic sturgeon captures per year. Using this estimate, we would expect no more than 75 captures in any five-year grant period. However, interannual variability is high, with annual captures ranging from 1-41. The highest number of Atlantic sturgeon captured in any five-year period is 113 (2005-2009). Therefore, we anticipate that no more than 113 Atlantic sturgeon will be captured in a future five-year grant period. Based on mixed-stock analysis (from the NEFOP data because we do not have site-specific analysis), we have determined that Atlantic sturgeon in the project area likely originate from the five DPSs at the following frequencies: 49% from the NYB DPS, 20% from the SA DPS, 14% from the CB DPS, 11% from the GOM DPS and 4%

from Carolina DPS. Therefore, we anticipate the capture of 56 individuals from the New York Bight DPS, 23 from the South Atlantic DPS, 16 from the Chesapeake Bay DPS, 13 from the Gulf of Maine DPS and 5 from the Carolina DPS. Assuming a 1-2% mortality rate, we expect no more than two mortalities during any five-year period; these fish could be from any of the five DPSs.

7.7.5 Virginia Striped Bass Spawning Stock Assessment - Gill Netting

The James and Rappahannock gill net surveys consist of twice-weekly samples of two 300' gill nets (24 hour set time) in each river. Each gill net is 6' in depth and consists of 10 30' panels of varied mesh sizes (3, 3 ¾, 4 ½, 5 ¼, 6, 6 ½, 7, 8, 9 and 10" stretched). The nets are located approximately 100 miles apart at mile 48 on the Rappahannock River and mile 60 on the James River. The gill net surveys commenced in 1991 on the Rappahannock River and in 1994 on the James River. To date, one Atlantic sturgeon has been captured in the Rappahannock River gill nets (2005) and two Atlantic sturgeon have been captured in the James River gill nets (one each in 2008 and 2010). Based on the past capture rate, we expect no more than one capture each year for a total of five captures in each five year period. Based on the mixed stock analysis (using results from the NEFOP database because we do not have site-specific analysis), we expect that: 49% of the captured Atlantic sturgeon will originate from the NYB DPS, 20% from the SA DPS 14% from the CB DPS, 11% from the GOM DPS and 4% from Carolina DPS. Therefore, we anticipate the capture of two individuals from the NYB DPS, one from the South Atlantic DPS and one from the CB, GOM or Carolina DPS. Given an expected 1-2% mortality rate in research gillnets, we expect that no more than 1 Atlantic sturgeon will be killed during the five-year grant period; this individual could originate from any of the five DPSs.

7.8 Interactions with the research vessels

Sea turtles are known to be injured and/or killed as a result of being struck by vessels on the water and as a result of capture in or physical contact with fishing gear. With respect to the surveys considered here, the effects to sea turtles as a result of vessel activities are discountable. This is because each survey will operate with only a single vessels, contributing an extremely small increase in the amount of vessel traffic in any area. The likelihood that a survey vessel will strike a sea turtle is extremely low given that: (a) the vessels will operate/travel at a slow speed such that a sea turtle would have the speed and maneuverability to avoid contact with the vessel and (b) sea turtles spend part of their time at depths out of range of a vessel collision.

As noted in the 2007 Status Review and the proposed rule, in certain geographic areas vessel strikes have been identified as a threat to Atlantic sturgeon. While the exact number of Atlantic sturgeon killed as a result of being struck by boat hulls or propellers is unknown, it is an area of concern in the Delaware and James rivers. Brown and Murphy (2010) examined twenty-eight dead Atlantic sturgeon observed in the Delaware River from 2005-2008. Fifty-percent of the mortalities resulted from apparent vessel strikes and 71% of these (10 of 14) had injuries consistent with being struck by a large vessel (Brown and Murphy 2010). Eight of the fourteen vessel struck sturgeon were adult-sized fish (Brown and Murphy 2010). Given the time of year in which the fish were observed (predominantly May through July; Brown and Murphy 2010), it is likely that many of the adults were migrating through the river to the spawning grounds.

The factors relevant to determining the risk to Atlantic sturgeon from vessel strikes are currently unknown, but they may be related to size and speed of the vessels, navigational clearance (*i.e.*, depth of water and draft of the vessel) in the area where the vessel is operating, and the behavior of Atlantic sturgeon in the area (e.g., foraging, migrating, etc.). It is important to note that vessel strikes have only been identified as a significant concern in the upper Delaware and James rivers and current thinking suggests that there may be unique geographic features in these areas (e.g., potentially narrow migration corridors combined with shallow/narrow river channels) that increase the risk of interactions between vessels and Atlantic sturgeon. The risk of vessel strikes between Atlantic sturgeon and research vessels operating in the action area is likely to be low given that the research vessels are likely to be operating at slow speeds and there are no restrictions forcing Atlantic sturgeon into close proximity with the vessel as may be present in some rivers.

Given the large volume of vessel traffic in the action area and the wide variability in traffic in any given day, the increase in traffic (one vessel, traveling at relatively slow speeds) associated with any of the surveys is extremely small. Given the small and localized increase in vessel traffic that would result from the surveys and the slow speeds that any vessels would be operating at, it is unlikely that there would be any detectable increase in the risk of vessel strike. As such, effects to Atlantic sturgeon from the increase in vessel traffic are likely to be discountable.

7.9 Effects to Prey

Sea turtles could be negatively affected by the loss of prey as a result of mobile fishing gear that removes or incidentally kills such prey during commercial fishing or marine survey activities The use of trawls and gillnets for the surveys carried out by the states will not reduce the availability of prey for loggerhead, Kemp's ridley, green, or leatherback sea turtles. The sampling gear is expected to catch a variety of organisms including fish and crab species. None of these are typical prey species of leatherback sea turtles or of neritic juvenile or adult green sea turtles (Rebel 1974; Mortimer 1982; Bjorndal 1985, 1997; USFWS and NMFS 1992). Some organisms that are caught in the surveys will be sampled according to the survey protocol. Species that meet the sampling criteria will be sampled for scientific purposes and not returned to the water, while the other species will be returned to the water alive, dead, or injured to the extent that they will subsequently die. All of the species that will be retained for further study are fish. Crabs, on the other hand, which are the preferred prey of loggerhead and Kemp's ridley sea turtles, will not be retained for further study, and thus would still be available as prey for loggerheads and Kemp's ridleys when returned to the water, as both of these species of sea turtles are known to eat a variety of live prey as well as scavenge dead organisms (Lutcavage and Musick 1985; Keinath *et al.*1987; Dodd 1988; Burke *et al.*1993, 1994; Morreale and Standora 2005). Thus, the surveys are not expected to affect the availability of prey for loggerhead and Kemp's ridley sea turtles in the action area given that: (a) the sea turtle food items that are returned to the water could still be preyed upon by loggerheads and Kemp's ridleys, (b) the number of trawl tows for the studies are limited in scope and duration, and (c) the priority species that will be retained for scientific analysis are all fish species, which are not the preferred prey for loggerhead and Kemp's ridley sea turtles (Keinath *et al.*1987; Lutcavage and Musick 1985; Burke *et al.*1993, 1994; Morreale and Standora 2005).

Atlantic and shortnose sturgeon feed primarily on small benthic invertebrates and occasionally on small fish such as sand lance. Because of the small size or benthic nature of these prey species, it is unlikely that any of the surveys will capture any Atlantic or shortnose sturgeon prey items. Thus, the surveys will not affect the availability of prey for Atlantic or shortnose sturgeon. Any effects to prey will be limited to minor disturbances to the bottom from any bottom tending sampling gear. Because of this, we have determined that any effects to Atlantic and shortnose sturgeon prey or foraging Atlantic sturgeon will be insignificant and discountable.

7.10 Effects to Habitat

The only sampling gear that has the potential to result in the disturbance of habitat are bottom trawls. The areas to be surveyed by bottom trawls is principally sand substrate (NEFMC 2007). A panel of experts has previously concluded that the effects of even light weight otter trawl gear would include: (1) the scraping or plowing of the doors on the bottom, sometimes creating furrows along their path, (2) sediment suspension resulting from the turbulence caused by the doors and the ground gear on the bottom, (3) the removal or damage to benthic or demersal species, and (4) the removal or damage to structure forming biota. The panel also concluded that the greatest impacts from otter trawls occur in high and low energy gravel habitats and in hard clay outcroppings, and that sand habitats were the least likely to be impacted (NREFHSC 2002). The areas to be surveyed for the state surveys include very few habitats that are purely gravel or hard clay—so few that the area encompassed by these habitats is insignificant compared to the area encompassed by sand and silt type habitats, which are more resilient to bottom trawling. For sea turtles and sturgeon, the effects on habitat due to bottom otter trawl gear would be felt as an effect on their benthic prey species. Similarly, effects to habitat of gillnet gear are expected to be minor. As stated above, the effects on sea turtle and sturgeon prey items are expected to be insignificant.

8.0 CUMULATIVE EFFECTS

Cumulative effects, as defined in 50 CFR § 402.02, are those effects of future State or private activities, not involving Federal activities, which are reasonably certain to occur within the action area. Future Federal actions are not considered in the definition of "cumulative effects."

Actions carried out or regulated by the states within the action area that may affect sea turtles and Atlantic sturgeon include the authorization of state fisheries and the regulation of dredged material discharges through CWA Section 401-certification and point and non-point source pollution through the National Pollutant Discharge Elimination System. We are not aware of any local or private actions that are reasonably certain to occur in the action area that may affect listed species. It is important to note that the definition of "cumulative effects" in the section 7 regulations is not the same as the NEPA definition of cumulative effects[10].

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[10] Cumulative effects are defined for NEPA as "the impact on the environment, which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time."

Future recreational and commercial fishing activities in state waters may take shortnose and Atlantic sturgeon. Information on interactions with sea turtles and Atlantic sturgeon for state fisheries operating in the action area is summarized in the Environmental Baseline section above, and it is not clear to what extent these future activities would affect listed species differently than the current state fishery activities described in the Status of the Species/Environmental Baseline sections. However, this Opinion assumes effects in the future would be similar to those in the past and are, therefore, reflected in the anticipated trends described in the status of the species/environmental baseline sections.

State NPDES Permits – All of the states in the action area, with the exception of Massachusetts, New Hampshire and Washington D.C., have been delegated authority to issue NPDES permits by the EPA. These permits authorize the discharge of pollutants in the action area. Permitees include municipalities for sewage treatment plants and other industrial users. The states will continue to authorize the discharge of pollutants through these state issued permits. However, this Opinion assumes effects in the future would be similar to those in the past and are therefore reflected in the anticipated trends described in the status of the species/environmental baseline section.

9.0 INTEGRATION AND SYNTHESIS OF EFFECTS

We have determined that Atlantic sturgeon, shortnose sturgeon and sea turtles will be captured in several of the studies considered in this Opinion. No mortalities or serious injuries of any shortnose sturgeon or sea turtles are anticipated. A small number of Atlantic sturgeon may be killed due to interactions with gillnets (six total in a five-year period). We anticipate the following interactions during a five-year grant period (all non-lethal captures, unless otherwise indicated):

Study	**shortnose sturgeon**	**Total Atlantic sturgeon**	**GOM DPS Atlantic sturgeon**	**NYB DPS Atlantic sturgeon**	**CB DPS Atlantic sturgeon**	**Carolina DPS Atlantic sturgeon**	**SA DPS Atlantic sturgeon**	**loggerhead sea turtle**	**Kemp's ridley sea turtle**	**green sea turtle**	**leatherback sea turtle**
Maine beach seine	3	0	0	0	0	0	0	0	0	0	0
Delaware beach seine	1	0	0	0	0	0	0	0	0	0	0
NY beach and haul seine	4	2	2 individuals from GOM, NYB or CB			0	0	0	0	0	0
MA fish ladder	1	0	0	0	0	0	0	0	0	0	0
Maine/NH trawl	0	10	1	5	1	1	2	0	0	0	0
MA trawl	0	5	1 GOM, CB or Carolina	3	1 GOM, CB or Carolina	1 GOM, CB or Carolina	1	0	0	0	0
CT LIST	0	160	6	126	11	1	16	4	1 Kemps, green or leatherback		
NY Peconic trawl	0	0	0	0	0	0	0	1	1 Kemps, green or leatherback		
NJ Ocean	0	125	14	62	19	5	25	15*	5*: Kemps, green or leatherback		
DE Estuary bottom trawl	5	5	1 GOM, SA or Carolina	3	1	1 GOM, SA or Carolina	1 GOM, SA or Carolina	0	0	0	0
DE Bay Groundfish	5	16	1 GOM or Carolina	9	3	1 GOM or Carolina	3	4	2	1 green or leatherback	
MD Coastal Bays	0	0	0	0	0	0	0	1 sea turtle any species			
VA ChesMMAP	0	5	1 GOM, CB or Carolina	3	1 GOM, CB or Carolina	1 GOM, CB or Carolina	1	1 sea turtle any species			

VA juvenile fish	0	17	2	8	3	1	3	1 sea turtle any species			
NY Striped bass electrofishing	35	0	0	0	0	0	0	0	0	0	0
Delaware striped bass electrofishing	1	1	one Atlantic sturgeon from any of the five DPSs					0	0	0	0
NY shad gillnet	0	1	one capture (may be lethal) from any of the five DPSs					0	0	0	0
VA striped bass gillnet	0	5	1	2	1	1	1	0	0	0	0
			one mortality - individual could originate from any of the five DPSs								
NJ striped bass gillnet	0	41	3	23	7	1	7	0	0	0	0
			one mortality - individual could originate from any of the five DPSs								
MD striped bass drift gillnet	0	1	one capture (may be lethal) from any of the five DPSs					0	0	0	0
VA shad gillnet	0	113	13	56	16	5	23	0	0	0	0
			two mortalities - individuals could be from any of the five DPSs								

*In the NJ Ocean Trawl Survey, we anticipate the capture of 15 sea turtles in a five-year grant period, no more than 5 will be Kemp’s ridley, leatherback or green sea turtles, the rest will be loggerhead sea turtles.

As explained in the "Effects of the Action" section, all other effects to sea turtles and Atlantic sturgeon, including to their prey, will be insignificant or discountable.

In the discussion below, we consider whether the effects of the proposed actions reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of the listed species in the wild by reducing the reproduction, numbers, or distribution of the listed species that will be adversely affected by the action. The purpose of this analysis is to determine whether the proposed actions, in the context established by the status of the species, environmental baseline, and cumulative effects, would jeopardize the continued existence of any listed species. 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." We summarize below the status of the species and consider whether the proposed action will result in reductions in reproduction, numbers or distribution of these species and then consider 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 these species, as those terms are defined for purposes of the Endangered Species Act.

9.1 Northwest Atlantic DPS of loggerhead sea turtles

We have estimated that the actions under consideration in this Opinion will result in the capture of up to 27 loggerhead sea turtles over a five-year period. We do not anticipate any injury or mortality. All other effects to loggerhead sea turtles, including effects to prey, are expected to be insignificant and discountable.

The NWA DPS of loggerhead sea turtles is listed as "threatened" under the ESA. It takes decades for loggerhead sea turtles to reach maturity. Once they have reached maturity, females typically lay multiple clutches of eggs within a season, but do not typically lay eggs every season (NMFS and USFWS 2008). There are many natural and anthropogenic factors affecting the survival of loggerheads prior to their reaching maturity as well as for those adults who have reached maturity. As described in the Status of the Species/Environmental Baseline and Cumulative Effects sections above, loggerhead sea turtles in the action area continue to be affected by multiple anthropogenic impacts including bycatch in commercial and recreational fisheries, habitat alteration, dredging, power plant intakes and other factors that result in mortality of individuals at all life stages. Negative impacts causing death of various age classes occur both on land and in the water. Many actions have been taken to address known negative impacts to loggerhead sea turtles. However, many remain unaddressed, have not been sufficiently addressed, or have been addressed in some manner but whose success cannot be quantified.

The SEFSC (2009) estimated the number of adult females in the NWA DPS at 30,000, and if a 1:1 adult sex ratio is assumed, the result is 60,000 adults in this DPS. Based on the reviews of nesting data, as well as information on population abundance and trends, NMFS and USFWS determined in the September 2011 listing rule that the NWA DPS should be listed as threatened. They found that an endangered status for the NWA DPS was not warranted given the large size of the nesting population, the overall nesting population remains widespread, the trend for the nesting population appears to be stabilizing, and substantial conservation efforts are underway to address threats.

As there will be no injury or mortality to any individual loggerhead sea turtle and no effects to the prey base that would cause sea turtles to leave the action area to forage elsewhere, the proposed actions not likely to reduce the numbers of loggerhead sea turtles in the action area, the numbers of loggerheads in any subpopulation or the species as a whole. Similarly, as the proposed actions will not affect the fitness of any individuals, no effects to reproduction are anticipated. The action is also not likely to affect the distribution of loggerhead sea turtles in the action area or affect the distribution of sea turtles throughout their range. Because effects are limited to capture, with no injury or mortality, there are not anticipated to be any population level impacts. Despite the threats faced by individual loggerhead sea turtles inside and outside of the action area, the proposed action will not increase the vulnerability of individual sea turtles to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed action. While we are not able to predict with precision how climate change will continue to impact loggerhead sea turtles in the action area or how the species will adapt to climate-change related environmental impacts, no additional effects related to climate change to loggerhead sea turtles in the action area are anticipated over the life of the proposed action (*i.e.*, for five years). We have considered the effects of the proposed action in light of cumulative effects explained above, including climate change, and has concluded that even in light of the ongoing impacts of these activities and conditions, the conclusions reached above do not change.

Based on the information provided above, the non-lethal capture of 27 or fewer NWA DPS loggerhead sea turtles in the trawl surveys considered here will not appreciably reduce the likelihood of survival of this species (*i.e.*, it will not increase the risk of extinction faced by this species) given that: (1) there will be no mortality and therefore, no reduction in the numbers of NWA DPS sea turtles; (2) there will be no effect to the fitness of any individuals and no effect on reproductive output of the species; (3) and, the action will have only a minor and temporary effect on the distribution of NWA DPS loggerhead sea turtles in the action area (related to the temporary capture and handling of captured individuals) 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 NWA DPS will survive in the wild. Here, NMFS considers the potential for the action to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate. Section 4(a)(1) of the ESA requires listing of a species if it is in danger of extinction throughout all or a significant portion of its range (*i.e.*, "endangered"), or likely to become in danger of extinction throughout all or a significant portion of its range in the foreseeable future (*i.e.*, "threatened") because of any of the following five listing factors: (1) the present or threatened destruction, modification, or curtailment of its habitat or range, (2) overutilization for commercial, recreational, scientific, or educational purposes, (3) disease or predation, (4) the inadequacy of existing regulatory mechanisms, (5) other natural or manmade factors affecting its continued existence.

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

9.2 Leatherback sea turtles

We have estimated that the actions under consideration in this Opinion will result in the capture of up to eleven leatherback sea turtles over a five-year period. We do not anticipate any injury or mortality. All other effects to leatherback sea turtles, including effects to prey, are expected to be insignificant and discountable.

Leatherback sea turtles are listed as "endangered" under the ESA. Leatherbacks are widely distributed throughout the oceans of the world, and are found in waters of the Atlantic, Pacific, and Indian Oceans, the Caribbean Sea, Mediterranean Sea, and the Gulf of Mexico (Ernst and Barbour 1972). Leatherback nesting occurs on beaches of the Atlantic, Pacific, and Indian Oceans as well as in the Caribbean (NMFS and USFWS 2007b). Leatherbacks face a multitude of threats that can cause death prior to and after reaching maturity. Some activities resulting in leatherback mortality have been addressed. There are some population estimates for leatherback sea turtles although there appears to be considerable uncertainty in the numbers. The most recent population size estimate for the North Atlantic alone is 34,000-94,000 adult leatherbacks (TEWG 2007; NMFS and USFWS 2007b).

Leatherback nesting in the eastern Atlantic (*i.e.,* off Africa) and in the Caribbean appears to be stable, but there is conflicting information for some sites and it is certain that some nesting groups (*e.g.*, St. John and St. Thomas, U.S. Virgin Islands) have been extirpated (NMFS and USFWS 1995). Data collected for some nesting beaches in the western Atlantic, including leatherback nesting beaches in the U.S., clearly indicate increasing numbers of nests (NMFS SEFSC 2001; NMFS and USFWS 2007b). However, declines in nesting have been noted for beaches in the western Caribbean (NMFS and USFWS 2007b). The largest leatherback rookery in the western Atlantic remains along the northern coast of South America in French Guiana and Suriname. More than half the present world leatherback population is estimated to nest on the beaches in and close to the Marowijne River Estuary in Suriname and French Guiana (Hilterman and Goverse 2004). The long-term trend for the Suriname and French Guiana nesting group seems to show an increase (Hilterman and Goverse 2004). In 2001, the number of nests for Suriname and French Guiana combined was 60,000, one of the highest numbers observed for this region in 35 years (Hilterman and Goverse 2004). Studies by Girondot *et al.*(2007) also suggest that the trend for the Suriname - French Guiana nesting population over the last 36 years is stable or slightly increasing.

Increased nesting by leatherbacks in the Atlantic is not expected to affect leatherback abundance in the Pacific where the abundance of leatherback sea turtles on nesting beaches has declined dramatically over the past 10 to 20 years (NMFS and USFWS 2007b). Although genetic analyses suggest little difference between Atlantic and Pacific leatherbacks (Bowen and Karl 2007), it is generally recognized that there is little to no genetic exchange between these turtles.

There will be no injury or mortality to any individual leatherback sea turtle; there will be no effects to the prey base that would cause sea turtles to leave the action area. Therefore, the proposed actions are not likely to reduce the numbers of leatherback sea turtles in the action area, the numbers of leatherbacks in any subpopulation or the species as a whole. The proposed action will not affect the fitness of any individuals and we do not anticipate any effects to reproduction. The action is also not likely to affect the distribution of leatherback sea turtles in the action area or affect the distribution of leatherback sea turtles throughout their range. Because effects are limited to capture, with no injury or mortality, we do not anticipate any population level impacts. Despite the threats faced by individual leatherback sea turtles inside and outside of the action area, the proposed actions will not increase the vulnerability of individual sea turtles to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed action. While we are not able to predict with precision how climate change will continue to impact leatherback sea turtles in the action area or how the species will adapt to climate-change related environmental impacts, no additional effects related to climate change to leatherback sea turtles in the action area are anticipated over the five-year life of the proposed actions. We have considered the effects of the proposed action in light of cumulative effects explained above, including climate change, and has concluded that even in light of the ongoing impacts of these activities and conditions, the conclusions reached above do not change.

Based on the information provided above, the non-lethal capture of up to eleven leatherback sea turtles will not appreciably reduce the likelihood of survival of this species (*i.e.*, it will not increase the risk of extinction faced by this species) given that: (1) there will be no mortality and therefore, no reduction in the numbers of leatherback sea turtles; (2) there will be no effect to the fitness of any individuals and no effect on reproductive output of the species; (3) and, the action will have only a minor and temporary effect on the distribution of leatherback sea turtles in the action area (related to the temporary capture and handling of captured individuals) 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, we have determined that the proposed action will not appreciably reduce the likelihood that the leatherback sea turtle species will survive in the wild. Here, we consider the potential for the action to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate. Section 4(a)(1) of the ESA requires listing of a species if it is in danger of extinction throughout all or a significant portion of its range (*i.e.*, "endangered"), or likely to become in danger of extinction throughout all or a significant portion of its range in the foreseeable future (*i.e.*, "threatened") because of any of the following five listing factors: (1) the present or threatened destruction, modification, or curtailment of its habitat or range, (2) overutilization for commercial, recreational, scientific, or educational purposes, (3) disease or predation, (4) the inadequacy of existing regulatory mechanisms, (5) other natural or manmade factors affecting its continued existence.

We do not expect the proposed actions to modify, curtail or destroy the range of the species since it will not result in a reduction in the number of leatherback sea turtles and since it will not affect the overall distribution of the species other than to cause minor temporary adjustments in movements in the action area. The proposed action is not likely to result in any mortality or reductions in fitness or future reproductive output and therefore, the proposed actions will not affect the persistence of the species. There will not be a change in the status or trend of the species. As there will be no reduction in numbers or future reproduction the action would not cause any reduction in the likelihood of improvement in the status of leatherback sea turtles. The effects of the proposed action will not delay the recovery timeline or otherwise decrease the likelihood of recovery since the action will not cause any mortality or reduction of overall reproductive fitness for the species. The effects of the proposed action will also not reduce the likelihood that the status of the species can improve to the point where it is recovered and could be delisted. Therefore, the proposed action will not appreciably reduce the likelihood that leatherback sea turtles 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.

9.3 Kemp's ridley sea turtles

We have estimated that the actions under consideration in this Opinion will result in the capture of up to twelve Kemp's ridley sea turtles over a five-year period. We do not anticipate any injury or mortality. All other effects to Kemp's ridley sea turtles, including effects to prey, are expected to be insignificant and discountable.

Kemp's ridley sea turtles are listed as a single species classified as "endangered" under the ESA. Kemp's ridleys occur in the Atlantic Ocean and Gulf of Mexico. The only major nesting site for Kemp's ridleys is a single stretch of beach near Rancho Nuevo, Tamaulipas, Mexico (Carr 1963; USFWS and NMFS 1992; NMFS and USFWS 2007c).

Nest count data provides the best available information on the number of adult females nesting each year. As is the case with the other sea turtles species discussed above, nest count data must be interpreted with caution given that these estimates provide a minimum count of the number of nesting Kemp's ridley sea turtles. In addition, the estimates do not account for adult males or juveniles of either sex. Without information on the proportion of adult males to females, and the age structure of the Kemp's ridley population, nest counts cannot be used to estimate the total population size (Meylan 1982; Ross 1996; Zurita *et al.*2003; Hawkes *et al.*2005; letter to J. Lecky, NMFS Office of Protected Resources, from N. Thompson, NMFS Northeast Fisheries Science Center, December 4, 2007). Nevertheless, the nesting data does provide valuable information on the extent of Kemp's ridley nesting and the trend in the number of nests laid. Estimates of the adult female nesting population reached a low of approximately 250-300 in 1985 (USFWS and NMFS 1992; TEWG 2000). From 1985 to 1999, the number of nests observed at Rancho Nuevo and nearby beaches increased at a mean rate of 11.3% per year (TEWG 2000). Current estimates suggest an adult female population of 7,000-8,000 Kemp's ridleys (NMFS and USFWS 2007c).

The most recent review of the Kemp's ridleys suggests that this species is in the early stages of recovery (NMFS and USFWS 2007b). Nest count data indicate increased nesting and increased numbers of nesting females in the population. NMFS also takes into account a number of recent conservation actions including the protection of females, nests, and hatchlings on nesting beaches since the 1960s and the enhancement of survival in marine habitats through the implementation of TEDs in the early 1990s and a decrease in the amount of shrimping off the coast of Tamaulipas and in the Gulf of Mexico in general (NMFS and USFWS 2007b).

As there will be no injury or mortality to any individual Kemp's ridley sea turtle and no effects to the prey base that would cause sea turtles to leave the action area to forage elsewhere, the proposed actions are not likely to reduce the numbers of Kemp's ridley sea turtles in the action area, the numbers of Kemp's ridleys in any subpopulation or the species as a whole. Similarly, as the proposed actions will not affect the fitness of any individual, no effects to reproduction are anticipated. The action is also not likely to affect the distribution of Kemp's ridley sea turtles in the action area or affect the distribution of sea turtles throughout their range. Because effects are limited to capture, with no injury or mortality, there are not anticipated to be any population level impacts. Despite the threats faced by individual Kemp's ridley sea turtles inside and outside of the action area, the proposed action will not increase the vulnerability of individual sea turtles to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed action. While we are not able to predict with precision how climate change will continue to impact Kemp's ridley sea turtles in the action area or how the species will adapt to climate-change related environmental impacts, no additional effects related to climate change to leatherback sea turtles in the action area are anticipated over the five-year life of the proposed actions. We have considered the effects of the proposed action in light of cumulative effects explained above, including climate change, and has concluded that even in light of the ongoing impacts of these activities and conditions, the conclusions reached above do not change.

Based on the information provided above, the non-lethal capture of up to twelve Kemp's ridley sea turtles in the NJ ocean trawl surveys will not appreciably reduce the likelihood of survival of this species (*i.e.*, it will not increase the risk of extinction faced by this species) given that: (1) there will be no mortality and therefore, no reduction in the numbers of Kemp's ridley sea turtles; (2) there will be no effect to the fitness of any individuals and no effect on reproductive output of the species; (3) and, the action will have only a minor and temporary effect on the distribution of Kemp's ridley sea turtles in the action area (related to the temporary capture and handling of captured individuals) 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, we have determined that the proposed action will not appreciably reduce the likelihood that the Kemp's ridley sea turtle species will survive in the wild. Here, we consider the potential for the action to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate. Section 4(a)(1) of the ESA requires listing of a species if it is in danger of extinction throughout all or a significant portion of its range (*i.e.*, "endangered"), or likely to become in danger of extinction throughout all or a significant portion of its range in the foreseeable future (*i.e.*, "threatened") because of any of the following five listing factors: (1) the present or threatened destruction, modification, or curtailment of its habitat or range, (2) overutilization for commercial, recreational, scientific, or educational purposes, (3) disease or predation, (4) the inadequacy of existing regulatory mechanisms, (5) other natural or manmade factors affecting its continued existence.

The proposed actions are not expected to modify, curtail or destroy the range of the species since it will not result in a reduction in the number of Kemp's ridley sea turtles and since it will not affect the overall distribution of the species other than to cause minor temporary adjustments in movements in the action area. The proposed actions are not likely to result in any mortality or reductions in fitness or future reproductive output and therefore, it is not expected to affect the persistence of the species. There will not be a change in the status or trend of the species. As there will be no reduction in numbers or future reproduction the action would not cause any reduction in the likelihood of improvement in the status of Kemp's ridley sea turtles. The effects of the proposed actions will not delay the recovery timeline or otherwise decrease the likelihood of recovery since the action will not cause any mortality or reduction of overall reproductive fitness for the species. The effects of the proposed actions 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 actions will not appreciably reduce the likelihood that Kemp's ridley sea turtles can be brought to the point at which they are no longer listed as endangered. Based on the analysis presented herein, the proposed actions are not likely to appreciably reduce the survival and recovery of this species.

9.4 Green sea turtles

We have estimated that the actions under consideration in this Opinion will result in the capture of up to eleven green sea turtles over a five-year period. We do not anticipate any injury or mortality. All other effects to green sea turtles, including effects to prey, are expected to be insignificant and discountable.

Green sea turtles are listed as both threatened and endangered under the ESA. Breeding colony populations in Florida and on the Pacific coast of Mexico are considered endangered while all others are considered threatened. Due to the inability to distinguish between these populations away from the nesting beach, for this Opinion, green sea turtles are considered endangered wherever they occur in U.S. waters. Green sea turtles are distributed circumglobally and can be found in the Pacific, Indian, and Atlantic Oceans as well as the Mediterranean Sea (NMFS and USFWS 1991; Seminoff 2004; NMFS and USFWS 2007d). As is also the case with the other sea turtle species, green sea turtles face numerous threats on land and in the water that affect the survival of all age classes.

A review of 32 Index Sites distributed globally revealed a 48% to 67% decline in the number of mature females nesting annually over the last three generations (Seminoff 2004). For example, in the eastern Pacific, the main nesting sites for the green sea turtle are located in Michoacan, Mexico, and in the Galapagos Islands, Ecuador, where the number of nesting females exceeds 1,000 females per year at each site (NMFS and USFWS 2007d). Historically, however, greater than 20,000 females per year are believed to have nested in Michoacan alone (Cliffton *et al.*1982; NMFS and USFWS 2007d). However, the decline is not consistent across all green sea turtle nesting areas. Increases in the number of nests counted and, presumably, the numbers of mature females laying nests were recorded for several areas (Seminoff 2004; NMFS and USFWS 2007d). Of the 32 index sites reviewed by Seminoff (2004), the trend in nesting was described as: increasing for 10 sites, decreasing for 19 sites, and stable (no change) for 3 sites. Of the 46 green sea turtle nesting sites reviewed for the 5-year status review, the trend in nesting was described as increasing for 12 sites, decreasing for 4 sites, stable for 10 sites, and unknown for 20 sites (NMFS and USFWS 2007d). The greatest abundance of green sea turtle nesting in the western Atlantic occurs on beaches in Tortuguero, Costa Rica (NMFS and USFWS 2007d). Nesting in the area has increased considerably since the 1970s and nest count data from 1999-2003 suggest nesting by 17,402-37,290 females per year (NMFS and USFWS 2007d). One of the largest nesting sites for green sea turtles worldwide is still believed to be on the beaches of Oman in the Indian Ocean (Hirth 1997; Ferreira *et al.*2003; NMFS and USFWS 2007d).

However, nesting data for this area has not been published since the 1980s and updated nest numbers are needed (NMFS and USFWS 2007d).

The results of genetic analyses show that green sea turtles in the Atlantic do not contribute to green sea turtle nesting elsewhere in the species' range (Bowen and Karl 2007). Therefore, increased nesting by green sea turtles in the Atlantic is not expected to affect green sea turtle abundance in other ocean basins in which the species occurs. However, the ESA-listing of green sea turtles as a species across ocean basins means that the effects of a proposed action must, ultimately, be considered at the species level for section 7 consultations. NMFS recognizes that the nest count data available for green sea turtles in the Atlantic clearly indicates increased nesting at many sites. However, NMFS also recognizes that the nest count data, including data for green sea turtles in the Atlantic, only provides information on the number of females currently nesting, and is not necessarily a reflection of the number of mature females available to nest or the number of immature females that will reach maturity and nest in the future. Given the late age to maturity for green sea turtles (20 to 50 years) (Balazs 1982; Frazer and Ehrhart 1985; Seminoff 2004), caution is urged regarding the trend for any of the nesting groups since no area has a dataset spanning a full green sea turtle generation (NMFS and USFWS 2007d).

We do not expect any of the captured green sea turtles to be injured or killed. There will be no effects to the prey base that would cause sea turtles to leave the action area to forage elsewhere. Therefore, the proposed actions are not likely to reduce the numbers of green sea turtles in the action area, the numbers of greens in any subpopulation or the species as a whole. Similarly, as the proposed actions will not affect the fitness of any individual, no effects to reproduction are anticipated. The actions are also not likely to affect the distribution of green sea turtles in the action area or affect the distribution of sea turtles throughout their range. Because effects are limited to capture, with no injury or mortality, we do not anticipate any population level impacts. Despite the threats faced by individual green sea turtles inside and outside of the action area, the proposed action will not increase the vulnerability of individual sea turtles to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed action. While we are not able to predict with precision how climate change will continue to impact green sea turtles in the action area or how the species will adapt to climate-change related environmental impacts, no additional effects related to climate change to green sea turtles in the action area are anticipated over the five-year life of the proposed action. We have considered the effects of the proposed action in light of cumulative effects explained above, including climate change, and has concluded that even in light of the ongoing impacts of these activities and conditions, the conclusions reached above do not change.

Based on the information provided above, the non-lethal capture of up to eleven green sea turtles will not appreciably reduce the likelihood of survival of this species (*i.e.*, it will not increase the risk of extinction faced by this species) given that: (1) there will be no mortality and therefore, no reduction in the numbers of green sea turtles; (2) there will be no effect to the fitness of any individuals and no effect on reproductive output of the species; (3) and, the action will have only a minor and temporary effect on the distribution of green sea turtles in the action area (related to the temporary capture and handling of captured individuals) 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, we have determined that the proposed action will not appreciably reduce the likelihood that the green sea turtle species will survive in the wild. Here, we consider the potential for the action to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate. Section 4(a)(1) of the ESA requires listing of a species if it is in danger of extinction throughout all or a significant portion of its range (*i.e.*, "endangered"), or likely to become in danger of extinction throughout all or a significant portion of its range in the foreseeable future (*i.e.*, "threatened") because of any of the following five listing factors: (1) the present or threatened destruction, modification, or curtailment of its habitat or range, (2) overutilization for commercial, recreational, scientific, or educational purposes, (3) disease or predation, (4) the inadequacy of existing regulatory mechanisms, (5) other natural or manmade factors affecting its continued existence.

The proposed action is not expected to modify, curtail or destroy the range of the species since it will not result in a reduction in the number of green sea turtles and since it will not affect the overall distribution of the species. The proposed action is not likely to result in any mortality or reductions in fitness or future reproductive output and therefore, it is not expected to affect the persistence of the species. There will not be a change in the status or trend of the species. As there will be no reduction in numbers or future reproduction the action would not cause any reduction in the likelihood of improvement in the status of green sea turtles. The effects of the proposed action will not delay the recovery timeline or otherwise decrease the likelihood of recovery since the action will not cause any mortality or reduction of overall reproductive fitness for the species. The effects of the proposed action will also not reduce the likelihood that the status of the species can improve to the point where it is recovered and could be delisted. Therefore, the proposed action will not appreciably reduce the likelihood that green sea turtles 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.

9.5 Shortnose sturgeon

We have determined that over a five-year period, the proposed actions are likely to result in the capture of 18 shortnose sturgeon in sampling gear; exposure of 36 shortnose sturgeon to electric current resulting from electrofishing; and capture of one shortnose sturgeon in the fish ladder on the Westfield River. We do not anticipate any injury or mortality of any captured shortnose sturgeon; we expect all will be returned to the water alive. Affected shortnose sturgeon will be from the Kennebec, Delaware, Hudson, and Connecticut River populations.

Historically, shortnose sturgeon are believed to have inhabited nearly all major rivers and estuaries along nearly the entire east coast of North America. Today, only 19 populations remain. The present range of shortnose sturgeon is disjunct, with northern populations separated from southern populations by a distance of about 400 km. Population sizes range from under 100 adults in the Cape Fear and Merrimack Rivers to tens of thousands in the St. John and Hudson Rivers. As indicated in Kynard 1996, adult abundance is less than the minimum estimated viable population abundance of 1,000 adults for five of 11 surveyed northern populations and all natural southern populations. The only river systems likely supporting populations close to expected abundance are the St John, Hudson and possibly the Delaware and the Kennebec (Kynard 1996), making the continued success of shortnose sturgeon in these rivers critical to the species as a whole.

While no reliable estimate of the size of either the shortnose sturgeon population in the Northeastern US or of the species throughout its range exists, it is clearly below the size that could be supported if the threats to shortnose sturgeon were removed. Based on the number of adults in population for which estimates are available, there are at least 104,662 adult shortnose sturgeon, including 18,000 in the Saint John River in Canada. Based on the best available information (2010 Draft Biological Assessment for Shortnose Sturgeon) trends in abundance for shortnose sturgeon in Northeast Rivers demonstrate the majority of populations are stable (i.e., Delaware, Hudson, Connecticut, Merrimack). The Kennebec River Complex is the only population in the Northeast that shows an increasing trend in abundance. In the Southeast abundance trends for many riverine populations are unknown due to lack of data (i.e., Chowan, Tar Pamlico, Neuse, New, North, Santee, S-C Reservoir system, Satilla, St. Mary's, and St. John's). The Winyah Bay Complex, Cooper, Savannah, Ogeechee, and Altamaha Rivers show stable trends in abundance. The only riverine population in the Southeast demonstrating increasing trends in abundance is the ACE Basin.

We do not expect any of the captured shortnose sturgeon to be injured or killed. There will be no effects to the prey base that would cause shortnose sturgeon to leave the action area to forage elsewhere. Therefore, the proposed actions are not likely to reduce the numbers of shortnose sturgeon in the action area, the numbers of shortnose sturgeon in any river population or the species as a whole. Similarly, as the proposed actions will not affect the fitness of any individual, no effects to reproduction are anticipated. The actions are also not likely to affect the distribution of shortnose sturgeon in the action area or affect the distribution of shortnose sturgeon throughout their range. Because effects are limited to capture, with no injury or mortality, we do not anticipate any population level impacts. Despite the threats faced by individual shortnose sturgeon inside and outside of the action area, the proposed action will not increase the vulnerability of individual sea turtles to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed action. While we are not able to predict with precision how climate change will continue to impact shortnose sturgeon turtles in the action area or how the species will adapt to climate-change related environmental impacts, no additional effects related to climate change to shortnose sturgeon in the action area are anticipated over the five-year life of the proposed action. We have considered the effects of the proposed action in light of cumulative effects explained above, including climate change, and has concluded that even in light of the ongoing impacts of these activities and conditions, the conclusions reached above do not change.

Based on the information provided above, the anticipated effects to up to 55 shortnose sturgeon over a five-year period will not appreciably reduce the likelihood of survival of this species (*i.e.*, it will not increase the risk of extinction faced by this species) given that: (1) there will be no mortality and therefore, no reduction in the numbers of shortnose sturgeon; (2) there will be no effect to the fitness of any individuals and no effect on reproductive output of the species; (3) and, the action will have only a minor and temporary effect on the distribution of shortnose sturgeon in the action area (related to the temporary capture and handling of captured individuals) 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, we have determined that the proposed action will not appreciably reduce the likelihood that the shortnose sturgeon species will survive in the wild. Here, we consider the potential for the action to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate. Section 4(a)(1) of the ESA requires listing of a species if it is in danger of extinction throughout all or a significant portion of its range (*i.e.*, "endangered"), or likely to become in danger of extinction throughout all or a significant portion of its range in the foreseeable future (*i.e.*, "threatened") because of any of the following five listing factors: (1) the present or threatened destruction, modification, or curtailment of its habitat or range, (2) overutilization for commercial, recreational, scientific, or educational purposes, (3) disease or predation, (4) the inadequacy of existing regulatory mechanisms, (5) other natural or manmade factors affecting its continued existence.

The proposed action is not expected to modify, curtail or destroy the range of the species since it will not result in a reduction in the number of green sea turtles and since it will not affect the overall distribution of the species. The proposed action is not likely to result in any mortality or reductions in fitness or future reproductive output and therefore, it is not expected to affect the persistence of the species. There will not be a change in the status or trend of the species. As there will be no reduction in numbers or future reproduction the action would not cause any reduction in the likelihood of improvement in the status of shortnose sturgeon. The effects of the proposed action will not delay the recovery timeline or otherwise decrease the likelihood of recovery since the action will not cause any mortality or reduction of overall reproductive fitness for the species. The effects of the proposed action will also not reduce the likelihood that the status of the species can improve to the point where it is recovered and could be delisted. Therefore, the proposed action will not appreciably reduce the likelihood that 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.

9.6 Atlantic sturgeon

The proposed actions are likely to result in the interaction with or capture of up to 507 Atlantic sturgeon. These captures or interactions are likely to occur in seine surveys, ocean trawl surveys, electrofishing surveys and gillnet studies. We have considered the best available information to determine from which DPSs these individuals are likely to have originated. Using site specific mixed stock analysis when possible, we have determined that the 507 affected Atlantic sturgeon are likely to consist of: up to 45 individuals from the GOM DPS, up to 305 from the NYB DPS, 64 from the CB DPS, up to 21 from the Carolina DPS, and up to 81 from the South Atlantic DPS. We have determined that there are likely to be no more than six mortalities. These individuals could originate from any of the five DPSs. It is unlikely that there would be more than two mortalities from any one DPS but we have considered the possibility that up to six individuals from any one DPS could be killed. However, given the distribution of individuals from each DPS throughout the action area, it is much more likely that each DPS will lose one or two individuals over the five-year period.

9.6.1 Gulf of Maine DPS

The GOM DPS is listed as threatened. While Atlantic sturgeon occur in several rivers in the Gulf of Maine region, recent spawning has only been documented in the Kennebec; spawning is suspected to also occur in the Androscoggin river. No estimate of the number of Atlantic sturgeon in any river or for any life stage or the total population is available although the ASSRT stated that there were likely less than 300 spawners per year. GOM origin Atlantic sturgeon are affected by numerous sources of human induced mortality and habitat disturbance throughout the riverine and marine portions of their range. While there are some indications that the status of the GOM DPS may be improving, there is currently not enough information to establish a trend for any life stage or for the DPS as a whole.

We have estimated that the proposed actions will result in the capture of 493 or fewer Atlantic sturgeon over a five-year period, of which up to 45 are expected to be GOM DPS Atlantic sturgeon. We anticipate the mortality of only six individuals; no injury or mortality of any other captured Atlantic sturgeon is anticipated. While it is unlikely that all six Atlantic sturgeon that die as a result of the proposed actions will originate from the GOM DPS, we have considered this worst-case scenario in this analysis.

With the exception of a small percentage of Atlantic sturgeon captured in gill net surveys, all sturgeon captured in beach or haul seines, trawl surveys, or gill nets are anticipated to fully recover from capture without any injury or impact on fitness or future reproductive potential. We also anticipate that any Atlantic sturgeon exposed to electrical current during electrofishing will fully recover within a few minutes and not experience any injury or impact to fitness or future reproductive potential. The short duration of any capture and handling (*i.e.*, less than 45 minutes total, 20-30 tow or gillnet set plus up to 10-15 minutes of handling time) will not cause a delay or disruption of any essential behavior including spawning, there will be no reduction in individual fitness or any future reduction in numbers of individuals. Additionally, given the locations of the surveys and the time of year, we do not anticipate the capture of handling of any spawning individuals. The proposed actions will also not affect their spawning habitat in any way and will not create any barrier to pre-spawning sturgeon accessing foraging or overwintering sites or the spawning grounds. Any effects to distribution will be minor and temporary and limited to the temporary capture and handling of individuals.

Here, we consider the effect of the loss of up to six Atlantic sturgeon over a five-year period from the GOM DPS. Mortalities are likely to occur in gillnets. The gillnet surveys that may result in mortality will take place in the Hudson River, Delaware Bay and Chesapeake Bay. Atlantic sturgeon killed may be juveniles, subadults or adults.

The reproductive potential of the GOM DPS will not be affected in any way other than through a reduction in numbers of individuals. The loss of a total of up to six individuals over a five-year period, would have the effect of reducing the amount of potential reproduction as any dead GOM DPS Atlantic sturgeon would have no potential for future reproduction. However, this small reduction in potential future spawners is expected to result in an extremely small reduction in the number of eggs laid or larvae produced in future years and similarly, an extremely small effect on the strength of subsequent year classes. Even considering the potential future spawners that would be produced by the individual that would be killed as a result of the proposed action, any effect to future year classes is anticipated to be extremely small and would not change the status of this species. As noted above, reproductive potential of Atlantic sturgeon captured and not killed is not expected to be affected in any way. Additionally, we have determined that any impacts to behavior of captured fish will be minor and temporary and that there will not be any delay or disruption of any normal behavior including spawning; there will also be no reduction in individual fitness or any future reduction in numbers of individuals. The proposed actions will also not affect the spawning grounds within the rivers where GOM DPS fish spawn. The actions will also not create any barrier to pre-spawning sturgeon accessing the overwintering sites or the spawning grounds used by GOM DPS fish.

Because we do not have a population estimate for the GOM DPS, it is difficult to evaluate the effect of the mortality caused by these actions on the species. However, because the proposed actions will result in the loss of no more than six individuals over a five-year period, and there is unlikely to be more than one mortality each year, it is unlikely that these deaths will have a detectable effect on the numbers and population trend of the GOM DPS.

The proposed actions are not likely to reduce distribution because the actions will not impede Atlantic sturgeon from accessing any seasonal concentration areas, including foraging areas within the action area that may be used by GOM DPS subadults or adults. Further, the actions are not expected to reduce the river by river distribution of Atlantic sturgeon. Any effects to distribution will be minor and temporary and limited to the temporary avoidance of the area where suspended sediment levels are high.

Based on the information provided above, the death of up to six GOM DPS Atlantic sturgeon over a five-year period, will not appreciably reduce the likelihood of survival of the GOM DPS (*i.e.*, it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). The action will not affect GOM DPS Atlantic sturgeon in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, and it will not result in effects to the environment which would prevent Atlantic sturgeon from completing their entire life cycle, including reproduction, sustenance, and shelter. This is the case because: (1) the death of one GOM DPS Atlantic sturgeon in any year and the total loss of up to six individuals will not change the status or trends of the species as a whole; (3) the loss of these GOM DPS Atlantic sturgeon is not likely to have an effect on the levels of genetic heterogeneity in the population; (4) the loss of these GOM DPS Atlantic sturgeon over a five-year period is likely to have such a small effect on reproductive output that the loss of these individuals will not change the status or trends of the species; (5) the actions will have only a minor and temporary effect on the distribution of GOM DPS Atlantic sturgeon in the action area and no effect on the distribution of the species throughout its range; and, (6) the actions will have no effect on the ability of GOM DPS Atlantic sturgeon to shelter and only an insignificant effect on any foraging GOM DPS Atlantic sturgeon.

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, we have determined that the proposed actions will not appreciably reduce the likelihood that the GOM DPS will survive in the wild. Here, we consider the potential for the actions to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate. Thus, we have considered whether the proposed actions will affect the likelihood that the GOM DPS can rebuild to a point where listing is no longer appropriate. No Recovery Plan for the GOM DPS has been published. The Recovery Plan will outline the steps necessary for recovery and the demographic criteria, which once attained would allow the species to be delisted. We know that in general, to recover, a species must have a sustained positive trend over time and an increase in population. To allow those things to happen, a species must have enough habitat in suitable condition that allows all normal life functions to occur (i.e., spawning, foraging, resting) and have access to enough food. Here, we consider whether the proposed actions will affect the population size and/or trend in a way that would affect the likelihood of recovery.

We do not expect the proposed actions to modify, curtail or destroy the range of the species since it will result in an extremely small reduction in the number of GOM DPS Atlantic sturgeon and since it will not affect the overall distribution of GOM DPS Atlantic sturgeon. Any effects to habitat will be insignificant and discountable and will not affect the ability of Atlantic sturgeon to carry out any necessary behaviors or functions. Any impacts to available forage will also be insignificant. The proposed actions will result in an extremely small amount of mortality annually (one individual) and a subsequent small reduction in future reproductive output. For these reasons, we do not expect the actions to affect the persistence of the GOM DPS of Atlantic sturgeon. These actions will not change the status or trend of the GOM DPS of Atlantic sturgeon. The very small reduction in numbers and future reproduction resulting from the proposed actions will not reduce the likelihood of improvement in the status of the GOM DPS of Atlantic sturgeon. The effects of the proposed actions will not delay the recovery timeline or otherwise decrease the likelihood of recovery. The effects of the proposed actions 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 actions will not appreciably reduce the likelihood that the GOM DPS of Atlantic sturgeon can be brought to the point at which they are no longer listed as threatened. Based on the analysis presented herein, the proposed actions are not likely to appreciably reduce the survival and recovery of this species.

Despite the threats faced by individual GOM DPS Atlantic sturgeon inside and outside of the action area, the proposed actions will not increase the vulnerability of individual sturgeon to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed actions. We have considered the effects of the proposed action in light of cumulative effects explained above, including climate change, and have concluded that even in light of the ongoing impacts of these activities and conditions; the conclusions reached above do not change. Based on the analysis presented herein, the proposed actions, resulting in the mortality of up to six GOM DPS Atlantic sturgeon over a five-year period, are not likely to appreciably reduce the survival and recovery of this species.

9.6.2 New York Bight DPS

We have estimated that the proposed actions will result in the capture of 493 or fewer Atlantic sturgeon over a five-year period, of which up to 305 are expected to be NYB DPS Atlantic sturgeon. We anticipate the mortality of only six individuals; no injury or mortality of any other captured Atlantic sturgeon is anticipated. While it is unlikely that all six Atlantic sturgeon that die as a result of the proposed actions will originate from the NYB DPS, we have considered this worst-case scenario in this analysis.

The NYB DPS is listed as endangered. While Atlantic sturgeon occur in several rivers in the NYB DPS region, recent spawning has only been documented in the Delaware and Hudson rivers. As noted above, we expect all Atlantic sturgeon impinged at Indian Point will originate from the Hudson River. There is limited information on the demographics of the Hudson River population of Atlantic sturgeon. An annual mean estimate of 863 mature adults (596 males and 267 females) was calculated for the Hudson River based on fishery-dependent data collected from 1985-1995 (Kahnle *et al.* 2007).

No data on abundance of juveniles are available prior to the 1970s; however, catch depletion analysis estimated conservatively that 6,000-6,800 females contributed to the spawning stock during the late 1800s (Secor 2002, Kahnle *et al*. 2005). Two estimates of immature Atlantic sturgeon have been calculated for the Hudson River population, one for the 1976 year class and one for the 1994 year class. Dovel and Berggren (1983) marked immature fish from 1976-1978. Estimates for the 1976 year class at age were approximately 25,000 individuals. Dovel and Berggren estimated that in 1976 there were approximately 100,000 juvenile (non-migrant) Atlantic sturgeon from approximately 6 year classes, excluding young of year.

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

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

The Long River Survey (LRS) samples ichthyoplankton river-wide from the George Washington

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

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

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

We have estimated that the proposed actions will result in the capture of 493 or fewer Atlantic sturgeon over a five-year period, of which up to 45 are expected to be GOM DPS Atlantic sturgeon. We anticipate the mortality of only six individuals; no injury or mortality of any other captured Atlantic sturgeon is anticipated. While it is unlikely that all six Atlantic sturgeon that die as a result of the proposed actions will originate from the GOM DPS, we have considered this worst-case scenario in this analysis.

With the exception of a small percentage of Atlantic sturgeon captured in gill net surveys, all sturgeon captured in beach or haul seines, trawl surveys, or gill nets are anticipated to fully recover from capture without any injury or impact on fitness or future reproductive potential. We also anticipate that any Atlantic sturgeon exposed to electrical current during electrofishing will fully recover within a few minutes and not experience any injury or impact to fitness or future reproductive potential. The short duration of any capture and handling (*i.e.*, less than 45 minutes total, 20-30 tow or gillnet set plus up to 10-15 minutes of handling time) will not cause a delay or disruption of any essential behavior including spawning, there will be no reduction in individual fitness or any future reduction in numbers of individuals. Additionally, given the locations of the surveys and the time of year, we do not anticipate the capture of handling of any spawning individuals. The proposed actions will also not affect their spawning habitat in any way and will not create any barrier to pre-spawning sturgeon accessing foraging or overwintering sites or the spawning grounds. Any effects to distribution will be minor and temporary and limited to the temporary capture and handling of individuals.

Here, we consider the effect of the loss of up to six Atlantic sturgeon over a five-year period from the NYB DPS. Mortalities are likely to occur in gillnets. The gillnet surveys that may result in mortality will take place in the Hudson River, Delaware Bay and Chesapeake Bay. Atlantic sturgeon killed may be juveniles, subadults or adults.

The reproductive potential of the NYB DPS will not be affected in any way other than through a reduction in numbers of individuals. The loss of a total of up to six individuals over a five-year period, would have the effect of reducing the amount of potential reproduction as any dead NYB DPS Atlantic sturgeon would have no potential for future reproduction. However, this small reduction in potential future spawners is expected to result in an extremely small reduction in the number of eggs laid or larvae produced in future years and similarly, an extremely small effect on the strength of subsequent year classes. Even considering the potential future spawners that would be produced by the individual that would be killed as a result of the proposed action, any effect to future year classes is anticipated to be extremely small and would not change the status of this species. As noted above, reproductive potential of Atlantic sturgeon captured and not killed is not expected to be affected in any way. Additionally, we have determined that any impacts to behavior of captured fish will be minor and temporary and that there will not be any delay or disruption of any normal behavior including spawning; there will also be no reduction in individual fitness or any future reduction in numbers of individuals. The proposed actions will also not affect the spawning grounds within the rivers where NYB DPS fish spawn. The actions will also not create any barrier to pre-spawning sturgeon accessing the overwintering sites or the spawning grounds used by NYB DPS fish.

Because we do not have a population estimate for the NYB DPS, it is difficult to evaluate the effect of the mortality caused by these actions on the species. However, because the proposed actions will result in the loss of no more than six individuals over a five-year period, and there is unlikely to be more than one mortality each year, it is unlikely that these deaths will have a detectable effect on the numbers and population trend of the NYB DPS.

Based on the information provided above, the death of up to SIX NYB DPS Atlantic sturgeon over a five-year period, will not appreciably reduce the likelihood of survival of the New York Bight DPS (*i.e.*, it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). The actions will not affect NYB DPS Atlantic sturgeon in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, and it will not result in effects to the environment which would prevent Atlantic sturgeon from completing their entire life cycle, including reproduction, sustenance, and shelter. This is the case because: (1) the death of these NYB DPS Atlantic sturgeon over a five-year period represents an extremely small percentage of the species as a whole; (2) the death of these NYB DPS Atlantic sturgeon will not change the status or trends of the species as a whole; (3) the loss of these NYB DPS Atlantic sturgeon is not likely to have an effect on the levels of genetic heterogeneity in the population; (4) the loss of these NYB DPS Atlantic sturgeon is likely to have such a small effect on reproductive output that the loss of these individuals will not change the status or trends of the species; (5) the actions will have only a minor and temporary effect on the distribution of NYB DPS Atlantic sturgeon in the action area and no effect on the distribution of the species throughout its range; and, (6) the actions will have no effect on the ability of NYB DPS Atlantic sturgeon to shelter and only an insignificant effect on individual foraging NYB DPS Atlantic sturgeon.

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, we have determined that the proposed actions will not appreciably reduce the likelihood that the NYB DPS will survive in the wild. Here, we consider the potential for the actions to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate. Thus, we have considered whether the proposed actions will affect the likelihood that the NYB DPS can rebuild to a point where listing is no longer appropriate. No Recovery Plan for the NYB DPS has been published. The Recovery Plan will outline the steps necessary for recovery and the demographic criteria which once attained would allow the species to be delisted. We know that in general, to recover, a species must have a sustained positive trend over time and an increase in population. To allow those things to happen, a species must have enough habitat in suitable condition that allows all normal life functions to occur (i.e., spawning, foraging, resting) and have access to enough food. Here, we consider whether these proposed actions will affect the population size and/or trend in a way that would affect the likelihood of recovery.

The proposed actions are not expected to modify, curtail or destroy the range of the species since it will result in an extremely small reduction in the number of NYB DPS Atlantic sturgeon and since it will not affect the overall distribution of NYB DPS Atlantic sturgeon. Any effects to habitat will be insignificant and discountable and will not affect the ability of Atlantic sturgeon to carry out any necessary behaviors or functions. Any impacts to available forage will also be insignificant. The proposed actions will result in a small amount of mortality (no more than one individual per year) and a subsequent small reduction in future reproductive output. For these reasons, it is not expected to affect the persistence of the NYB DPS of Atlantic sturgeon. These actions will not change the status or trend of the NYB DPS of Atlantic sturgeon. The very small reduction in numbers and future reproduction resulting from the proposed actions will not reduce the likelihood of improvement in the status of the NYB DPS of Atlantic sturgeon. The effects of the proposed actions will not delay the recovery timeline or otherwise decrease the likelihood of recovery. The effects of the proposed actions 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 actions will not appreciably reduce the likelihood that the NYB DPS of Atlantic sturgeon can be brought to the point at which they are no longer listed as threatened. Based on the analysis presented herein, the proposed actions are not likely to appreciably reduce the survival and recovery of this species.

Despite the threats faced by individual NYB DPS Atlantic sturgeon inside and outside of the action area, the proposed actions will not increase the vulnerability of individual sturgeon to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed actions. Based on the analysis presented herein, the proposed actions, resulting in the mortality of up to six NYB DPS Atlantic sturgeon over a five-year period, is not likely to appreciably reduce the survival and recovery of this species.

9.6.3 Chesapeake Bay DPS

We have estimated that the proposed actions will result in the capture of 493 or fewer Atlantic sturgeon over a five-year period, of which up to 64 are expected to be CB DPS Atlantic sturgeon. We anticipate the mortality of only six individuals; no injury or mortality of any other captured Atlantic sturgeon is anticipated. While it is unlikely that all six Atlantic sturgeon that die as a result of the proposed actions will originate from the CB DPS, we have considered this worst-case scenario in this analysis.

The CB DPS is listed as endangered. While Atlantic sturgeon occur in several rivers in the CB DPS, recent spawning has only been documented in the James River. Chesapeake Bay DPS origin Atlantic sturgeon are affected by numerous sources of human induced mortality and habitat disturbance throughout the riverine and marine portions of their range. There is currently not enough information to establish a trend for any life stage, for the James River spawning population or for the DPS as a whole.

With the exception of a small percentage of Atlantic sturgeon captured in gill net surveys, all sturgeon captured in beach or haul seines, trawl surveys, or gill nets are anticipated to fully recover from capture without any injury or impact on fitness or future reproductive potential. We also anticipate that any Atlantic sturgeon exposed to electrical current during electrofishing will fully recover within a few minutes and not experience any injury or impact to fitness or future reproductive potential. The short duration of any capture and handling (*i.e.*, less than 45 minutes total, 20-30 tow or gillnet set plus up to 10-15 minutes of handling time) will not cause a delay or disruption of any essential behavior including spawning, there will be no reduction in individual fitness or any future reduction in numbers of individuals. Additionally, given the locations of the surveys and the time of year, we do not anticipate the capture of handling of any spawning individuals. The proposed actions will also not affect their spawning habitat in any way and will not create any barrier to pre-spawning sturgeon accessing foraging or overwintering sites or the spawning grounds. Any effects to distribution will be minor and temporary and limited to the temporary capture and handling of individuals.

Here, we consider the effect of the loss of up to six Atlantic sturgeon over a five-year period from the CB DPS. Mortalities are likely to occur in gillnets. The gillnet surveys that may result in mortality will take place in the Hudson River, Delaware Bay and Chesapeake Bay. Atlantic sturgeon killed may be juveniles, subadults or adults.

The reproductive potential of the CBDPS will not be affected in any way other than through a reduction in numbers of individuals. The loss of a total of up to six individuals over a five-year period, would have the effect of reducing the amount of potential reproduction as any dead CBDPS Atlantic sturgeon would have no potential for future reproduction. However, this small reduction in potential future spawners is expected to result in an extremely small reduction in the number of eggs laid or larvae produced in future years and similarly, an extremely small effect on the strength of subsequent year classes. Even considering the potential future spawners that would be produced by the individual that would be killed as a result of the proposed action, any effect to future year classes is anticipated to be extremely small and would not change the status of this species. As noted above, reproductive potential of Atlantic sturgeon captured and not killed is not expected to be affected in any way. Additionally, we have determined that any impacts to behavior of captured fish will be minor and temporary and that there will not be any delay or disruption of any normal behavior including spawning; there will also be no reduction in individual fitness or any future reduction in numbers of individuals. The proposed actions will also not affect the spawning grounds within the rivers where CB DPS fish spawn. The actions will also not create any barrier to pre-spawning sturgeon accessing the overwintering sites or the spawning grounds used by CB DPS fish.

Because we do not have a population estimate for the CB DPS, it is difficult to evaluate the effect of the mortality caused by these actions on the species. However, because the proposed actions will result in the loss of no more than six individuals over a five-year period, and there is unlikely to be more than one mortality each year, it is unlikely that these deaths will have a detectable effect on the numbers and population trend of the CB DPS.

The proposed actions are not likely to reduce distribution because the actions will not impede Atlantic sturgeon from accessing any seasonal concentration areas, including foraging areas within the action area that may be used by CB DPS subadults or adults. Further, the actions are not expected to reduce the river by river distribution of Atlantic sturgeon. Any effects to distribution will be minor and temporary and limited to the temporary avoidance of the area where suspended sediment levels are high.

Based on the information provided above, the death of up to six CB DPS Atlantic sturgeon over a five-year period, will not appreciably reduce the likelihood of survival of the CB DPS (*i.e.*, it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). The action will not affect CB DPS Atlantic sturgeon in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, and it will not result in effects to the environment which would prevent Atlantic sturgeon from completing their entire life cycle, including reproduction, sustenance, and shelter. This is the case because: (1) the death of one CB DPS Atlantic sturgeon in any year and the total loss of up to six individuals will not change the status or trends of the species as a whole; (3) the loss of these CB DPS Atlantic sturgeon is not likely to have an effect on the levels of genetic heterogeneity in the population; (4) the loss of these CB DPS Atlantic sturgeon over a five-year period is likely to have such a small effect on reproductive output that the loss of these individuals will not change the status or trends of the species; (5) the actions will have only a minor and temporary effect on the distribution of CB DPS Atlantic sturgeon in the action area and no effect on the distribution of the species throughout its range; and, (6) the actions will have no effect on the ability of CB DPS Atlantic sturgeon to shelter and only an insignificant effect on any foraging CB DPS Atlantic sturgeon.

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, we have determined that the proposed actions will not appreciably reduce the likelihood that the CB DPS will survive in the wild. Here, we consider the potential for the actions to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate. Thus, we have considered whether the proposed actions will affect the likelihood that the CB DPS can rebuild to a point where listing is no longer appropriate. No Recovery Plan for the CB DPS has been published. The Recovery Plan will outline the steps necessary for recovery and the demographic criteria, which once attained would allow the species to be delisted. We know that in general, to recover, a species must have a sustained positive trend over time and an increase in population. To allow those things to happen, a species must have enough habitat in suitable condition that allows all normal life functions to occur (i.e., spawning, foraging, resting) and have access to enough food. Here, we consider whether the proposed actions will affect the population size and/or trend in a way that would affect the likelihood of recovery.

We do not expect the proposed actions to modify, curtail or destroy the range of the species since it will result in an extremely small reduction in the number of CB DPS Atlantic sturgeon and since it will not affect the overall distribution of CB DPS Atlantic sturgeon. Any effects to habitat will be insignificant and discountable and will not affect the ability of Atlantic sturgeon to carry out any necessary behaviors or functions. Any impacts to available forage will also be insignificant. The proposed actions will result in an extremely small amount of mortality annually (one individual) and a subsequent small reduction in future reproductive output. For these reasons, we do not expect the actions to affect the persistence of the CB DPS of Atlantic sturgeon. These actions will not change the status or trend of the CB DPS of Atlantic sturgeon. The very small reduction in numbers and future reproduction resulting from the proposed actions will not reduce the likelihood of improvement in the status of the CB DPS of Atlantic sturgeon. The effects of the proposed actions will not delay the recovery timeline or otherwise decrease the likelihood of recovery. The effects of the proposed actions 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 actions will not appreciably reduce the likelihood that the CB DPS of Atlantic sturgeon can be brought to the point at which they are no longer listed as threatened. Based on the analysis presented herein, the proposed actions are not likely to appreciably reduce the survival and recovery of this species.

Despite the threats faced by individual CB DPS Atlantic sturgeon inside and outside of the action area, the proposed actions will not increase the vulnerability of individual sturgeon to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed actions. We have considered the effects of the proposed action in light of cumulative effects explained above, including climate change, and have concluded that even in light of the ongoing impacts of these activities and conditions; the conclusions reached above do not change. Based on the analysis presented herein, the proposed actions, resulting in the mortality of up to six CB DPS Atlantic sturgeon over a five-year period, are not likely to appreciably reduce the survival and recovery of this species.

9.6.4 Carolina DPS

We have estimated that the proposed actions will result in the capture of 493 or fewer Atlantic sturgeon over a five-year period, of which up to 21 are expected to be CA DPS Atlantic sturgeon. We anticipate the mortality of only six individuals; no injury or mortality of any other captured Atlantic sturgeon is anticipated. While it is unlikely that all six Atlantic sturgeon that die as a result of the proposed actions will originate from the CA DPS, we have considered this worst-case scenario in this analysis.

Individuals originating from the CA DPS are likely to occur in the action area. The CA DPS is listed as endangered. The CA DPS consists of Atlantic sturgeon originating from at least five rivers where spawning is still thought to occur. Carolina DPS origin Atlantic sturgeon are affected by numerous sources of human induced mortality and habitat disturbance throughout the riverine and marine portions of their range.

With the exception of a small percentage of Atlantic sturgeon captured in gill net surveys, all sturgeon captured in beach or haul seines, trawl surveys, or gill nets are anticipated to fully recover from capture without any injury or impact on fitness or future reproductive potential. We also anticipate that any Atlantic sturgeon exposed to electrical current during electrofishing will fully recover within a few minutes and not experience any injury or impact to fitness or future reproductive potential. The short duration of any capture and handling (*i.e.*, less than 45 minutes total, 20-30 tow or gillnet set plus up to 10-15 minutes of handling time) will not cause a delay or disruption of any essential behavior including spawning, there will be no reduction in individual fitness or any future reduction in numbers of individuals. Additionally, given the locations of the surveys and the time of year, we do not anticipate the capture of handling of any spawning individuals. The proposed actions will also not affect their spawning habitat in any way and will not create any barrier to pre-spawning sturgeon accessing foraging or overwintering sites or the spawning grounds. Any effects to distribution will be minor and temporary and limited to the temporary capture and handling of individuals.

Here, we consider the effect of the loss of up to six Atlantic sturgeon over a five-year period from the CA DPS. Mortalities are likely to occur in gillnets. The gillnet surveys that may result in mortality will take place in the Hudson River, Delaware Bay and Chesapeake Bay. Atlantic sturgeon killed may be juveniles, subadults or adults.

The reproductive potential of the CA DPS will not be affected in any way other than through a reduction in numbers of individuals. The loss of a total of up to six individuals over a five-year period, would have the effect of reducing the amount of potential reproduction as any dead CA DPS Atlantic sturgeon would have no potential for future reproduction. However, this small reduction in potential future spawners is expected to result in an extremely small reduction in the number of eggs laid or larvae produced in future years and similarly, an extremely small effect on the strength of subsequent year classes. Even considering the potential future spawners that would be produced by the individual that would be killed as a result of the proposed action, any effect to future year classes is anticipated to be extremely small and would not change the status of this species. As noted above, reproductive potential of Atlantic sturgeon captured and not killed is not expected to be affected in any way. Additionally, we have determined that any impacts to behavior of captured fish will be minor and temporary and that there will not be any delay or disruption of any normal behavior including spawning; there will also be no reduction in individual fitness or any future reduction in numbers of individuals. The proposed actions will also not affect the spawning grounds within the rivers where CA DPS fish spawn. The actions will also not create any barrier to pre-spawning sturgeon accessing the overwintering sites or the spawning grounds used by CA DPS fish.

Because we do not have a population estimate for the CA DPS, it is difficult to evaluate the effect of the mortality caused by these actions on the species. However, because the proposed actions will result in the loss of no more than six individuals over a five-year period, and there is unlikely to be more than one mortality each year, it is unlikely that these deaths will have a detectable effect on the numbers and population trend of the CA DPS.

The proposed actions are not likely to reduce distribution because the actions will not impede Atlantic sturgeon from accessing any seasonal concentration areas, including foraging areas within the action area that may be used by CA DPS subadults or adults. Further, the actions are not expected to reduce the river by river distribution of Atlantic sturgeon. Any effects to distribution will be minor and temporary and limited to the temporary avoidance of the area where suspended sediment levels are high.

Based on the information provided above, the death of up to six CA DPS Atlantic sturgeon over a five-year period, will not appreciably reduce the likelihood of survival of the CA DPS (*i.e.*, it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). The action will not affect CA DPS Atlantic sturgeon in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, and it will not result in effects to the environment which would prevent Atlantic sturgeon from completing their entire life cycle, including reproduction, sustenance, and shelter. This is the case because: (1) the death of one

CA DPS Atlantic sturgeon in any year and the total loss of up to six individuals will not change the status or trends of the species as a whole; (3) the loss of these CA DPS Atlantic sturgeon is not likely to have an effect on the levels of genetic heterogeneity in the population; (4) the loss of these CA DPS Atlantic sturgeon over a five-year period is likely to have such a small effect on reproductive output that the loss of these individuals will not change the status or trends of the species; (5) the actions will have only a minor and temporary effect on the distribution of CA DPS Atlantic sturgeon in the action area and no effect on the distribution of the species throughout its range; and, (6) the actions will have no effect on the ability of CA DPS Atlantic sturgeon to shelter and only an insignificant effect on any foraging CA DPS Atlantic sturgeon.

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, we have determined that the proposed actions will not appreciably reduce the likelihood that the CA DPS will survive in the wild. Here, we consider the potential for the actions to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate. Thus, we have considered whether the proposed actions will affect the likelihood that the CA DPS can rebuild to a point where listing is no longer appropriate. No Recovery Plan for the CA DPS has been published. The Recovery Plan will outline the steps necessary for recovery and the demographic criteria, which once attained would allow the species to be delisted. We know that in general, to recover, a species must have a sustained positive trend over time and an increase in population. To allow those things to happen, a species must have enough habitat in suitable condition that allows all normal life functions to occur (i.e., spawning, foraging, resting) and have access to enough food. Here, we consider whether the proposed actions will affect the population size and/or trend in a way that would affect the likelihood of recovery.

We do not expect the proposed actions to modify, curtail or destroy the range of the species since it will result in an extremely small reduction in the number of CA DPS Atlantic sturgeon and since it will not affect the overall distribution of CA DPS Atlantic sturgeon. Any effects to habitat will be insignificant and discountable and will not affect the ability of Atlantic sturgeon to carry out any necessary behaviors or functions. Any impacts to available forage will also be insignificant. The proposed actions will result in an extremely small amount of mortality annually (one individual) and a subsequent small reduction in future reproductive output. For these reasons, we do not expect the actions to affect the persistence of the CA DPS of Atlantic sturgeon. These actions will not change the status or trend of the CA DPS of Atlantic sturgeon. The very small reduction in numbers and future reproduction resulting from the proposed actions will not reduce the likelihood of improvement in the status of the CA DPS of Atlantic sturgeon. The effects of the proposed actions will not delay the recovery timeline or otherwise decrease the likelihood of recovery. The effects of the proposed actions 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 actions will not appreciably reduce the likelihood that the CA DPS of Atlantic sturgeon can be brought to the point at which they are no longer listed as threatened. Based on the analysis presented herein, the proposed actions are not likely to appreciably reduce the survival and recovery of this species.

Despite the threats faced by individual CA DPS Atlantic sturgeon inside and outside of the action area, the proposed actions will not increase the vulnerability of individual sturgeon to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed actions. We have considered the effects of the proposed action in light of cumulative effects explained above, including climate change, and have concluded that even in light of the ongoing impacts of these activities and conditions; the conclusions reached above do not change. Based on the analysis presented herein, the proposed actions, resulting in the mortality of up to six CA DPS Atlantic sturgeon over a five-year period, are not likely to appreciably reduce the survival and recovery of this species.

9.6.5 South Atlantic DPS

We have estimated that the proposed actions will result in the capture of 493 or fewer Atlantic sturgeon over a five-year period, of which up to 81 are expected to be SA DPS Atlantic sturgeon. We anticipate the mortality of only six individuals; no injury or mortality of any other captured Atlantic sturgeon is anticipated. While it is unlikely that all six Atlantic sturgeon that die as a result of the proposed actions will originate from the SA DPS, we have considered this worst-case scenario in this analysis.

The SA DPS is listed as endangered. The SA DPS consists of Atlantic sturgeon originating from at least six rivers where spawning is still thought to occur. Schueller and Peterson (2006) estimate that there were 343 adults spawning in the Altamaha River, GA in 2004 and 2005. This represents a percentage of the total adult population for the Altamaha River. Males spawn every 1-5 years and females spawn every 2-5 years; thus, the total Altamaha River adult population, assuming a 2:1 ratio of males: females as seen on the Hudson River, could range from 457 - 1,715. Spawning occurs in at least five other rivers in this DPS, thus the number of Atlantic sturgeon in the Altamaha River population is only a portion of the total DPS. No estimate of the number of Atlantic sturgeon in any of the other spawning rivers or for the DPS as a whole is available.

With the exception of a small percentage of Atlantic sturgeon captured in gill net surveys, all sturgeon captured in beach or haul seines, trawl surveys, or gill nets are anticipated to fully recover from capture without any injury or impact on fitness or future reproductive potential. We also anticipate that any Atlantic sturgeon exposed to electrical current during electrofishing will fully recover within a few minutes and not experience any injury or impact to fitness or future reproductive potential. The short duration of any capture and handling (*i.e.*, less than 45 minutes total, 20-30 tow or gillnet set plus up to 10-15 minutes of handling time) will not cause a delay or disruption of any essential behavior including spawning, there will be no reduction in individual fitness or any future reduction in numbers of individuals. Additionally, given the locations of the surveys and the time of year, we do not anticipate the capture of handling of any spawning individuals. The proposed actions will also not affect their spawning habitat in any way and will not create any barrier to pre-spawning sturgeon accessing foraging or overwintering sites or the spawning grounds. Any effects to distribution will be minor and temporary and limited to the temporary capture and handling of individuals.

Here, we consider the effect of the loss of up to six Atlantic sturgeon over a five-year period from the SA DPS. Mortalities are likely to occur in gillnets. The gillnet surveys that may result in mortality will take place in the Hudson River, Delaware Bay and Chesapeake Bay. Atlantic sturgeon killed may be juveniles, subadults or adults.

The reproductive potential of the SA DPS will not be affected in any way other than through a reduction in numbers of individuals. The loss of a total of up to six individuals over a five-year period, would have the effect of reducing the amount of potential reproduction as any dead SA DPS Atlantic sturgeon would have no potential for future reproduction. However, this small reduction in potential future spawners is expected to result in an extremely small reduction in the number of eggs laid or larvae produced in future years and similarly, an extremely small effect on the strength of subsequent year classes. Even considering the potential future spawners that would be produced by the individual that would be killed as a result of the proposed action, any effect to future year classes is anticipated to be extremely small and would not change the status of this species. As noted above, reproductive potential of Atlantic sturgeon captured and not killed is not expected to be affected in any way. Additionally, we have determined that any impacts to behavior of captured fish will be minor and temporary and that there will not be any delay or disruption of any normal behavior including spawning; there will also be no reduction in individual fitness or any future reduction in numbers of individuals. The proposed actions will also not affect the spawning grounds within the rivers where SA DPS fish spawn. The actions will also not create any barrier to pre-spawning sturgeon accessing the overwintering sites or the spawning grounds used by SA DPS fish.

Because we do not have a population estimate for the SA DPS, it is difficult to evaluate the effect of the mortality caused by these actions on the species. However, because the proposed actions will result in the loss of no more than six individuals over a five-year period, and there is unlikely to be more than one mortality each year, it is unlikely that these deaths will have a detectable effect on the numbers and population trend of the SA DPS.

The proposed actions are not likely to reduce distribution because the actions will not impede Atlantic sturgeon from accessing any seasonal concentration areas, including foraging areas within the action area that may be used by SA DPS subadults or adults. Further, the actions are not expected to reduce the river by river distribution of Atlantic sturgeon. Any effects to distribution will be minor and temporary and limited to the temporary avoidance of the area where suspended sediment levels are high.

Based on the information provided above, the death of up to six SA DPS Atlantic sturgeon over a five-year period, will not appreciably reduce the likelihood of survival of the SA DPS (*i.e.*, it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). The action will not affect SADPS Atlantic sturgeon in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, and it will not result in effects to the environment which would prevent Atlantic sturgeon from completing their entire life cycle, including reproduction, sustenance, and shelter. This is the case because: (1) the death of one SA DPS Atlantic sturgeon in any year and the total loss of up to six individuals will not change the status or trends of the species as a whole; (3) the loss of these SA DPS Atlantic sturgeon is not likely to have an effect on the levels of genetic heterogeneity in the population; (4) the loss of these SA DPS Atlantic sturgeon over a five-year period is likely to have such a small effect on reproductive output that the loss of these individuals will not change the status or trends of the species; (5) the actions will have only a minor and temporary effect on the distribution of SA DPS Atlantic sturgeon in the action area and no effect on the distribution of the species throughout its range; and, (6) the actions will have no effect on the ability of SA DPS Atlantic sturgeon to shelter and only an insignificant effect on any foraging SA DPS Atlantic sturgeon.

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, we have determined that the proposed actions will not appreciably reduce the likelihood that the SA DPS will survive in the wild. Here, we consider the potential for the actions to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate. Thus, we have considered whether the proposed actions will affect the likelihood that the SA DPS can rebuild to a point where listing is no longer appropriate. No Recovery Plan for the SA DPS has been published. The Recovery Plan will outline the steps necessary for recovery and the demographic criteria, which once attained would allow the species to be delisted. We know that in general, to recover, a species must have a sustained positive trend over time and an increase in population. To allow those things to happen, a species must have enough habitat in suitable condition that allows all normal life functions to occur (i.e., spawning, foraging, resting) and have access to enough food. Here, we consider whether the proposed actions will affect the population size and/or trend in a way that would affect the likelihood of recovery.

We do not expect the proposed actions to modify, curtail or destroy the range of the species since it will result in an extremely small reduction in the number of SA DPS Atlantic sturgeon and since it will not affect the overall distribution of SA DPS Atlantic sturgeon. Any effects to habitat will be insignificant and discountable and will not affect the ability of Atlantic sturgeon to carry out any necessary behaviors or functions. Any impacts to available forage will also be insignificant. The proposed actions will result in an extremely small amount of mortality annually (one individual) and a subsequent small reduction in future reproductive output. For these reasons, we do not expect the actions to affect the persistence of the SA DPS of Atlantic sturgeon. These actions will not change the status or trend of the SA DPS of Atlantic sturgeon. The very small reduction in numbers and future reproduction resulting from the proposed actions will not reduce the likelihood of improvement in the status of the SA DPS of Atlantic sturgeon. The effects of the proposed actions will not delay the recovery timeline or otherwise decrease the likelihood of recovery. The effects of the proposed actions 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 actions will not appreciably reduce the likelihood that the SA DPS of Atlantic sturgeon can be brought to the point at which they are no longer listed as threatened. Based on the analysis presented herein, the proposed actions are not likely to appreciably reduce the survival and recovery of this species.

Despite the threats faced by individual SA DPS Atlantic sturgeon inside and outside of the action area, the proposed actions will not increase the vulnerability of individual sturgeon to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed actions. We have considered the effects of the proposed action in light of cumulative effects explained above, including climate change, and have concluded that even in light of the ongoing impacts of these activities and conditions; the conclusions reached above do not change. Based on the analysis presented herein, the proposed actions, resulting in the mortality of up to six SA DPS Atlantic sturgeon over a five-year period, are not likely to appreciably reduce the survival and recovery of this species.

10.0 CONCLUSION

After reviewing the best available information on the status of endangered and threatened species under NMFS jurisdiction, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is our biological opinion that the proposed action may adversely affect but is not likely to jeopardize the continued existence of Kemp's ridley, green, or leatherback sea turtles; the NWA DPS of loggerhead sea turtles; shortnose sturgeon or the GOM, NYB, CB, Carolina or SA DPSs of Atlantic sturgeon. We have also determined that the proposed action is not likely to adversely affect hawksbill sea turtles, North Atlantic right whales, humpback whales, fin or sei whales. We have also determined that the proposed action is not likely to adversely affect critical habitat designated for right whales or the GOM DPS of Atlantic salmon.

11.0 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 measures described below are non-discretionary, and must be undertaken by USFWS so that they become binding conditions for the exemption in section 7(o)(2) to apply. USFWS has a continuing duty to regulate the activity covered by this Incidental Take Statement. If USFWS (1) fails to assume and implement the terms and conditions or (2) fails to require any grantees to adhere to the terms and conditions of the Incidental Take Statement through enforceable terms that are added contracts or other documents as appropriate, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, USFWS must report the progress of the action and its impact on the species to us 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).

11.1 Anticipated Amount or Extent of Incidental Take

Based on the information presented in the Opinion, we anticipate that the surveys described in this Opinion, to be funded by FWS and carried out by the states over a five-year period, will result in the capture of:

- A total of 18 shortnose sturgeon plus one in the Westfield River fish passage facility and 36 interactions during electrofishing activities;
- A total of 32 sea turtles; and,
- A total of no more than 507 Atlantic sturgeon.

The only mortalities that we anticipate are six Atlantic sturgeon (originating from any of the five DPSs) during gillnet surveys carried out by New York, New Jersey, Maryland and Virginia.

While we have completed one Biological Opinion, the actions considered here consist of eleven independent actions carried out by the FWS (i.e., awarding of each grant fund to each state is an independent action). As such, we have organized the ITS by activity and provided a summary by state.

This ITS exempts the following take:

Study	**shortnose sturgeon**	**Total Atlantic sturgeon**	**GOM DPS Atlantic sturgeon**	**NYB DPS Atlantic sturgeon**	**CB DPS Atlantic sturgeon**	**Carolina DPS Atlantic sturgeon**	**SA DPS Atlantic sturgeon**	**loggerhead sea turtle**	**Kemp's ridley sea turtle**	**green sea turtle**	**leatherback sea turtle**
Maine beach seine	3	0	0	0	0	0	0	0	0	0	0
Maine/NH trawl	0	10	1	5	1	1	2	0	0	0	0
MAINE/NH TOTAL	**3**	**10**	**1**	**5**	**1**	**1**	**2**	**0**	**0**	**0**	**0**
MA trawl	0	5	1 GOM, CB or Carolina	3	1 GOM, CB or Carolina	1 GOM, CB or Carolina	1	0	0	0	0
MA fish ladder	1	0	0	0	0	0	0	0	0	0	0
MA TOTAL	**1**	**5**	**1 GOM, CB or Carolina**	**3**	**1 GOM, CB or Carolina**	**1 GOM, CB or Carolina**	**1**	**0**	**0**	**0**	**0**
CT LIST	0	160	6	126	11	1	16	4	1 Kemps, green or leatherback		
CT TOTAL	**0**	**160**	**6**	**126**	**11**	**1**	**16**	**4**	**1 Kemps, green or leatherback**		
NY beach and haul seine	4	2	2 individuals from GOM, NYB or CB			0	0	0	0	0	0
NY Striped bass electrofishing	35	0	0	0	0	0	0	0	0	0	0
NY shad gillnet	0	1	one capture (may be lethal) from any of the five DPSs					0	0	0	0
NY Peconic	0	0	0	0	0	0	0	1	1 Kemps, green or leatherback		

trawl											
NY TOTAL	**39**	**3 (1 lethal)**	**3 individuals from GOM, NYB or CB** **one mortality - individual could originate from any of the five DPSs**			**1 individual from Carolina or SA**		**1**	**1 Kemps, green or leatherback**		
Delaware River beach seine	1	0	0	0	0	0	0	0	0		
NJ Ocean	0	125	14	62	19	5	25	15*	5* Kemps, green or leatherback		
NJ striped bass gillnet	0	41	3 one mortality - individual could originate from any of the five DPSs	23	7	1	7	0	0	0	0
NJ TOTAL	**1**	**166 (1 lethal)**	**15** **one mortality - individual could originate from any of the five DPSs**	**86**	**22**	**6**	**28**	**15**	**5 Kemps, green or leatherback**		
DE Estuary bottom trawl	5	5	1 GOM, SA or Carolina	3	1	1 GOM, SA or Carolina	1 GOM, SA or Carolina	0	0	0	0
DE Bay Groundfish	5	16	1 GOM or Carolina	9	3	1 GOM or Carolina	3	4	2	1 green or leatherback	
Delaware striped bass electrofishing	1	1	one Atlantic sturgeon from any of the five DPSs					0	0	0	0
DE TOTAL	**12**	**22**	**up to 2**	**up to 13**	**up to 5**	**up to 3**	**up to 5**	**4**	**2**	**1 green or leatherback**	
MD Coastal	0	0	0	0	0	0	0	1 sea turtle any species			

Bays											
MD striped bass drift gillnet	0	1	one capture (may be lethal) from any of the five DPSs					0	0	0	0
MD TOTAL	**0**	**1 (lethal)**	**one capture (may be lethal) from any of the five DPSs**					**1 sea turtle any species**			
VA ChesMMAP	0	5	1 GOM, CB or Carolina	3	1 GOM, CB or Carolina	1 GOM, CB or Carolina	1	1 sea turtle any species			
VA juvenile fish	0	17	2	8	3	1	3	1 sea turtle any species			
VA striped bass gillnet	0	5	1	2	1	1	1	0	0	0	0
			one mortality - individual could originate from any of the five DPSs								
VA shad gillnet	0	113	13	56	16	5	23	0	0	0	0
			two mortalities - individuals could be from any of the five DPSs								
VA TOTAL	**0**	**140 (no more than 3 lethal)**	**up to 17; up to 3 lethal**	**up to 69 (up to 3 lethal)**	**up to 21 (up to 3 lethal)**	**up to 8 (up to 3 lethal)**	**up to 28 (3 lethal)**	**2 sea turtles any species**			

*In the NJ Ocean Trawl Survey, we anticipate the capture of 15 sea turtles in a five-year grant period, no more than 5 will be Kemp's ridley, leatherback or green sea turtles, the rest will be loggerhead sea turtles.

As explained in the "Effects of the Action" section of the Opinion, none of these sea turtles or shortnose sturgeon are expected to die, immediately or later, as a result of interactions with the proposed actions. Only six of the captured Atlantic sturgeon are likely to die. In the accompanying Opinion, we determined that this level of anticipated take is not likely to result in jeopardy to any listed species.

11.2 Reasonable and Prudent Measures

In order to effectively monitor the effects of this action, it is necessary to monitor the impacts of the proposed action to document the amount of incidental take (*i.e.*, the number of sea turtles and sturgeon captured, collected, injured or killed) and to examine any sea turtles or Atlantic sturgeon that are captured during this monitoring. Monitoring provides information on the characteristics of the turtles and 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 handling and examining sea turtles and sturgeon as required in the RPMs. All live animals are to be released back into the water following the required documentation.

NMFS believes the following reasonable and prudent measures are necessary or appropriate to minimize and monitor impacts of incidental take of listed sea turtles and sturgeon:

RPMs relevant to all actions

1. Any listed species caught during the survey must be handled and resuscitated according to established procedures.

2. Any listed species caught and retrieved in the sampling gear must be identified to species.

3. Any listed species caught and retrieved in the sampling gear must be properly documented.

4. NMFS NERO must be notified regarding all interactions with or observations of listed species.

RPMs relevant to Electrofishing Activities

5. All electrofishing procedures are designed to minimize the potential for injury or mortality of listed species.

RPMs relevant to Fish Passage Facilities (MA only)

6. For the period of time when the Commonwealth of Massachusetts uses funds provided by FWS to operate the Denil ladder at the West Springfield fish passage facility on the Westfield River, the facility must be monitored for shortnose sturgeon whenever it is open between May and October.

7. For the period of time when the Commonwealth of Massachusetts uses funds provided by FWS to operate the Denil ladder at the West Springfield fish passage facility, shortnose sturgeon must be collected and handled appropriately if present in the ladder.

11.3 Terms and Conditions

In order to be exempt from prohibitions of section 9 of the ESA, USFWS 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)). It is our understanding that FWS will include special conditions within grants to states that require adherence to these terms and conditions.

1. To implement RPM #1 above, all states must have copies of the sea turtle handling and resuscitation requirements found at 50 CFR 223.206(d)(1) and as reproduced in Appendix B to the vessel operator prior to the commencement of any on-water activity where sea turtles may be encountered. All states must carry out these handling and resuscitation procedures as appropriate.

2. To implement RPM#1 above, state staff must give priority to handling and processing any sea turtles or sturgeon that are captured in the sampling gear. Handling times must be minimized for these species.

3. To implement RPM#1 above, attempts must be made to resuscitate any Atlantic sturgeon that may appear to be dead must be by providing a running source of water over the gills.

4. To comply with RPM #2 above, all states must have at least one crew member who is experienced in the identification of western North Atlantic sea turtles and/or sturgeon on the vessel(s) used for survey where interactions with sturgeon and/or sea turtles are anticipated (i.e., those studies listed in the table above) at all times that the on-water survey work is conducted . Experience would include personnel that have received training as a NMFS fisheries observer or who have career experience in the identification of western North Atlantic sea turtles and sturgeon. Information provided as Appendix D can aid in species identification.

5. To comply with RPM #2 above, genetic samples must be obtained from all captured Atlantic sturgeon. This must be done in accordance with the procedures provided in Appendix E.

6. To comply with RPM #3, all interactions with sea turtles and sturgeon must be documented. Photographs should be taken whenever possible. The condition of each animal must be recorded and any injuries documented on forms provided as Appendix F or on similar forms that contain all of the information fields provided in Appendix F. Individuals should be measured (length) if possible and weighed if adequate scales are available on the sampling vessel.

7. To comply with RPM#3 above, on all vessels where appropriate Passive Integrated Transponder (PIT) tag readers are available, captured sturgeon must be scanned for existing PIT tags. Any recorded sturgeon PIT tags must be reported to the USFWS tagging database. During surveys where the appropriate PIT tags are available, any untagged sturgeon must be tagged with PIT tags according to the procedure included as Appendix C and the tag numbers recorded and reported to the USFWS tagging database.

8. To implement RPM#3 above, all sea turtles must be inspected for external tags (typically found on the flipper). All tag numbers must be recorded and reported to NMFS on the incident reporting form included as Appendix F.

9. To comply with RPM #3, whenever possible, any dead Atlantic or shortnose sturgeon or sea turtle must be retained and held in cold storage until disposal can be discussed with NMFS. A sturgeon salvage form (Appendix G) must be filled out for any dead sturgeon and provided to NMFS.

10. To comply with RPM #4, NMFS PRD must be notified within 24 hours of any interaction with a listed species. If reporting within 24 hours is not possible, the report must be made as soon as possible, preferably on the next business day. These reports should be sent by e-mail (Incidental.take@noaa.gov). If e-mail notification within 24 hours is not possible, this information can be faxed (978-281-9394 Attn: Section 7 Coordinator) or phoned in (NMFS Protected Resources Division 978-281-9328). For purposes of monitoring the incidental take of sea turtles and sturgeon during the surveys, reports must be made for any sea turtle or sturgeon: (a) found alive, dead, or injured within the sampling gear; (b) found alive, dead, or injured and retained on any portion of the sampling gear outside of the net bag; or (c) interacting with the vessel and gear in any other way must be reported to NMFS. The report must include: a clear photograph of the animal (multiple views if possible, including at least one photograph of the head scutes); identification of the animal to the species level; GPS or Loran coordinates describing the location of the interaction; time of interaction; date of interaction; condition of the animal upon retrieval (alive uninjured, alive injured, fresh dead, decomposed, comatose or unresponsive); the condition of the animal upon return to the water; GPS or Loran coordinates of the location at which it was released; a description of the care or handling provided; information any tags detected and/or inserted; and notification that a genetic sample was taken (if required).

11. To comply with RPM #4, written reports must be provided to NMFS NERO within 90 days after the grant period ends, indicating either that no interactions with ESA-listed species occurred, or providing the total number of interactions that occurred with ESA-listed species. Any reports required by Term and Condition 9 that have not been provided to NMFS NERO must be included in this report. This report must be sent to the NMFS Northeast Regional Office, Attn: Section 7 Coordinator, 55 Great Republic Drive, Gloucester, MA 01930.

12. To implement RPM #5, for electrofishing, no sturgeon over two feet in length shall be netted. All observations of netted sturgeon must be reported to NMFS as required in Term and Condition #9. All observations of non-netted sturgeon should also be reported to NMFS via e-mail (incidental.take@noaa.gov), as soon as practicable. This report must contain the date, location, tentative species identification, and approximated size of the fish.

13. To implement RPM #5, in the event sturgeon come in contact with sampling gear, all electrofishing must cease for 5 minutes or until the fish is observed to recover and leave

the sampling area.

14. To implement RPM#6, the State of Massachusetts must develop a monitoring plan for shortnose sturgeon at the West Springfield passage facility. This plan would likely involve daily visual inspections of the ladder and trap during the time of year when shortnose sturgeon may be present. This plan should be submitted to NMFS for approval and should be put in place prior to the spring 2013 fish passage season. This plan must be implemented for the period of time that the Commonwealth uses funds provided by FWS to operate the Denil ladder at the West Springfield fish passage facility.

15. To implement RPM #7, the State of Massachusetts must develop a handling plan for shortnose sturgeon collected at the West Springfield fish passage facility. This plan should outline contact procedures and procedures for ensuring the safe removal of the fish from the ladder or trap and return of the fish to a downstream location. This plan should be submitted to NMFS for approval and should be put in place prior to the spring 2013 fish passage season. This plan must be implemented for the period of time that the Commonwealth uses funds provided by FWS to operate the Denil ladder at the West Springfield fish passage facility

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 ensure that NMFS and USFWS monitor the impacts of the activities considered here that allows for the detection, identification and reporting of all interactions with listed species. The discussion below explains why each of these RPMs and Terms and Conditions are necessary or appropriate to minimize or monitor the level of incidental take associated with the proposed action. The RPMs and terms and conditions involve only a minor change to the proposed actions.

RPM #1 and the accompanying Term and Condition establish the requirements for handling sea turtles and sturgeon captured in gear used in the surveys in order to avoid the likelihood of injury to these species from the hauling, handling, and emptying of the trawl gear.

RPMs #2-4 and the accompanying Terms and Conditions specify the collection of information for any ESA-listed species observed captured in the gear. This is essential for monitoring the level of incidental take associated with the proposed action. The taking of fin clips allows NMFS to run genetic analysis to determine the DPS of origin for Atlantic sturgeon. This allows us to determine if the actual level of take has been exceeded. Sampling of fin tissue is used for genetic sampling. This procedure does not harm sturgeon and is common practice in fisheries science. Tissue sampling does not appear to impair the sturgeon's ability to swim and is not thought to have any long-term adverse impact. NMFS has received no reports of injury or mortality to any sturgeon sampled in this way.

RPM#5 and its implementing Term and Condition specify procedures to minimize the potential for injury of sturgeon during electrofishing activities. RPM #6 and 7 and their implementing Terms and Conditions are designed to allow for the timely observation and safe handling of any sturgeon captured in the West Springfield fish passage facility which is operated by the State of MA.

12.0 CONSERVATION RECOMMENDATIONS

In addition to section 7(a)(2), which requires agencies to ensure that proposed actions are not likely to jeopardize the continued existence of listed species, section 7(a)(1) of the ESA places a responsibility on all Federal agencies to utilize their authorities in furtherance of the purposes of the ESA by carrying out programs for the conservation of endangered and threatened species. Conservation Recommendations are discretionary activities designed to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The following additional measures are recommended regarding incidental take and sea turtle conservation:

1. USFWS should advise the Principal Investigator for all surveys to provide guidance, before each survey to the vessel crew members (including scientific crew and vessel operators) to the effect that: (a) all personnel are alert to the possible presence of ESA listed species in the study area, (b) care must be taken when emptying/retrieving sampling gear to avoid damage to sea turtles and sturgeon , and (c) survey gear should be emptied as quickly as possible after retrieval in order to determine whether sea turtles or sturgeon are present in the gear.

13.0 REINITIATION OF CONSULTATION

This concludes formal consultation on the proposed actions. 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 incidental take is exceeded; (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this Opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In the event that the amount or extent of incidental take is exceeded, Section 7 consultation must be reinitiated immediately.

Depending on the circumstances associated with the cause for reinitiation, it may not be necessary to reinitiate consultation for all of the actions considered here. For example, if a new species is listed that may be affected by surveys carried out by all states, it would likely be necessary to reinitiate consultation on all of the activities considered here. However, if the cause for reinitiation has effects that are limited to one action (for example, a change in a survey carried out by one state or a species is listed or critical habitat designated in only a portion of the action area) reinitiation of consultation on only that action would be necessary. We expect that determinations about the scope of any future reinitiation(s) will be made in cooperation between the USFWS and us.

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APPENDIX A

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APPENDIX A
DESCRIPTION OF PROPOSED ACTIVITIES

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1.0 Maine

The State of Maine distributes funds for surveys in inland waters and marine waters. Studies in inland waters are carried out by the Maine Department of Inland Fisheries and Wildlife. The State has indicated that they have no current studies in inland waters where shortnose or Atlantic sturgeon are present.

Studies in estuarine and marine waters are carried out by the Maine Department of Marine Resources (MDMR). Funds are used to carry out three research surveys: (1) Striped Bass Tagging in the Kennebec Estuary; (2) Kennebec and Penobscot Juvenile Striped Bass and Alosine Beach Seine Survey; and, (3) Maine – New Hampshire Inshore Trawl Survey.

1.1 Striped Bass Telemetry in the Kennebec and Androscoggin Estuaries

In 2007, MDMR initiated an acoustic telemetry study of striped bass in the Kennebec Estuary. Sampling has been conducted by hook-and-line below the Brunswick Dam in the Androscoggin estuary (tidal fresh water), near the head-of-tide on the mainstem Kennebec (tidal fresh water), and below the Lockwood Dam in the upper Kennebec River (fresh water). Striped bass in good condition were measured (total length in millimeters), anaesthetized, and implanted with an acoustic transmitter.

1.2 Kennebec River Juvenile Striped Bass and Alosine Beach Seine Survey

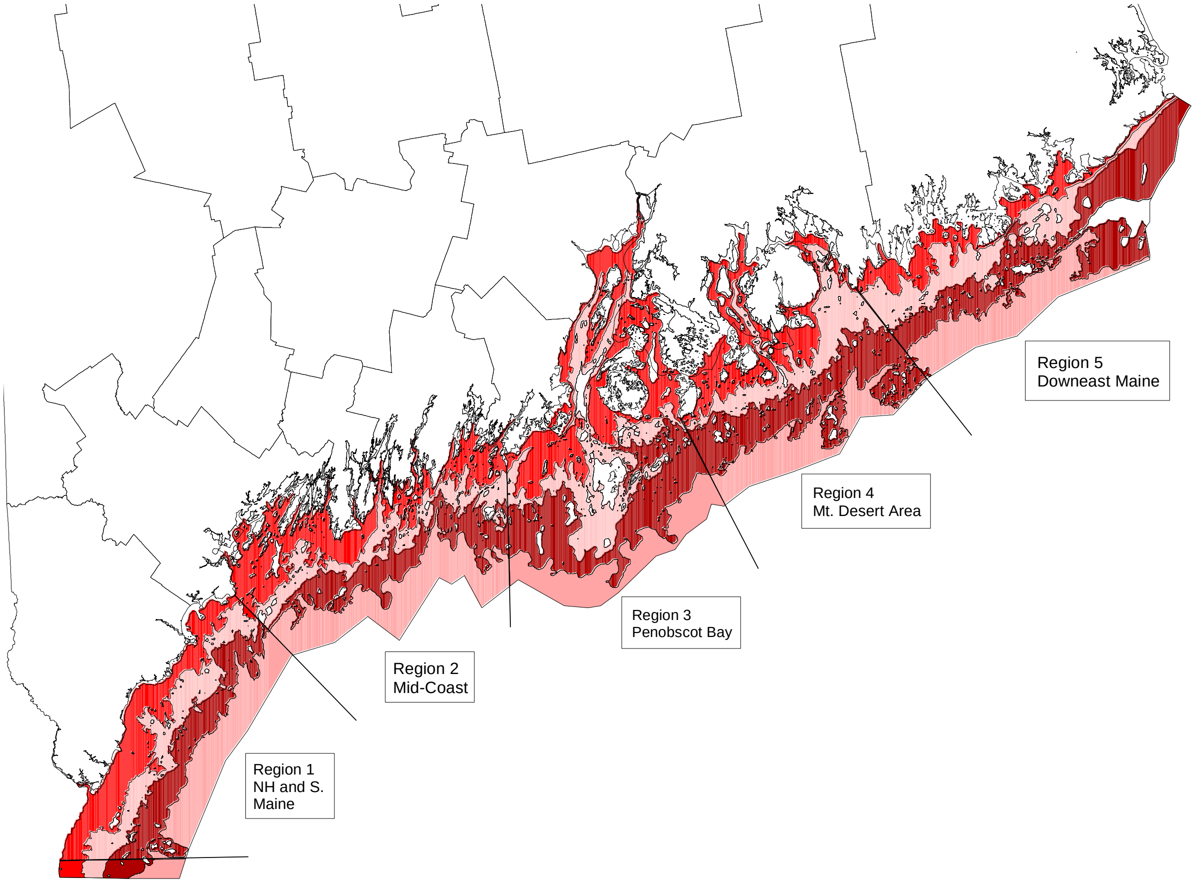
In the Kennebec, each of 20 permanent sites is sampled with a beach seine six times each year on a biweekly schedule beginning in mid-July and ending approximately in mid-September. Fourteen sites are in tidal freshwater (four on the Upper Kennebec River, three on the Androscoggin River, four on Merrymeeting Bay, one on the Cathance River, one on the Abagadasset River, and one on the Eastern River) and six are in the tidal salinity-stratified portion of the estuary. All samples are taken within three hours of low slack water with a beach seine made of 6.35 mm stretch mesh nylon, measuring 17m long and 1.8 m deep, and with a 1.8 m x 1.8 m bag at the center. The sample is sorted and processed in the field. All alosines and striped bass are counted, and the total lengths of a maximum of 50 of each species are measured. Other species are identified, enumerated, and the total lengths of a maximum of 10 of each species are measured. Soak time for each haul is approximately 10 min.

In the Penobscot, eight index sites are sampled with a beach seine 8 times each year on a biweekly schedule from July thru September. Five of the sites are in the tidal freshwater and 3 sites are in the tidal salinity-stratified portion of the Penobscot estuary. All samples are taken within three hours of low slack water with a beach seine made of 6.35 mm stretch mesh nylon, measuring 50 m long and 2.4 m deep, and with a 1.8 m x 1.8 m bag at the center. The sample is sorted and processed in the field. All alosines and striped bass are counted, and the total lengths of a maximum of 50 of each species are measured. Other species are identified, enumerated, and the total lengths of a maximum of 30 of each species are measured. Soak time for each haul is approximately 10 min.

1.3 Maine-New Hampshire Inshore Trawl Survey

The Maine-New Hampshire Inshore Trawl Survey is a stratified random survey with a fixed component. The inshore area sampled includes four[1] depth strata: 5-20 fathoms, 21-35 fathoms, 36-55 fathoms, and >56 fathoms out to approximately the 12-mile limit, and five longitudinal regions based on oceanographic, geologic, and biological features (Figure 1). Together, 20 separate strata exist.

Figure 1. Regional and Depth Strata for the Maine-New Hampshire Inshore Trawl Survey



With the addition of the fourth strata, the total survey area increased from ~3,626 nautical miles (NM^2) to ~4,665 NM^2. To keep sampling density of the original strata roughly equivalent with previous surveys, an additional 15 stations were added to the original goal of 100 stations per survey. A target of 115 stations is selected for sampling in each survey resulting in a sampling density of 1 station for every 40 NM^2. Number of tows per stratum is apportioned according to its total area (Tables 1 and 2).

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[1] From Fall 2000 to Fall 2002, the outer depth stratum was not sampled. The fourth stratum, 56 fathom to the 12-mile limit was added in the Spring 2003 survey. It expands our coverage area to approximately equal that area covered by the Atlantic States Marine Fisheries Commission (ASMFC) and allows more overlap between this survey and the NMFS survey area.

Table 1. Area in square miles of the 20 strata of the ME/NH Trawl Survey

Region	5-20 fathoms	21-35 fathoms	36-55 fathoms	>56 fathoms	Total
1	253.27	214.22	227.35	225.65	920.50
2	279.63	191.23	211.66	263.49	946.02
3	259.62	262.90	280.03	183.69	986.25
4	205.30	206.12	310.49	170.72	892.63
5	138.54	220.49	365.04	196.11	920.19
Total	1136.37	1094.96	1394.59	1039.66	4665.58

Table 2. Number of tows per stratum of the ME/NH Trawl Survey

Region	5-20 fathoms	21-35 fathoms	36-55 fathoms	>56 fathoms	Total
1	6	6	6	5	23
2	7	5	6	5	23
3	6	7	7	4	24
4	5	5	8	4	22
5	4	6	9	4	23
Total	28	29	36	22	115

Random stations are selected from a NOAA nautical chart in Arc View™ GIS overlain with 1-NM^2 grids. Each grid within each region is assigned a unique identification number that serves as a call number. Grids are selected using an Excel™ random number generator. Tows approximately 1 NM long are proposed in each grid and plotted in P-Sea Windplot™ (using charts of the NAD 1983 datum). From prior experience and local knowledge, some grids are classified as untowable during the plotting process. Due to the large amount of fixed gear and the appeal to fishermen to cooperate with the survey by clearing the tows, identifying good tow locations is a priority. If no towable bottom can be found within a 2-mile radius, a new random number is chosen within the same stratum. Beginning and end points of each tow are identified in P-Sea Windplot. To the extent possible, for ease of identification by lobster industry members, tows follow loran lines. Loran C coordinates are converted to latitude/longitude degrees to the nearest 0.001 decimal minutes.[2]

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[2] This conversion is not exact due to the distortion LORAN signals experience coming over land. The distortion is constant, so the position is repeatable in LORAN TD's. The final conversion to an accurate geographical position takes place when the area is visited and the vessel's equipment records the true geographical position using differentially corrected GPS.

After the initial survey in the fall of 2000, two stations per stratum were designated as fixed stations to be sampled on each subsequent survey. In areas where previous work had been done, the stations were selected due to their historical importance[3]. In areas with no history, one station was selected as being roughly representative of the average catch for its respective stratum and the other was randomly selected. After the addition of the fourth stratum in the spring of 2003, fixed stations were designated for that stratum using the same criteria.

Two virtually identical commercial fishing vessels, the F/V Tara Lynn and F/V Robert Michael, are used for this survey. Both vessels are Down East 54's constructed of a combination of solid and sandwich fiberglass, with full displacement hulls taken from the same mold. They are powered by 8-cylinder GMC diesel engines producing 365 H.P. Reverse gear is a Twin Disc, Model 514, with a 4.5 to 1 ratio. A 3-inch stainless steel shaft turns a 47x45-inch, 4-bladed power propeller housed in a 48-inch Michigan nozzle. The vessel's hull displacement is 73 gross tons, allowing it to perform well in sea states up to eight feet. While only one vessel at a time is planned for each survey, the other nearly identical sistership is immediately available in the event of an equipment breakdown, allowing the survey to be completed on schedule.

Since the fall 2000 survey, the two vessels have alternated between spring and fall surveys (Table 3), with the intent of alternating spring and fall vessel participation in blocks of 2 years (4 surveys). Starting with the spring 2004 survey, all future surveys will be conducted by the F/V Robert Michael, with the F/V Tara Lynn available as backup.

Table 3. Survey schedule for the F/V Robert Michael (RM) and the F/V Tara Lynn (TL)

	SPRING	**FALL**
2000	------	Robert Michael
2001	Tara Lynn	Robert Michael
2002	Tara Lynn	Robert Michael
2003	Robert Michael	Tara Lynn
2004	Robert Michael	Robert Michael

Trawl design considerations for the survey include effectiveness of the gear for sampling the complex bottom in the nearshore areas of the Gulf of Maine and comparability with previous and ongoing surveys by NMFS and Massachusetts Division of Marine Fisheries. The net is a modified version of the shrimp net design used in Maine waters (Appendix A), designed to fish for a variety of near-bottom dwelling species without targeting any specific component. Robert Tetrault, the vessels' owner, and net designer Jeff Flagg designed the net to fish effectively, be easily maintained, and be towed by vessels ranging from 45 to 70 feet in length with nominal horsepower. Three identical nets were constructed for this survey in the event of tearing or loss. Net tapers were cut to permit the shape of the net to get maximum height while allowing the net to remain tight on the bottom. The net is shackled from the footrope to the frame with two 3/8th inch shackles to a banded wire that runs parallel with the footrope. Heavy rubber wing bobbins retard bottom wing lift at the net end of the bottom leg. Top legs are 7/16th wire, 60 feet in length with soft eyes at each end, and bottom legs are 5/8th inch wire, 58 feet in length with two feet of 5/8th inch chain at the end where the leg attaches to the bottom wing for a total of 60 feet.

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[3] Historical data for several of these sites exists from previous surveys conducted by Maine DMR.

Bottom legs are covered with 2 -3/8" cookies to prevent them from digging into the mud. The net is constructed of 2-inch #24 polyethylene mesh, with a 1-inch (stretched measure) mesh liner in the cod end. Otter boards are #7.5 Bisons. Attached to the 70-foot, 5/8th inch Rander's Combination Wire Rope footrope is a roller frame strung onto ¾" IPS of 6x19 construction with a fiber core. The ten-foot wide bosom section is made up of eight-inch rubber discs on six-inch centers along with eight evenly spaced toggles. Spacing is maintained by smaller four-inch cookies strung between the discs. The two 29-foot wing sections are made up of six-inch rubber discs spaced 4 ½ inches apart, with the same four inch cookies used to maintain spacing. Each wing section contains twelve toggles spaced evenly to facilitate footrope attachment. The 5/8" Rander's combination rope headrope has twenty-eight 8" center-hole, deep-sea net floats strung with 5/8" yellow polyethylene float line. Between surveys, the net is sent back to the manufacturer where it is returned to specification (Appendix B). Nets will be replaced as they age to keep the gear in good working condition and insure consistency.

2.0 New Hampshire

The State of New Hampshire uses the FWS funds to carry out three projects: (1) Anadromous Alosid Restoration and Evaluation; (2) Estuarine Survey of Juvenile Finfish; and, (3) Monitoring of Rainbow Smelt Spawning Activity.

2.1 Anadromous Alosid Restoration and Evaluation

The restoration or anadromous alosids in the coastal river systems of New Hampshire is assessed by regular monitoring of fish ladders owned by the Fish and Game Department. These fishways, their river location and their initial year of operation are Cocheco (1976), Lamprey (1972), Oyster (1976), Taylor (1978), Winnicut (1998) and Exeter (1975). Fish utilizing these coastal fish ladders are identified and enumerated by hand counting, electronic fish tubes or estimated by time counts. Counts recorded by electronic fish counters are adjusted by the results of regular calibration counts.

Biological samples are collected from anadromous alosids using fish traps at the upper end of several coastal fishways. Staff use dip nets to collect samples of river herring at the beginning, middle and end of the spawning run. Each sample consists of length measurements and sex determination from approximately 150 fish as well as collecting scale samples for aging and speciation from 50 of these fish. All returning adult American shad encountered at the fish passage facilities are enumerated, measured, sexed and scales collected for aging. If stressful conditions like high water temperatures exist, these fish are passed upriver without biological data taken to assure maximum survivability of all returns.

River herring are trapped and transferred to enhance runs in New Hampshire rivers. During May and June, river herring are collected by dip net from traps of selected fishways and transported to impoundments or lakes in the coastal and Merrimack River drainages. No more than 10 percent of run from the selected river is removed for out-of-basin transfers.

2.2 Estuarine Survey of Juvenile Finfish

Monthly seine hauls are conducted from June through November at 11 fixed location sites in Great Bay Estuary and four fixed location sites in Hampton Harbor Estuary. The beach seine hauls are conducted by boat using a 30.5 m by 1.8 m bag seine with 6.4 mm mesh. The catch is identified to the lowest possible taxon, enumerated, and up to 25 individuals per species measured for total length. The mean annual catch per seine haul of selected juvenile species is calculated and used as a measure of relative abundance.

2.3 NH Rainbow Smelt Survey

This project will monitor trends in the spawning population, attempt to identify the nature and extent of the threats to rainbow smelt, and recommend management strategies to reduce, prevent, or reverse the threats to rainbow smelt within the Great Bay Estuary. In order to accurately characterize the peak of the smelt run, the sampling team will plan to set fyke nets upon ice-out conditions (generally middle to end of March) until the third Thursday in April. This threshold has been able to capture 97-100% of the run at the Squamscott River (2008-2012) and 82-98% (2010-2012) of the run at the Oyster River. The nets will be set in three rivers: Oyster, Squamscott, and Winnicut.

The fyke nets being used have six hoops measuring 2.5 feet (ft) in diameter attached to a box frame which measures 4x4 (ft). Throats are attached to the second and fourth hoop inside the mouth. Soft wings 4x16 (ft) with leads and floats are attached to both sides of the box frame mouth so that the net spans 50-75% of the river channel at high tide.

Fyke nets will be deployed for three nights each week during the spawning run at low tide when samplers can enter the water. The net will be left in position until the next low tide when samplers will haul the net and empty the contents into 5-gallon buckets or large coolers with aerators. All smelt in the net will be randomly distributed into the buckets. One hundred males and one hundred females will be measured to the nearest millimeter, and the length and sex of each fish recorded. All remaining smelt will be counted and sexed. Approximately 500 scale samples will be taken for aging over the course of the run at each site. Scales will be taken from the dorsal side directly below the dorsal fin after first wiping the area to avoid loose scales from other fish. At least 20 samples will be taken for each centimeter size class per sex (10 cm to 20 cm), and samples taken from size classes above 20 cm as they occur. Scale samples will be taken at all sites. Bycatch in the net will be identified and measured up to 25 fish per species and then counted.

Scales will be placed in a micro-centrifuge tube containing a 5% solution of pancreatin. The vials will then be floated in a sonicator for 15 minutes. The vials are emptied one at a time into a small Petri dish and rinsed with clean water. Approximately sixteen scales are mounted from each fish and labeled with a sample number. The label only contains the sample number with no information regarding the fish size. To avoid bias when reading the scales, slides are stored in a slide box instead of in the envelope with the fish information written on it.

Scales are read using Image Pro (image analysis program) which drives a digital video camera mounted atop a lens tube. The computer is calibrated to the zoom selected for reading the scales so that measurements of annuli can be made. Annuli will be identified along with a "shiny line" scar. Two readers will go through all the scales collected during the sampling season separately. For the scales that they disagree on, they will go back and read together along with the sex and length information. If they still do not agree, a third reader will be the tie-break. If a consensus age is not reached the fish will be removed from the data set.

Water quality monitoring will be conducted at each site with YSI 6920V2 data sondes. Grab samples will be collected at each haul to obtain a snapshot of the water quality below the spawning rifle where the fyke net is placed. Continuous monitoring, deployment of sonde in river with parameters digitally stored every 15 minutes, will be conducted as needed among the study sites.

The data collected and observed trends will be analyzed from this project to recommend changes in policies and/or regulations to reduce, prevent, or reverse threats to rainbow smelt within the Great Bay Estuary.

3.0 Massachusetts

The State of Massachusetts distributes funds for surveys in inland waters and marine waters. Studies in inland waters are carried out by the Massachusetts Department of Inland Fisheries and Wildlife. Studies in marine and estuarine waters are carried out by the MA Division of Marine Fisheries (MA DMF).

3.1 MA-T-3 Fish Community Assessments (Inland)

The approach for this state-wide project will be to continue to conduct fish community assessments to identify the current status of the resource. Standard fishery assessment tools will be used and will include: electroshocking (backpack, barge and boat methods), seining, and gill netting. Methodologies will be selected based on the habitat to allow for the use of the most appropriate technique for any given situation. Division of Fisheries and Wildlife Standard Operating Procedures will be employed for each methodology. Sampling effort will be quantified and fish will be identified to species and measured for total length. In cases where more than 100 fish of one species are collected at one site, each fish of that species will be counted but not measured to length. Voucher collections will be kept at each site (1 or 2 specimens of each species in 10% formalin) to allow independent verification of species identification in the laboratory. Although historical surveys have been conducted, survey data gathered under the current SOPs is necessary to continue with the plan as outlined below.

3.2 MA-T-3 Westfield River Fish Passage Facility Evaluation (Inland)

This project includes monitoring of the West Springfield fish passage facility on the Westfield River during the period of migration for American shad, blueback herring, and Atlantic salmon. The facility is monitored during the spring (April - July) and fall (September - October) fish passage seasons. There is a trap at the top of the fishway that is used to sample ascending fish. Migrating fish are identified to species and enumerated

3.3 MA-T-3 Essex Dam River Fish Passage Facility Evaluation (Inland)

The Essex Dam fish lift on the Merrimack River in Lawrence, MA is monitored during the period of upstream migration of American shad, Atlantic salmon, and other anadromous fish species. Passing fish are identified and counted and adult Atlantic salmon are trapped and transported to the Nashua Fish Hatchery for broodstock purposes from May through July. The fishway will be continuously monitored during its operating period (June to the end of November) for efficiency and to document fishway-induced mortality.

3.4 Massachusetts Fishery Resource Assessment

3.4.1 Fishery Resource Assessment, Coastal Massachusetts

The objective of this survey is to collect, analyze, and summarize bottom trawl data for fishery management purposes. This survey occurs statewide in coastal/ territorial waters. The daytime survey of Massachusetts inshore territorial waters is conducted in 3-week time spans during the months of May and September. The survey utilizes a stratified random sampling design consisting of 23 sampling strata based on six depth zones (< 30', 31-60', 61-90', 91-120', 120-180', and > 180') and five geographic regions (Massachusetts Bay north to the Merrimac River, Cape Cod Bay, waters south and east of Cape Cod and Nantucket, Nantucket Sound, and Vineyard Sound/ Buzzards Bay). A total of 101 stations are allocated to strata, in approximate proportion to each stratum's area; a minimum of two stations are assigned to each stratum to provide estimates of variance. Sampling intensity is about one station every 19 square nautical miles. Tow locations within each stratum are randomly chosen. An alternate tow site in the same stratum is selected if concentrations of fixed gear or untowable bottom are expected.

Trawl survey sampling is conducted using a Division of Marine Fisheries 3/4, North Atlantic type, two seam "whiting" trawl (39' headrope/ 51' footrope). The trawl is equipped with a fine mesh cod end liner, rubber disc (3.5"), chain sweep, wooden trawl doors (6' X 40" X 325 lbs) and 10 fathom legs. At each station, the standard tow is 20 minutes at an average speed of 2.5 kts with a 3:1 scope. Vessel services are provided by the Northeast Fisheries Science Center, NOAA R/V GLORIA MICHELLE (65' LOA, 355 hp); this vessel has been chartered since 1982.

The catch from each tow is manually sorted, and weights, numbers, and length-frequencies are recorded by species. Large catches, which are impractical to completely process are subsampled by weight or volume and expanded to represent the entire sample. Routine collections and observations include scale/otolith samples, sex, and maturity stage. Bottom water temperatures are recorded at each station.

3.4.2 Winter flounder year-class strength

This study is designed to assess year-class strength by monitoring relative abundance of shore zone young-of-the-year winter flounder. It occurs in intertidal and shallow subtidal areas of Cape Cod southern shore estuaries. Quantitative beach seining is a feasible sampling technique for young-of-the-year (YOY) winter flounder within areas of low tidal amplitude and smooth, sandy bottoms. These conditions occur in Cape Cod's southern estuaries (i.e., encompassing a fraction of the winter flounder's Southern New England stock unit range). A time series of YOY indices provides an additional, complementary index to trawl survey information and catch trends. Summer flounder (age 0) catches from the seine survey are also routinely utilized by assessment Working Groups as indices of recruitment.

Coincidental with the period of greatest availability of YOY winter flounder in intertidal and shallow subtidal zones, seining is conducted on the top half of the diurnal tidal cycle from mid-June through mid-July. Forty-nine fixed sites or stations are proportionately allocated by each estuary's littoral perimeter. For analytical purposes, each estuary is considered a stratum. The six estuaries seined are: Great Pond, Cotuit Bay, Waquoit Bay-Eel Pond, Lewis Bay, Bass River, and Stage Harbor. Stations are selected subjectively with consideration for efficient seining (i.e., smooth sediment bottom generally devoid of attached vegetation) and historic availability of 0-group flounder.

A 21' (6 m) straight seine of ¼" (6.5 mm) nylon mesh, equipped with weighted lead line to minimize escapement, is set and hauled perpendicular to shore from a depth of 3 to 4'. The three hauls made at every station are sufficiently separated along the beach so as not to scare fish from the path of adjacent hauls. To enumerate 0-group winter flounder (and other species') density (# YOY per square meter), each haul is quantified to area swept by maintaining a taut spreader rope (5.5 m) and measuring seining distance.

Statistical analysis of the seine data employs stratification techniques; each estuary is considered a stratum, and the three hauls at each station are treated as one sample. A stratified mean density index and confidence limits are derived from standard and modified formulae for mean and variance.

3.5 Marine Recreational Fisheries Investigations

3.5.1 Cooperative Striped Bass Tagging Study.

The goal of this study is to conduct tagging and long-term monitoring of tag recoveries to improve understanding of distribution and movement of Atlantic striped bass stocks and to generate vital information related to mortality rates with special emphasis on larger individuals. The study takes place in shoal areas in Cape Cod Bay and Nantucket Sound. Although tags have been applied to over 150,000 wild and hatchery fish along the East coast, very few fish in excess of 30" have been tagged. During summer and fall, large striped bass concentrate and are available for tagging on shoal grounds around Cape Cod, Massachusetts.

Tagging will be conducted by trained MADMF biologists aboard 2 to 3 charter boats contracted by the MADMF. Fish will be caught using traditional hook and line. Internal anchor tags will be applied in accordance with protocol established by the State-Federal Cooperative Striped Bass Tagging Study. The total number of tagged fish targeted is 700 annually but numbers may increase or decrease according to weather, availability of vessels and/or fish, status of funding, etc. Information collected will include a summary of the tagging activity, fishing operations and characteristics of the catch. Information will be input annually into the coastwide striped bass tagging database maintained by USFWS.

Two modeling approaches, recommended by the ASMFC striped bass tagging committee, will be used to analyze the tagging data. Program MARK will be used to estimate a time series of annual survival rates (S). The instantaneous rates model of Jiang et al. (2007) that accounts for the re-release of previously tagged fish will be used to estimate fishing mortality and natural mortality. The models will be compared over time and analyses will be conducted to determine the efficacy of each modeling approach. These data will be supplied to the ASMFC Striped Bass Technical Committee for use in regularly conducted stock assessments.

3.5.2 The Massachusetts Large Pelagics Research Project.

The objective of this study is to investigate the life history, ecology, physiology, and relative abundance of large pelagic fish species (sharks, tunas, swordfish, billfish) of recreational importance in the coastal and offshore waters of Massachusetts. The study occurs in

Massachusetts Bay, Cape Cod Bay, Nantucket Sound, Buzzards Bay. See the attached chart with locations of all project acoustic receiver arrays.

Large pelagic fish species, including sharks, tunas, and billfish, will be sampled during research cruises and in conjunction with commercial/recreational fishing activities and big game tournaments. Sharks, tunas, and billfish will be captured by standard recreational single hook and line fishing. Biological parameters including age structure, feeding ecology, and reproductive status will be described through the dissection of a representative sample of specimens. All other specimens may be blood sampled and tagged with conventional, acoustic, or satellite tags to examine the physiological effects of capture, behavior, essential habitat, local and broad-scale movements, and post-release mortality. Research will be conducted in cooperation with the NMFS Apex Predator Investigation (Narragansett, RI) and researchers from other state, federal, academic, and private institutions with assistance from the recreational and commercial fishing sectors. Information generated by this research will made available to the scientific community, the general public, and fisheries managers through peer reviewed publications, educational presentations, and intra- and inter-agency correspondence. This information will contribute to more effective state, federal, and international management of these species

In addition, total catch and effort data will be collected from major offshore fishing tournaments targeting tunas, billfish and sharks. Data collected will include number of boats/fishermen, fishing hours (effort), number and weight of catch by species, number released and tagged by species, and weather conditions. Catch-per-unit-effort indices will be generated and analyzed annually. Data will be made available to NMFS tuna, billfish, and shark programs to enhance the coastwide database and contribute to more effective management.

3.5.3 Monitoring Movements and Habitat Use by Striped Bass, Morone saxatilis, using Acoustic Telemetry

The only field work that will be conducted for the period of this study will be the maintenance of the acoustics arrays located in the Gulf of Maine at the eastern edge of Massachusetts Bay, and inshore areas along Massachusetts and Cape Cod Bay. We will check, clean and download data from the acoustic receivers on a monthly basis For data analysis, a variety of analytical techniques ranging from generalized linear models to neural networks will be used to examine and summarize the large amount of acoustic data collected during 2008-2011. The study takes place in Massachusetts Bay. All acoustic buoys have been specially designed and deployed with breakaway lines under the direction of our agency's Protected Species Specialist in order to eliminate any chance of entanglement by listed marine mammals and/or sea turtles.

3.5.4 Monitoring spawning behavior and movement of Atlantic Cod (Gadus morhua) at inshore spawning sites in the western Gulf of Maine

The objectives of this project are to:

1) Observe the residence time and spawning behavior of cod on their spawning site.
2) Test for spawning site fidelity between each year of monitoring.
3) Examine the movement of the fish when not at the spawning ground.
4) Monitor environmental cues that may influence cod behavior.
5) Detect any variation in the behavior of males and females.
6) Estimate immigration and emigration rates from the spawning area

7) Estimate biomass of mature Atlantic cod on the spawning ground
8) Characterize the habitat of the spawning site.

The project takes place in Massachusetts Bay. The following procedures are implemented:

Spring Cod Conservation Zone

MADMF has partnered with researchers at the University of Massachusetts-Dartmouth/Massachusetts Marine Fisheries Institute to implement a comprehensive study of the biology, behavior and habitat of spawning Atlantic cod in the Spring Cod Conservation Zone. One doctoral student will be funded to investigate site fidelity, immigration-emigration rates, residence time, spawning behavior, and movement patterns. MADMF staff will conduct complementary studies to observe fine-scale movements on the spawning site, as well as characterize habitat parameters and estimate spawning stock biomass.

Tagging Strategy

Atlantic cod will be captured using a traditional hook and line method for cod called "jigging" in which lures, or jigs, are used instead of bait; thereby, virtually eliminating bycatch. Beginning in 2012, cod will also be captured using demersal long lines. Those fish for which the sex can be determined and spawning condition verified will be tagged with archival data storage tags (DST's) traditional T-bar anchor tag. After tagging, the fish will be held on board in a tank with fresh-flowing seawater pumped from below the thermocline and the health of the fish will be assessed. When the fish has been observed to be in good condition and fully recovered from the tagging procedure, it will be released at the surface. In 2008 through 2010, 66 Atlantic cod were tagged with VEMCO V16 acoustic transmitters. The tags have a battery life of over 3 years and therefore it is anticipated they will be returning to the spawning aggregation every spring.

Acoustic Monitoring

VEMCO VR2W receivers will be organized into an array that will allow us to monitor the entire area of focus, as well as, some of the surrounding area. The receivers will allow us to observe the behavior and residence time of the cod on and near the spawning ground, as well as their on-site and off-site movements and how they may be related to time of day. Monitoring in multiple years will allow us to test for spawning site fidelity. Records of cod activity will also be analyzed to observe any variation in behavior between males and females in relation to spawning activity, arrivals/departures, on-site/off-site movements, size relationships, and potential lekking behavior.

Cod Movement

Recaptured DST's will be used to geolocate the movements of the cod as well as to investigate seasonal habitat preferences. Any detections from MADMF array will be incorporated into the analysis of movement. DST records will permit observation of potential 'spawning columns', or vertical behavior during spawning. Movement of fish can be used to infer how they are incorporated in the population structure of the GOM.

Environmental Cues

Temperature data from loggers attached to the acoustic moorings will allow inferences to be made on the role that temperature may play in the movement of cod related to the spawning ground. In addition, physical parameters such as moon phase and tide will be monitored to observe how they may influence cod behavior. Weather patterns will also be recorded while receivers are deployed to observe potential responses of cod to weather changes.

Habitat Characteristics
Using a combination of side scan sonar, underwater video, and bottom grabs we will characterize the immediate area where cod are aggregated (already identified as a small 2-meter high plateau in 50 m of water in the SCCZ) and other areas within and outside the SCCZ where cod aggregations are not present. We will examine such factors as sediment type, algal and invertebrate cover, prey availability, and bottom relief in order to quantify/qualify attributes that are associated with spawning aggregations.

Spawning Biomass
Semi-weekly bioacoustic surveys will be conducted in the SCCZ during the spawning period using a Biosonics 200 kHz split-beam scientific echosounder deployed from MADMF 28-foot research boat, R/V Alosa. Resulting data will be analyzed using Sonardata Inc.'s Echoview software. Combining data from semi-week surveys of standing biomass with immigration/emigration rates will allow estimates of total spawning biomass in the SCCZ to be made.

Biological Sampling
Genetic fin clip samples will be collected from spawning cod for use in a study of cod stock structure in US waters by researchers at the University of New Hampshire. Such genetic investigations are expected to help identify the fine-scales at which population processes occur. Furthermore, otoliths will be collected for researchers at the University of Massachusetts-Dartmouth for incorporation into a study on the spawning origin of juveniles, natal homing, and growth rates.

Passive Acoustics
In collaboration with researchers from the Stellwagen Bank National Marine Sanctuary, an array of passive acoustic receivers will be used to document sound production of cod while on the spawning ground. Investigating sound production during active spawning is expected to provide further insight into the spawning behavior of cod by including the timing of spawning events and movements away from the spawning site. In addition, if proven successful, using passive acoustic technology could be used as a new tool for locating cod spawning activity in new areas. A passive acoustic receiver was deployed near the spawning aggregation in 2011. In 2012, 5-7 additional receivers were deployed into a full arra.

<u>Winter Cod Conservation Zone</u>
Our research plans have primarily focused on the SCCZ due to the spatial and temporal reliability of that spawning group. This allows us to partner with other researchers and pursue multiple agendas, without having to expend time in locating the aggregation. In contrast, the spawning group in the WCCZ appears to be far more variable from year to year, and therefore presents a greater challenge to study. Research efforts in the WCCZ will focus on expanding our understanding of the timing, spatial extent and size of the spawning aggregation:

Spatiotemporial Distribution:

MADMF's Fisheries Dependent Investigations Program is actively sea sampling local day boat gillnetters that are commercially fishing around the borders of the WCCZ. By monitoring the sex and maturity information and the cod catch rates collected by samplers in the fishery, researchers will use this information to identify the most appropriate time to conduct fishfinder surveys. These surveys will be conducted on MADMFs 28' research vessel and data collected will assist in the documentation of the presence timing and location of the spawning aggregations and spawning habitat.

Spawning Biomass:
Using similar techniques that have already been proven in our work in the SCCZ, BioSonics echosounder surveys will be conducted on the aggregations located through the fishfinder surveys to estimate biomass of the aggregations. Surveys will be conducted in concert with the fishfinder surveys until permanent and predictable aggregations are located at which semi-weekly surveys will be conducted.

Biological Sampling:
Similar to work previously conducted in the SCCZ, genetic fin clip samples will be collected from spawning cod for use in a study of cod stock structure in US waters by researchers at the University of New Hampshire. Such genetic investigations are expected to help identify the fine-scales at which population processes occur. Furthermore, otoliths will be collected for researchers at the University of Massachusetts-Dartmouth for incorporation into a study on the spawning origin of juveniles, natal homing, and growth rates. Atlantic cod will be caught using demersal long-line fishing gear using large 13/0 circle hooks to minimize bycatch of juvenile cod. Traditional hook and line using artificial lures will also be used.

Tagging Strategy
Atlantic cod that are not biologically sampled will be tagged with T-bar anchor tags. The UMass tagging program was started in 2000 and has tagged approximately 32,000 cod to date. Tagged cod will assist the UMass cod tagging project determine the large-scale seasonal movement patterns of cod throughout the Gulf of Maine and Georges Bank, measure growth rates and recruitment of cod in the wild, and evaluate the environmental conditions (e.g. temperature, salinity, habitat) in areas where cod are found.

Real-Time Acoustic Tracking
In 2010 and 2011 it was observed in the SCCZ that spawning activity most often occurred over flat featureless mud bottom during the night. During the day, the fish left the mud bottom and returned to a gravel/cobble outcrop forming aggregations in the exact same location every day where they remain before the next evening spawning event. To assist in the location of aggregating cod in the WCCZ, 4 large spawning females will be caught using traditional hook and line and/or demersal longline, and tagged with VEMCO V16 acoustic continuous transmitting tags. Tagged fish will be tracked using our VR100 acoustic field receiver and VR110 directional hydrophone. Tagged fish will be tracked to aggregations. Once other aggregations are located data elements that were collected in SCCZ will also be attainable for the WCCZ (e.g. residency time, wandering rates, fidelity, and spawning behavior).

Atlantic cod will be captured using a traditional hook and line method for cod called "jigging" in which lures, or jigs, are used instead of bait; thereby, virtually eliminating bycatch. Beginning in 2012, cod will also be captured using demersal long lines. Due to lower than expected angling catch rates in 2012, MADMF attempted to increase our efficiency by deploying small demersal long-lines. The long-lines used are short (<200 circle hooks), baited with clams, and set for approximately 1-2 hours. All fish caught have been vigorously alive (a requirement for our tagging purposes). While the catch has primarily been cod, a few other groundfish species (e.g. haddock, pollock) have also been caught and released alive. All acoustic buoys have been specially designed and deployed with break away lines under the direction of our agency's Protected Species Specialist in order to eliminate any chance of entanglement by listed marine mammals and/or sea turtles.

3.6 Diadromous Fish Research and Restoration

3.6.1 Diadromous Fish Biological Studies

The objective of this study is to conduct studies to better understand the biology and demographics of local diadromous fish populations, and to understand the biotic and abiotic factors affecting these populations. Through these studies, the goal is to be able to provide accurate scientific advice to managers that will allow for population increases and sustainability of our diadromous fish resources.

Several separate studies will be conducted under this job and are listed below. All work conducted is designed to investigate abundance, movement, habitat conditions, and biological characteristics of populations of diadromous fishes in Massachusetts coastal waters and streams.

Population and Spawning Habitat Monitoring for Rainbow Smelt

Rainbow smelt spawning populations will be monitored in eight coastal rivers (Parker, Crane, North, Saugus, Fore, Jones, Weweantic, and Westport) through fyke net sampling. Fyke nets will be set and hauled three times each week at each river throughout the spawning season (approximately Mar 7th to May 15th). All fishes caught will be counted and measured and basic water chemistry parameters will be recorded during each sampling event. A sub-sample will be collected each week from the Fore River for aging and to collect brood stock for restoration efforts. Scales will be removed, processed, and aged by the Age and Growth Project (F68R) according to standard protocol. An age key will be created and applied to the fyke net samples. An annual relative index of abundance will be calculated for each river and for separate age groups. Relative year class strength will be tracked over time. Otoliths will be collected from the North and Crane Rivers to document the presence of the oxytetracycline mark from our stocked larvae (see Job 2 under this grant). Fyke net catch data, water quality data and environmental data will be maintained in an Access database. In addition, specific efforts will focus on the quality of smelt spawning habitat at the fyke net stations. Spawning habitat conditions will be assessed and negative influences on spawning success (related to water flow, periphyton, and sedimentation) will be documented.

Monitoring of Biological Parameters and Habitat Characteristics for River Herring (alewives - Alosa pseudoharengus and blueback herring - Alosa aestivalis) and American Shad (Alosa sapidissima) Populations Along the Massachusetts Coast

This study will investigate the demographics and other biological characteristics of river herring and shad in Massachusetts coastal rivers. Additionally, MA will perform assessments of river herring spawning habitat.

Each year approximately 250 alewives will be collected from a minimum of three spawning runs (e.g., Nemasket River, Monument River, and Town Brook) representing the two distinct geographic regions of Massachusetts: Gulf of Maine and Southern New England. When present, equal numbers of bluebacks will also be collected. Additionally, 250 shad will be collected from the Merrimack River at the Lawrence Dam. All fish will be collected with the use of dip nets. For all three species, five collections of 50 fish will be staggered during the duration of the run so as to capture any temporal changes in the composition of migrating fish. All collected fish will be measured, weighed, and dissected for sex determination, and scales and otoliths will be removed for ageing. This sampling effort will yield up to 1,250 scale/otolith samples that will be aged according to standard methodology by the Age and Growth Project (F68R). Length-weight relationships, age structure, sex ratios, and length-at-age for each run will be compared across geographic regions. The data will be examined for co-occurrence of dominant year classes among regions. Where the data are appropriate, instantaneous rates of total mortality will be estimated from age composition.

Outward migrating young-of-the-year alewives and blueback herring will be collected from the Monument River, and additional rivers as staffing allows, during July through December. Lengths and weights will be recorded for all individuals and seasonal changes in the size and condition of individuals will be analyzed and compared across months. An age-1 index of abundance will be generated each year using data from the Massachusetts Spring Bottom Trawl Survey.

Spawning and nursery habitat for river herring will be assessed at coastal ponds, lakes and rivers using MADMF Quality Assurance Program Plan (QAPP) protocols (Chase 2010). The assessments include the measurement of parameters important to the spawning and rearing success of river herring including dissolved oxygen, pH, turbidity, nutrient levels (nitrogen and phosphorus), presence and amount of invasive aquatic plant species, depth, and acreage of suitable habitat. Assessments will be conducted over two years in order to capture interannual variability of parameters. Each year, one or two watersheds will be selected for assessments.

3.6.2. Stock Enhancement of Diadromous Species

The objective of this study is to restore depleted populations of American shad by augmentation of natural runs with fry/larva from hatchery culture and to augment weak alewife/blueback herring runs or runs with newly created/improved access with adult spawners transferred from other healthy systems.

Spawning-condition American shad will be brought into hatcheries and spawned by various means, and the resulting larvae will be stocked into historic nursery grounds to restore populations. Alewives will be netted from spawning runs where populations are judged to be healthy and transferred via stocking truck to systems that have depleted populations. The specific projects and methods are presented below.

American Shad Propagation: Restoration of Shad in the Charles River

The Charles River is the longest river in the Commonwealth (i.e., 80 miles) and is bordered by approximately 20,000 acres of wetland (Fig. 1). Historical records of American shad in the Charles date back to the 1600s, when thousands of migrating adults were captured and sold near Watertown. The Division of Marine Fisheries has been engaged in the restoration of American shad in the Charles River since 1971; however, attempts at both egg stocking and adult transfer programs have met with little success. The transfer of adults ceased in 1992. More recently, the artificial propagation and stocking of shad fry have resulted in the successful enhancement of adult shad populations in southern systems, such as the Susquehanna and Nanticoke Rivers and tributaries of the Delaware River. For example, since 1989 an estimated 60 to 76 percent of shad returning to the Susquehanna River have been of hatchery origin, and in 2005 more than 68,000 fish returned to this system. Additionally, the Susquehanna program has been so successful that on average, approximately 181 stocked larvae are required to produce one returning adult (Hendricks 2006).

The intent of the current project is to restore viable populations of American shad to the Charles River. This will be accomplished through a fry stocking program in conjunction with fish passage improvements. The fry stocking program will be modeled after the successful programs implemented by Virginia, Maryland, and Pennsylvania for restoring shad to the tributaries of the Chesapeake Bay (Hendricks 1995). The Charles River was selected for this restoration effort due to (a) the availability of spawning/rearing habitat, (b) the availability of functioning fishways suitable for shad, and (c) the historical significance of shad in this system

Approximately 500 brood stock shad will be obtained annually from the Merrimack River at the Essex Dam fish lift in Lawrence, MA. Most shad will be transported to and spawned at the USFWS hatcheries in North Attleboro, MA and Nashua, NH. The production goal is three million fry each year for distribution in the Charles River.

Rearing of larvae will take place at the USFWS hatcheries. The larvae will be raised for about 7-10 days before release as fry into the upper Charles River. All fry will be immersed in an oxytetracycline bath in order to mark their otoliths prior to release. Marking in this way will enable us to quantify hatchery returns in 3-4 years. Fry that have been released in this manner have shown high fidelity to their natal rivers (Hendricks et al. 2002).

To estimate juvenile survival and to help establish recruitment indices for the Charles River, juvenile sampling will begin in the weeks following stocking and continue through fall. Sampling will generally occur downriver of the stocking site(s) and will include several methods. First, qualitative samples will be taken by electroshocking. Second, drop nets will be used in open bays at the Moody Street Dam in Waltham, and third, a large incline plane trap will be installed near the pedestrian walkway above the Watertown Dam in Watertown. Drop nets and the inclined plane trap will be employed via specific quantitative protocols.

Returning adults will be collected by electroshocking below the Watertown Dam and by a trap placed in the fishway at that dam. The otoliths from these individuals will be examined for oxytetracycline marks. A successful restoration will be indicated by the presence of a greater number of naturally spawned individuals as compared to hatchery spawned individuals.

This project is a collaborative effort between the Massachusetts Division of Marine Fisheries and the U.S. Fish and Wildlife Service (Central New England Fishery Resource Complex).

River Herring Trap and Transfer
Alewives and bluebacks will be transported from healthy donor runs using the agency stocking truck, and placed in streams that have recently or will soon have improvements to fish passage, and have been depleted owing to the lack of adequate passage. Healthy donor sites are identified using a run's historic population data and data from continuous biological monitoring of the run during the current spring spawning season. This combined data set allows biologists to specifically select appropriate runs for each year's donor sites. This list may include the Nemasket River, Agawam River, Charles River, and Monument River. The following is a list of the proposed stocking that will occur under this project, listed by species. The actual number of sites stocked and fish transferred will be dependent on the annual availability of herring in the donor streams. These sites are all associated with recent or pending construction or improvements to fishways or dam removals. The number of fish stocked into each river is based on the acreage of the potential spawning grounds and the severity of depletion – generally between 1.000 and 5,000 individuals. All sites are be stocked for a minimum of three years and runs will be monitored for the return of progeny of the stocked fish three years post-stocking (river herring first return to spawn at age-3).

Species Site	No. of fish stocked	
Sippican River, Rochester	3,000	
Herring Brook, Pembroke/Hanson	3,000	
Town Brook, Plymouth		3,000
Island Creek, Duxbury		2,000
Monument River, Bourne/Plymouth	3,000	
Three Mile River, Dighton	3,000	
Eel River, Plymouth	2,000	

The stocking of fish is essential to the re-establishment of herring runs that have been eliminated or weakened by poor or lacking fish passage structures. Stocking is the next critical step following or in conjunction with MADMF continuing efforts to improve fish passage. Because anadromous herring exhibit some degree of fidelity to their natal streams, re-establishment of runs generally will not occur without stocking. Stocked runs will be monitored for at least three years. Successful re-establishment of spawning populations will be indicated by the return of new recruits at age-3.

4.0 Rhode Island

4.1 Assessment of Recreationally Important Finfish Stocks in Rhode Island Waters.

4.1.1 Seasonal Fishery Assessment in Rhode Island and Block Island Sound

Job focuses on spring and fall sampling of twenty-six stations in Narragansett Bay, six stations in Rhode Island Sound and 10 stations in Block Island Sound

Starting January 1, 2012, the trawl survey will be conducted using new doors and calibration study will begin. Each station will be sampled (towed) using a given set of doors and then re-sampled (re-towed) 1-tidal day later using the other set of doors. This type of experimental design allows for a paired-approach (offset by 1-tidal day) and allows the effect of net configuration due to door type to be assessed, resulting in catch calibration between door types comparing the catch at the same station between tows conducted using different door types (new and old).

4.2 Narragansett Bay Monthly Fishery Assessment

Job focuses on monthly collection of finfish and hydrological data at thirteen fixed stations in Narragansett Bay

Starting January 1, 2012, the trawl survey will be conducted using new doors and calibration study will begin. Each station will be sampled (towed) using a given set of doors and then re-sampled (re-towed) 1-tidal day later using the other set of doors. This type of experimental design allows for a paired-approach (offset by 1-tidal day) and allows the effect of net configuration due to door type to be assessed, resulting in catch calibration between door types comparing the catch at the same station between tows conducted using different door types (new and old). Since 1990, 2,896 tows have taken place.

4.3 Young of the Year Survey of Selected Rhode Island Coastal Ponds and Embayments

Job focuses on monthly collection of young of the year finfish species in four Rhode Island coastal embayment during spring, summer and fall seasons. The abundance and size composition of spawning adults are also monitored. Species are collected thru the deployment of a beach seine.

4.4 Juvenile Marine Finfish Survey

Job focuses on monitoring juvenile production of marine finfish stocks in Narragansett Bay, Rhode Island, which are subject to recreational fishing. It examines multi-species interactions and identifies and recommends management measures likely to result in optimum production of those species. Species are collected thru the deployment of a beach seine throughout Narragansett Bay and the Sakonnet River

4.5 Abundance and Distribution of Blue Crab

This is a new project that has recently been submitted for approval through the State Wildlife Grant program. Its objective is to determine the status of the blue crab population in Rhode Island waters. It will determine the distribution and relative abundance of blue crab in Narragansett bay and surrounding areas and collect biological information. The project will also address the effect of changes in climate in relation to recruitment, abundance and distribution.

The project will utilize blue crab information from the other Rhode Island trawl surveys described above. It will also use blue crab settlement collectors to monitor post larval settlement. Adults will be directly sampled through crab pots set at two sites each in coastal ponds, Upper Narragansett Bay, Mount Hope Bay, Lower East Passage and Lower West Passage. Ten crab pots will be set at each of the 10 sites from July through October. Soak time will be standardized. Blue crabs will be counted, measured and sexed.

4.6 Narragansett Bay Adult Winter Flounder Survey

The goal of this project is to collect, analyze, and summarize fyke net data from the Providence and Seekonk River system, the Barrington River system, Greenwich Bay, and adjacent coves, the Kickamuit River, and Nanaquacket Pond for the purpose of forecasting recruitment in relation to the spawning stock biomass of winter flounder and other recreationally important species. Additionally, the Division will gain invaluable knowledge about the anadromous finfish resources within these systems. Additionally, we will endeavor to establish size composition, age and weight at length profiles of stocks, sex ratios and spawning condition of fish where possible. Additionally, investigators will endeavor to document the status of winter flounder spawning activity in these upper reaches of Narragansett Bay.

A monthly fyke net will be conducted in the Providence and Seekonk River system, the Barrington River system, the coves of Greenwich Bay, the Kickamuit River, and Nanaquacket Pond, from 1 January to 1 May, in order to collect fisheries statistics on winter flounder and species of anadromous fishes. Investigators will utilize station locations formally utilized by The F-51-R project unless conditions have changed in the waterbodies and the station no longer can be occupied. If this happens, a new station will be established where practical. The fyke net will be set and left to soak for 48 hours +/-, however, due to the time of year weather may increase the set to as much as 96 hrs. Nets are not hauled or moved but fixed. Sampling will begin on 1 January in order to collect statistics on winter flounder spawning activity in these Northerly regions on Narragansett Bay and to gather information on sea herring, Clupea harengus, American shad, Alosa pseudoharengus, and other anadromous fish.

Sampling will be conducted aboard a 26ft fishing boat purchased for a previous pelagic finfish monitoring project (F-64-R). The fyke net to be used will be a modified New Hampshire type. The fyke net will be constructed of 1” aluminum “D” rings, - 4’ high; 0.75” square mesh; 2 – 12” diameter throats; Three compartments; 25’ wings – overall length 20’; 100’ leader – 6’ deep tapering to 4’ deep at the free end.

Upon hauling the gear, catch will be sorted by species. Fish will be measured to the nearest centimeter, fork length (FL) or total length (TL), and weighted. Length frequency data will be recorded for all species. If individual fish are large as in the case of striped bass and bluefish, the fish will be weighed individually. However, if individuals are small as in the case of scup or river herring, aggregate weights will be taken. Scales and otoliths will be taken from fish for the eventual aging of stocks caught as appropriate.

Scales and otoliths will be prepared according to NOAA Technical Report NMFS 72 (1988). Scales will be cleaned of dirt etc, and several scales from the same animal will be sandwiched, sculptured side up, between a base slide of 16” sq stainless steel and a laminated plastic slide, vinyl over soft polyethylene, with soft side down is placed on top of the scales and another heavy plastic slide is placed over that. The sandwiched slides are then pressed with a carver hydraulic press. The soft polyethylene slide, with the scale impressions, will then be removed and placed in the original scale envelope for future reading via a computer projector. Otoliths will be thin sectioned on an Isomet low speed saw and then will be folded into a protective piece of paper and stored in the original sample envelope until such time as it can be read by microscope or computer projector.

Indices of relative abundance and minimum biomass will be developed for each species. All data will be stored at the Rhode Island Division of Fish and Wildlife and analysis will be by Division staff. Data analysis will conform to standards of the National Marine Fisheries Service and the Atlantic States Marine Fisheries Commission. Data and results will be made available to other state federal and private institutions as required.

4.7 Narragansett Bay Ventless Pot Survey

The goal of this project is to assess and standardize a time series of abundance for structure oriented finfish (scup, black sea bass, and tautog) in Narragansett Bay. The project will set trawls of black sea bass pots and scup pots (generalized as "fish pots") over hard bottom, near wrecks, bridge abutments, pilings or other areas of structure within Narragansett Bay in order to develop a time series for the target species, namely scup, black sea bass, and tautog. Investigators will also take scales, otoliths, and operacla from a percentage of the catch to ascertain the age structure and other biological characteristics of the populations of these species while in RI state waters. Abundance data will be integrated into both local and coastwide stock assessments for the target species.

A monthly ventless black sea bass and scup pot survey will be conducted in the Narragansett Bay, North of the colregs line, from April through November. This "fish pot" survey will be directed toward three main target species (i.e. black sea bass, scup, and tautog), though it is anticipated that other sportfish and invertebrates may be harvested in addition to the targets. Sampling will be conducted aboard a 26ft research vessel purchased for a previous pelagic finfish monitoring project (F-64-R). The scup pots and black sea bass pots used in this survey will be identical to those used by the URI/Sea Grant for the last several years under "2013 Fisheries independent Scup Survey of Hard Bottom Areas in Southern New England Waters" and "2013 Industry Based Survey on Black Sea Bass Utilizing Ventless Traps". The scup pots (2'x2'x2') will be constructed of 1.5" x 1.5" coated wire mesh and unvented. Black Sea Bass Pots (43.5" L, 23" W, and16" H) will be also be constructed of 1.5" x 1.5" coated wire mesh, single mesh entry head, and single mesh inverted parlor nozzle. In addition all pots will be unvented and will be covered with vexar in August and September in an attempt to capture age 1 sea bass.

Narragansett Bay will be divided into six sampling areas, The Providence/lower Seekonk River, Upper Bay/Greenwich Bay, West Passage, East Passage, Mount Hope Bay, and the Sakonnet River. Each area will be subdivided into 0.5 deg of latitude and longitude and numbered. These numbered boxes will be referred to as stations. Investigators will then locate areas of hardbottom, shipwreck, major bridge abutments, or pilings, etc, in each station. The areas of structure will be noted in the stations containing structural elements and the goal for each month will be to randomly sample half of the replicates (see below for a description of replicates) in areas of known structure and half in areas without known structure.

Five scup and five black sea bass sampling stations will be selected in each of the six sampling areas using a random number generator. Two scup pots will be set at each location and left to soak for **48+/- 1 hr**. One pot will be baited with sea clams while the second will remain unbaited. Upon hauling the pot, they will be moved to another area. Similarly, investigators will set the unvented black sea bass pots in five pot trawls. Pots will remain unbaited as was the methodology in the Sea Grant experiment and allowed to fish for **48+/- 1 hr**. As with the scup pots, when they are hauled they will be moved to another area as determined by the above mentioned random process. This process will be repeated for three two day soak replicates in each month. Project personnel will collect data on water temperatures, salinities, dissolved oxygen, air temperature, and meteorological data and sea conditions at each sampling station. Upon hauling the gear, catch will be sorted by species. Fish will be measured to the nearest centimeter, fork length (FL) or total length (TL), and weighted. Individual length frequency data and weights will be recorded for all species. If individual fish weights are not manageable timewise, aggregate weights will be taken. Scales, otoliths, and opercula will be taken from a percentage of the catch, to be determined by statistical analysis, for the eventual aging of stocks caught as appropriate.

Scales and otoliths will be prepared according to NOAA Technical Report NMFS 72 (1988). Scales will be cleaned of dirt etc, and several scales from the same animal will be sandwiched, sculptured side up, between a base slide of 16" sq stainless steel and a laminated plastic slide, vinyl over soft polyethylene, with soft side down is placed on top of the scales and another heavy plastic slide is placed over that. The sandwiched slides are then pressed with a carver hydraulic press. The soft polyethylene slide, with the scale impressions, will then be removed and placed in the original scale envelope for future reading via a computer projector. Otoliths will be thin sectioned on an Isomet low speed saw and then will be folded into a protective piece of paper and stored in the original sample envelope until such time as it can be read by microscope or computer projector. Opercula will be removed, boiled to remove flesh, and then dried and stored for aging. A matrix of needed sizes will be developed for tracking the numbers needed for each size/age category. The aging structure for each species will be determined by the existing convention for aging species.

Indices of relative abundance and minimum biomass will be developed for each species. All data will be stored at the Rhode Island Division of Fish and Wildlife and analysis will be by Division staff. Data analysis will conform to standards of the National Marine Fisheries Service and the Atlantic States Marine Fisheries Commission. Data and results will be made available to other state federal and private institutions as requested or required.

5.0 Connecticut

5.1 Long Island Sound Trawl Survey

CT DEEP's principal fishery independent sampling program is the long-term trawl survey, used to monitor trends in species composition and abundance in Long Island Sound; this study has been ongoing since 1984.

The Long Island Sound Trawl Survey (LISTS) was initiated in 1984 to provide fishery independent monitoring of important recreational species in Long Island Sound. A stratified-random design based on bottom type and depth interval is used and forty sites are sampled monthly from April through November (1984-1990) to establish seasonal patterns of abundance and distribution. In 1991, the sampling schedule was changed to a spring/fall format, although sampling is still conducted on a monthly basis (April - June, September, and October).

LISTS is conducted from longitude 72° 03' (New London, Connecticut) to longitude 73° 39' (Greenwich, Connecticut). The sampling area includes Connecticut and New York waters from 5 to 46 m in depth and is conducted over mud, sand and transitional (mud/sand) sediment types. Sampling is divided into spring (April-June) and fall (Sept-Oct) periods, with 40 sites sampled monthly for a total of 200 sites annually. The sampling gear employed is a 14 m otter trawl with a 51 mm codend set from a 15.2m research vessel during daylight hours.

Prior to each tow, temperature (°C) and salinity (ppt) are measured at 1 m below the surface and 0.5 m above the bottom using an YSI model 30 S-C-T meter. Water is collected at depth with a five-liter Niskin bottle, and temperature and salinity are measured within the bottle immediately upon retrieval. Since 1992, coordinates for latitude and longitude have been collected when the water sample is taken. Beginning in 1995, GPS tow track logs were added to the data collected for each tow.

The survey's otter trawl is towed from the 15.2 m aluminum R/V John Dempsey for 30 minutes at approximately 3.5 knots, depending on the tide. At completion of the tow, the catch is placed onto a sorting table and sorted by species. Finfish, lobsters and squid are identified to species, counted and weighed in aggregate (to the nearest 0.1 kg) by species with a precision marine-grade scale (30 kg, +/- 10 gm capacity). Note, prior to acquisition of the marine-grade scale in 1992, there were no weights were collected. Catches weighing less than 0.1 kg are recorded as 0.1 kg. The complete time series of species counted and weighed in the survey is documented at: http://www.ct.gov/dep/lib/dep/fishing/fisheries_management/2010_trawl_survey_report.pdf.

For selected finfish species, lengths are recorded to the centimeter as either total length or fork length (e.g. measurements from 100 mm to 109 mm are recorded as 10 cm) and entered in the database as 105 mm. Atlantic sturgeon are measured to fork length. All indices of abundance (geometric mean count, or weight per tow) are standardized to 30-minute tows.

Sampling procedures have been modified in recent years to minimize the potential for injury to Atlantic sturgeon. When sampling in a season and area where the chance of catching a sturgeon is high (based on historic LISTS catch) and water depth is greater than 27 m, gear retrieval speed is reduced to decrease the stress induced by rapid changes in pressure. When a sturgeon is detected in the net, it is removed as quickly and carefully as possible. Subsequent handling and processing follow protocols described in A Protocol for Use of Shortnose, Atlantic, Gulf, and Green Sturgeons (Kahn and Mohead 2010).

5.2 Seine Surveys

CT DEEP also uses the FWS funds for two fishery independent sampling programs. This includes a 10-meter beach seine survey of young-of-year winter flounder and small forage fish. This study has been carried out since 1988 and occurs in a variety of Connecticut rivers and harbors. A 60 foot bag seine survey targeting juvenile shad and river herring on the Connecticut and Thames Rivers has been conducted since the 1980s. These seine surveys occur along the shoreline in shallow waters. Gear is deployed and retrieved by hand.

6.0 New York

6.1 Management and Enhancement of Marine and Diadromous Finfish – Marine Fisheries Investigations and Management

6.1.1 New York small mesh trawl survey

The New York Small Mesh Trawl Survey is used for long-term monitoring and assessment of annual recruitment of important marine finfish species in New York waters, including weakfish, winter flounder, scup, tautog, bluefish and northern puffer. The survey is also used to meet the Atlantic States Marine Fisheries Commission (ASMFC) compliance criteria for the Interstate Fishery Management Plan for winter flounder, horseshoe crab and weakfish.

The research vessel used throughout the survey was the *David H. Wallace,* a 10.7 meter lobster-style workboat. At each location, a 4.9 meter semi-balloon shrimp trawl with a small mesh liner was towed for 10 minutes at approximately 2.5 knots. From 1987 through 1990, nets were rigged using nylon scissors and tow ropes set by hand and retrieved using a hydraulic lobster pot hauler. Following the 1990 sampling season, the research vessel was re-outfitted to include an A-frame, wire cable and hydraulic trawl winches. For the remainder of the study, wire cable was substituted for the nylon scissor and tow ropes, and nets were set and retrieved using hydraulic winches.

Since the inception of this project in 1987 a total of 9,337 sample tows have been completed in the Peconic Bay study area with a total of 1,926,234 fish collected. Fish collected in each tow were sorted, identified, counted and measured to the nearest millimeter (fork or total length). Large catches were subsample, with length measurements taken on a minimum of 30 randomly selected individual fish of each species. Some samples were stratified by length group such that all large individuals were measured and only a subsample of small (usually yearlings or young of the year) specimens were measured. Subsampled counts greater than ten were then expanded by length group for each tow.

6.1.2 Long Island Sound trap survey

The New York State Department of Environmental Conservation initiated a trap survey in Long Island Sound in 2007 to develop estimates of relative abundance, size distribution and catch per unit effort of tautog (*Tautoga onitis*) in New York waters. The survey was conducted in 2007, 2008, 2010 and 2011 and will be continued in 2012. Repairs to the vessel used for the project prevented the survey from being done in 2009. The first year (2007) was used to evaluate the feasibility of the methodology and the project was expanded in 2008.

Sampling is conducted weekly, weather permitting, from May through October with small mesh, ventless fish traps. The traps are deployed between Mattituck Inlet, Southold NY (Lat: 41°00’09”; Long: 72°33’08”) and Rocky Point, Orient, NY (Lat:41°08’03”; Long: 71°21’02”). The majority of the traps are placed near shore (Figure 2), rocky areas in 20-30 feet of water. Three to five traps are placed in 55 feet of water north of Mattituck inlet. The sampling period, number of traps used, number of trap hauls and average soak time per year for the survey is given in Table 1.

The traps are 40.5 inches long, 21 inches wide and 15 inches tall, and are made of 1inch square, 14 gauge mesh wire. Each trap has one 5”x5” escape panel secured with biodegradable hog rings designed to fall open should the trap become lost. The traps are deployed with 3/8” poly line and marked at the surface with a foam buoy. The funnels at the entrance to the trap and between the two compartments in the trap are made from nylon mesh typical of other commercial type fish traps. The National Marine Fisheries Service has exempted Long Island Sound from gear restrictions established by Atlantic Large Whale Take Reduction Plan (ALWTRP Interim Final Rule 1997).

Although the survey is specifically designed to target tautog, data on all other species encountered by the traps is also collected. All finfish and lobster are enumerated and measured to the nearest millimeter. All other invertebrates are enumerated only.

Figure 2. Sampling Locations for the Long Island Sound Trap Survey.

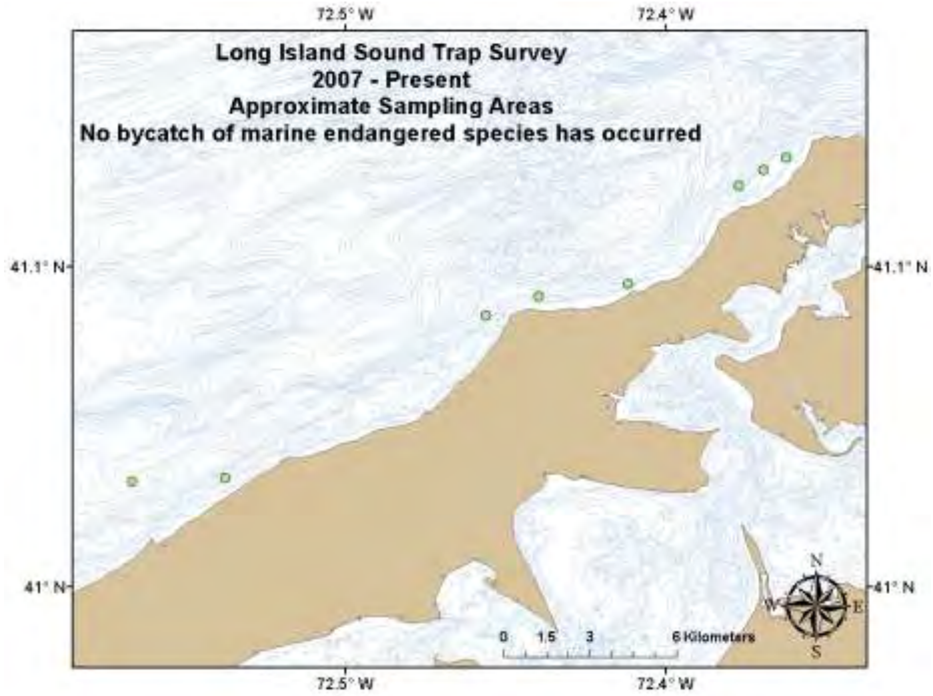


Table 6. Annual sampling period, number of traps, trap hauls and average soak time for the Long Island Sound Trap Survey.

Year	Sampling Period	# Traps	# Trap Hauls	Average Soak Time (Days)
2007	June- Dec	30	529	9.0
2008	May-Oct	40	685	8.7
2009		0	0	
2010	June-Oct	40	552	8.9
2011	May-Oct	35	441	11.1
Total			2207	

6.2Management and Enhancement of Marine and Diadromous Finfish – Marine Fishing Access

6.2.1 Artificial Reef Monitoring

The objectives of this project are to monitor the effectiveness of artificial reefs developed and enhanced with Sport Fish Restoration funding.

Lobster and black sea bass traps were used in 2007, 2008 and 2009 to monitor relative abundance of recreational important finfish species on artificial reefs. The reef sites surveyed were Hempstead Reef, Fire Island Reef, Kismet Reef, Moriches Reef and Shinnecock Reef. Although not used in recent years, it is possible that this sampling technique will be employed again in the future.

6.3 Diadromous Fisheries Investigations and Management

6.3.1 Western Long Island Seine Survey

The objectives of this survey are to annually determine catch per unit effort (CPUE) for juvenile striped bass and other important fisheries resources, including but not limited to bluefish, winter flounder, summer flounder, tautog, weakfish, American shad, river herring, and horseshoe crabs in western Long Island (WLI) bays; and to tag and release juvenile and adult striped bass in western Long Island bays.

In order to achieve these objectives, juvenile and adult striped bass are sampled in Little Neck Bay, Manhasset Bay, and Jamaica Bay bi-monthly from May through October. A 200 foot x 10 foot x 1/4 inch square mesh beach seine, with a 25 foot x 12 foot x 3/16 inch square mesh bunt area, is set by boat and hauled to shore by hand. All species captured by the beach seine are identified and counted.

Striped bass of the appropriate size and condition are tagged with internal anchor tags as part of a multi-state tagging program coordinated with the United States Fish and Wildlife Service (USFWS). Databases containing striped bass tag number, release date and site, total length, and age are sent to USFWS personnel at the end of each field season. The tag recapture data are used to examine survival and movements of juvenile and adult striped bass tagged in western Long Island bays.

Since 1984, stations have been seined twice a month from May through October in western Long Island bays, including Little Neck Bay, Manhasset Bay, and Jamaica Bay. Sampling was conducted in the past in eastern bays, when striped bass stock sizes were low. These bays are now no longer sampled, due to staffing shortages. Sampling has also occurred in bays in central Long Island, including Hempstead Harbor and Oyster Bay. In addition to the 200 ft x 10 ft beach seine mentioned above, (the gear used most consistently during the 28 years of the survey), a 500 foot x 12 foot beach seine with 3 inch stretched mesh in the wings, and a 2 inch stretched mesh bag, was used occasionally in the 1980's through the early 2000's, to supplement the catch of older, larger fish. From 1984 to 2002, one hundred sixty three (163) hauls were conducted using the larger, 500 foot seine.

6.3.2 Young of the Year American Eel Survey

The objective of this survey is to annually determine the abundance of young-of-the-year American eels in the Carman's River, on the south shore of Long Island, as a requirement of the ASMFC American Eel Fishery Management Plan.

The survey uses a fyke net, constructed of two wings of equal length attached to a tapered section which includes a single funnel. The entire length across the wings is thirty feet by eight feet deep. A line of seine floats is strung across the top of the fyke to keep it upright in the water column. A chain line holds the bottom down against the current. The net is set so that eels swimming upstream enter into the tapered section and are trapped after passing through the funnel section into the hold. This single fyke net is set in the tidal portion of the Carman's River, near the first impassable barrier on the River.

The fyke is checked daily over a nine-week period during early Spring. Each daily catch is sorted and enumerated by species. Glass eels are easily distinguishable from pigmented elvers, and each catch is recorded separately. Environmental and climatological data are also recorded for each catch. These included water and air temperature, tide stage, time of the previous high tide, and the amount of the previous day's precipitation. In addition the elapsed time between checks of the net, and the condition of the gear upon arrival to the survey site are also recorded. The catch of eels is released upriver, above a dam separating the tidal and non-tidal portions of the river so as not to affect estimates of annual recruitment.

6.4 Research and Management of Fisheries Resources of the Hudson River Estuary and the Delaware River

6.4.1 Spawning stock survey of American shad, river herring, and striped bass.

NY has sampled the spawning populations of Hudson River American shad and striped annually since 1983. Fish are collected by 152 m and 305 m haul seine in the vicinity of known spawning areas and at beaches where adults are susceptible to capture by shore gear. The nets are 3.7 m deep with 10.2 cm stretch mesh. Both nets have center located bags. The nets are set by boat and retrieved to shore by hand. Collections usually occur from late April through early June at sites between rkm 90 through 200. Captured fish are transferred to a floating net pen after which they are identified to species and sex, measured, weighed, and scale samples taken. Striped bass in good condition are tagged with USFWS internal anchor tags. Shad were tagged with dart tags until 2010.

6.4.2 Striped bass electrofishing.

Since 1989, NY has augmented haul seine collections of striped bass for tagging by electrofishing. Sampling generally occurs in late April and early May near Kingston, NY (rkm 140 – 155) using low amperage DC current. Fish are captured with long handled landing nets and placed in an onboard live tank with flow through river water and oxygenation. Once a few fish are collected (< 30), all captured fish are transferred to the floating net pen described above and processed in the same manner as fish collected in the spawning stock survey.

6.4.3 Alosine juvenile abundance survey.

NY has sampled recruitment of age zero (young of the year, YOY) American shad and river herring annually in the Hudson River Estuary since 1980. Collections are made with a 30.5 x 3.0

m beach seine with 0.64 mm mesh at 28 standard sites between river km 88 and 225. Sites are located in reaches of the river bracketing known near-shore concentrations of age zero alosines. Sampling generally occurs during the day on alternate weeks from July through October.

Fish collected by beach seine are sorted by species and life stage, counted, and returned to the river. Up to 30 age-zero American shad, alewife, and blueback herring from each haul are measured for total length (mm). Annual abundance indices are calculated as a geometric mean using data from weeks 26 through 42 (mid-June through October).

6.4.4 Striped bass juvenile abundance survey.

NY has sampled recruitment of age zero, or YOY, striped bass in the Hudson River Estuary annually since 1979. Collections are made with a 71 m x 3 m beach seine with 0.64 mm mesh at 25 stations selected from a suite of 36 fixed stations in the Tappan Zee to Haverstraw Bay, portion of the Hudson River (rkm 35 – 63). Sites are located in reaches of the river bracketing known near-shore concentrations of YOY striped bass. Sampling occurs during the day on alternate weeks from mid-July through early November.

Fish captured by seine are sorted by species and life stage, counted, and returned to the river. Lengths of striped bass and selected other species are obtained from a subset of the catch. Annual abundance indices are calculated as a geometric mean of total catch / number of hauls using data from sample weeks four through nine (late August through early November).

6.4.5 American shad spawning habitat studies.

NY initiated a five-year study of movement and habitat use of mature American shad in the Hudson River in 2009. The study involved use of both sonic and radio tags, mobile tracking, and stationary receivers to identify movement throughout the river. Sonic tags generally work best when fish are in deep water and radio tags work best in shallow water. NY used several different tag types, during the first two years to see if one type of technology would produce better data for identifying shad spawning habitat as both deep and shallow area are common through the spawning reach.

NY captured mature prespawning American shad for tagging by short sets of drifted gill net with 14 cm stretch mesh. Sampling occurred well downriver of, and at the lower end of, suspected spawning reaches from early April through early May. This period encompasses the first part of the shad spawning migration in the Hudson River Estuary. Most shad were collected in Haverstraw Bay and the Tappan Zee (rkm 20-65), near Poughkeepsie (rkm 115-130), and near Kingston (rkm148-155). Captured fish were measured for total length and sex was identified. American shad in good condition were tagged.

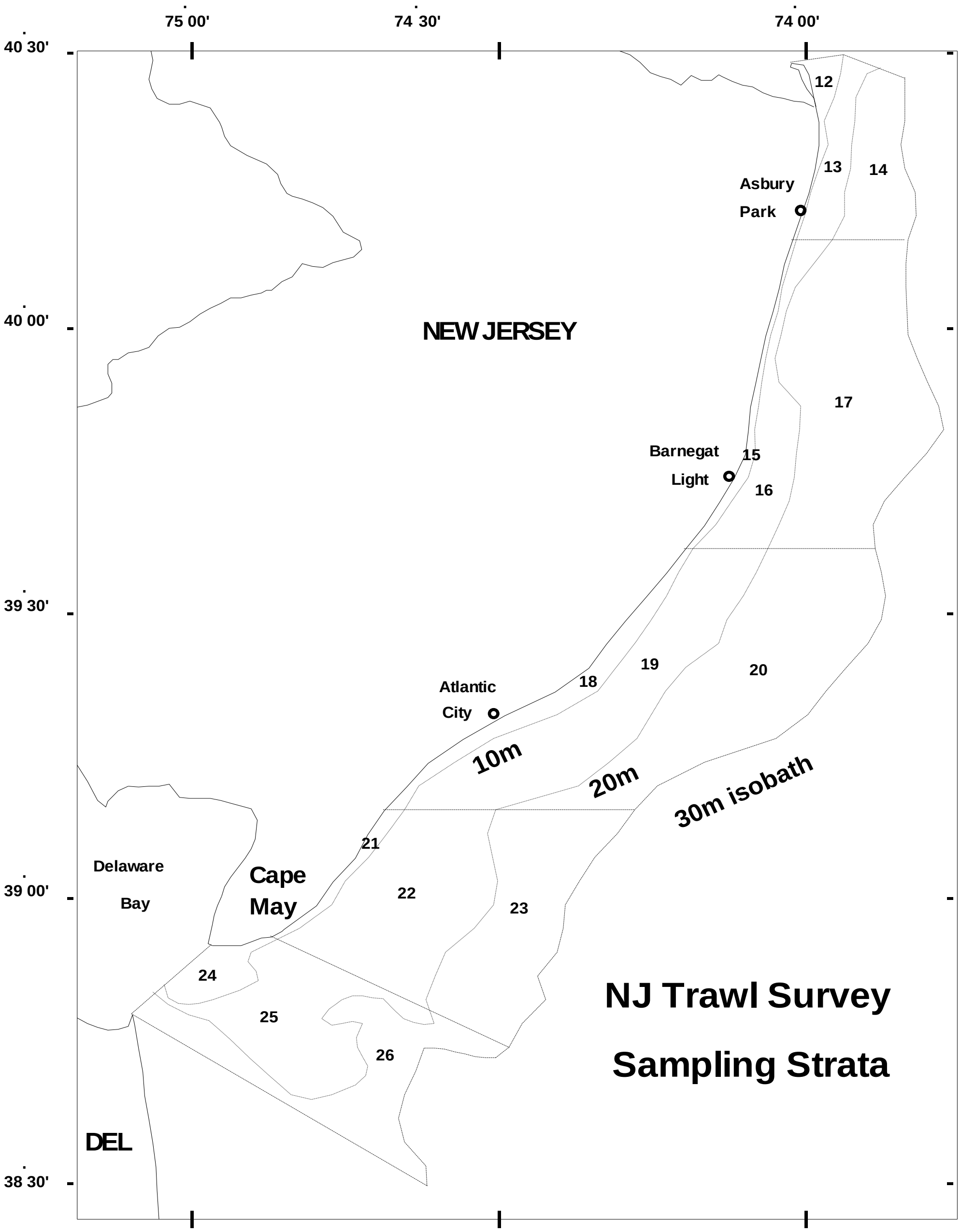
7.0 New Jersey

7.1 NJ Ocean Trawl Survey

The Ocean Trawl stock assessment program monitors the occurrence, distribution, and relative abundance of fishes inhabiting the nearshore coastal waters of New Jersey and has been ongoing since August 1988 (see Figure 1 for location). The data collected in the Ocean Trawl survey are used in the coastwide stock assessments for summer flounder, winter flounder, striped bass, bluefish, black sea bass, scup, tautog and weakfish. The survey is also used to meet the Atlantic States Marine Fisheries Commission (ASMFC) compliance criteria for the Interstate Fishery Management Plan for winter flounder.

The survey is a random stratified sampling design with a total of five cruises per year. Annually, 186 trawl samples are performed during January (30), April (39), June (39), August (39), October (39). Samples are collected with a three-in-one trawl, so named because all the tapers are three to one. The net is a two-seam trawl with forward netting of 12 cm (4.7 inches) stretch mesh and rear netting of 8 cm (3.0 inches) and is lined with a 6.4 mm (0.25 inch) bar mesh liner. The headrope is 25 m (82 feet) long and the footrope is 30.5 m (100 feet) long. The trawl bridle is 20 fathoms long, the top leg consisting of 0.5 inch wire rope and the bottom leg comprised of 0.75 inch wire rope covered with 2 3/8-inch diameter rubber cookies. A 10-fathom groundwire, also made of 0.75-inch wire rope covered with 2 3/8-inch diameter rubber cookies, extends between the bridle and trawl doors. The trawl doors are wood with steel shoes, 8 ft. x 4 ft. 2 in., and weigh approximately 1,000 lbs. each.

Figure 1. New Jersey Trawl Survey Sampling Area



Trawl samples are collected by towing the net for 20 minutes (approximately 1 nautical mile), timed from the moment the winch brakes are set to stop the deployment of tow wire to the beginning of haulback. Enough tow wire is released to provide a wire length to depth ratio of at least 3:1, but in shallow (< 10 m) water this ratio is often much greater, in order to provide separation between the vessel and the net. Following haulback, the catch is placed into a 4 x 8-ft. sorting table where fishes and macroinvertebrates are sorted by species into plastic buckets and fish baskets. The depth of tow is contingent on the water depth at the station location. The total weight of each species is measured with metric scales and the length of all individuals comprising each species caught, or a representative sample by weight for large catches, is measured to the nearest cm. Fork or total length, depending on tail shape, is measured for all fishes except stingrays, which have disk width measured instead. For invertebrates, carapace width is measured on crabs, carapace length (in mm) on lobster, and mantle length on squid. Catches containing large numbers of relatively small specimens are often mixed and the mix subsampled by weight. The mix is then sorted and measured and species components later extrapolated, based upon their representation in the subsample, to determine contribution to the total catch.

The survey area consists of New Jersey coastal waters from Ambrose Channel, or the entrance to New York Harbor, south to Cape Henlopen Channel, or the entrance to Delaware Bay, and from about the 3 fathom isobath inshore to approximately the 15 fathom isobath offshore (Figure 1). This area is divided into 15 sampling strata. Latitudinal boundaries are identical to those that define the sampling strata of the National Marine Fisheries Service (NMFS) Northwest Atlantic groundfish survey. Exceptions are those strata at the extreme northern and southern ends of New Jersey. Where NMFS strata extended into New York or Delaware waters, truncated boundaries were drawn which included only waters adjacent to New Jersey, except for the ocean waters off the mouth of Delaware Bay, which were also included.

Longitudinal boundaries consist of the 5, 10, and 15 fathom isobaths. Where these bottom contours were irregular, stratum boundaries were smoothed by eye. As a result, the longitudinal strata boundaries for the New Jersey survey area are similar, but not identical, to the corresponding NMFS boundaries.

Each stratum is divided by grid lines into blocks which represent potential sampling sites; each block is identified by a number assigned sequentially within each stratum. The dimensions of mid-shore (5-10 fathoms) and offshore (10-15 fathoms) blocks are 2.0 minutes longitude by 2.5 minutes latitude; inshore (3-5 fathoms) blocks were 1.0 minutes longitude by 1.0 minutes latitude. Inshore block dimensions were smaller because inshore strata were narrower and of much less area compared to mid- and offshore strata; small block size permits a greater number of potential sampling sites than would be possible with the larger dimensions. This is important for statistical analysis and follows the strategy of NMFS Northeast Fisheries Science Center (NEFSC) for their groundfish survey.

Dimensions of blocks transected by stratum boundaries have less area than described above; blocks reduced in area by more than one-half were generally not assigned a number. Sampling sites in 1988-91 were determined by blindly picking disks numbered to correspond to stratum blocks and mixed to assure randomness. In 1992, this method was replaced by using a computer to generate random numbers.

7.2 NJ Striped Bass Tagging Program

In 1989, New Jersey Division of Fish and Wildlife (NJDFW) began collaborating with other agencies by entering the USFWS Cooperative Coastal Striped Bass Tagging Program. Sampling was initiated in areas of lower Delaware Bay near Bidwell's Creek/Reeds Beach, New Jersey where striped bass had been reported as bycatch in the shad gill net fishery (Figure 2). In 1995, this program became a mandatory compliance issue under the ASMFC Atlantic Striped Bass Interstate Fishery Management Plan. Failure to complete this program annually could result in a closure to New Jersey's recreational striped bass fishery.

The program currently utilizes 0.40 mm to 0.47 mm diameter monofilament gill nets, ranging from 5 to 6 inch stretch mesh from early March through early May. Nets are 600 feet in length, 8 to 12 feet in depth and typically set in water depths of 6 to 12 feet. The average soak time in recent years has been 0.5 hours (Table 4). In the mid 1990s, the NJDFW began the switch over from anchored gear to the use of drifting gear resulting in a decrease in average annual soak times since 2000. Usually, only one net is set at a time, and all nets are monitored to diminish potential mortalities to any species.

Although the survey specifically targets striped bass, it has developed into a valuable assessment mechanism for collecting multispecies biological information. All species, especially Atlantic sturgeon and horseshoe crabs, are examined for tags or other markings, while otoliths are collected from bluefish and weakfish. Additional data will be collected from black drum for use in the upcoming ASMFC Fishery Management Plan for that species.

American shad collected during the survey are an essential component in the development of the Delaware River Sustainable Fishing Plan for American Shad. American shad caught in good condition are tagged while a subsample of fish provides scale and otolith samples for age determination and fin clips for genetic analysis.

In 2005, NJDFW began tagging Atlantic sturgeon captured in good condition while targeting striped bass during this program. All sturgeon were processed according to USFWS tagging protocols in the following manner: fork and total length (millimeters) recorded, scanned for pit tags, tagged using dart and pit tags provided by the USFWS, fin clipped and then released alive.

Striped bass in good condition are processed as follows: fork and total lengths (millimeters) recorded, scale samples taken, tagged using internal anchor/external streamer tags provided by the USFWS and then released. A subsample of tagged fish is weighed. In addition, a subsample of fish caught is retained for biological characterization including otolith removal. Basic water quality parameters, net specifications, duration of the sets and other data as outlined by the USFWS are also recorded.

7.3 Delaware River Juvenile Striped Bass Seine Survey

Since 1980, NJDFW has conducted a juvenile striped bass survey in the Delaware River to provide an annual index of striped bass juvenile abundance. Field sampling utilizes a bagged, 100-foot long by 6-foot deep by ¼-inch mesh beach seine. The seine is set by boat in nearshore waters normally less than six feet in depth and therefore soak times are typically less than ten minutes. All striped bass, as well as other target species, caught are quantified and measured. Basic water quality parameters that include water temperature, salinity and dissolved oxygen are also recorded.

This program was identified in 1989 as an essential tool for the management of the coastwide stocks of striped bass. The ASMFC mandated that the NJDFW continue this program as a compliance criterion. Data collected for American shad was added as a compliance criterion in 1999. As with the striped bass tagging program in Delaware Bay, discontinuation of this program would be costly in regards to New Jersey's recreational fishing industry.

Although the survey specifically targets striped bass, it has always been a valuable tool for collecting multispecies information essential for ASMFC stock assessments and management plans. Annual abundance indices are developed for the following species: American shad (ASMFC compliance), alewife, blueback herring, Atlantic croaker, weakfish, bluefish, spot, American eel, white perch, menhaden and black drum. The survey has provided samples for various species including striped bass, blueback herring, alewife, American shad, hogchoker and bunker for research at various universities across the US and Canada. In addition, this survey is available tool for providing information for use in waterfront development projects and dredging operations.

Although the juvenile survey has been modified throughout the time series the current fixed station format has been followed since 2002. The NJDFW samples 32 stations from mid-June to mid-November for a total of 320 annual hauls (see Figure 3). During the time series, the sampling area has ranged from river mile 44.9 to 129.7. Since 1998, sampling stations are located from Augustine Beach to Newbold Island. Occasionally due to tidal extremes, sediment, or construction, alternate sites are sampled.

The Delaware River recruitment survey area is divided into three distinct habitats:

1) Region I -- brackish, tidal water extending from the springtime saltwater/freshwater interface to the Delaware Memorial Bridges
2) Region II -- brackish to fresh tidal water extending from the Delaware Memorial Bridges to the Schuylkill River at the Philadelphia Naval Yard, and
3) Region III -- tidal freshwater from Philadelphia to the fall line at Trenton

Saltmarsh vegetation predominates along the Region I shoreline while Region II is primarily urban with a shoreline heavily developed for commerce and industry. Region III is sporadically developed by industry with considerable freshwater marsh.

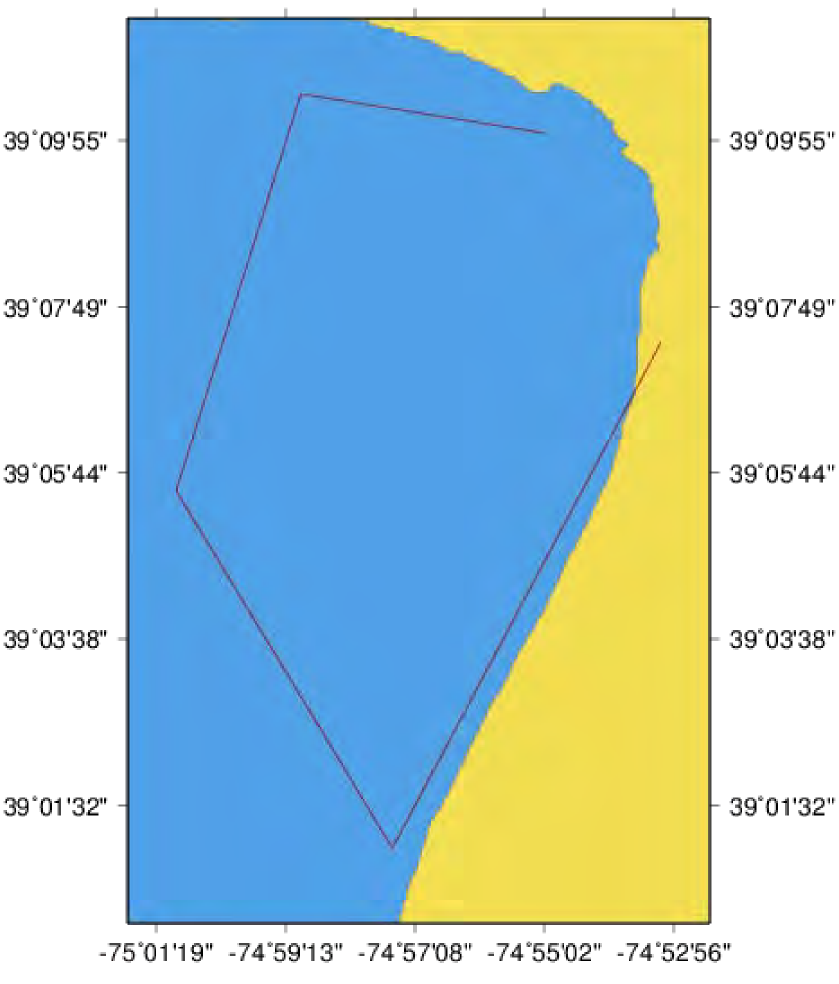
Figure 3. Striped Bass Seine Survey Locations

7.4 Relative Abundance of Selected Finfish Species in Delaware Bay

The New Jersey Division of Fish and Wildlife initiated an estuarine finfish sampling program in Delaware Bay in 1991 to identify and develop relative abundance estimates for finfish utilizing this estuary. The estimated year class strength of important finfish and the creation of a time series provide data necessary to assess trends in relative abundance for select species, assess spawning success via juvenile abundance and assess the effects of various management strategies instituted for these species.

Sampling is conducted monthly from April to October at eleven fixed stations on the New Jersey side of Delaware Bay (Figure 3). The area sampled ranges from the Villas in Cape May to the mouth of the Cohansey River. All samples collected during this program are taken on shoals located near shore.

Figure 3. Finfish Sampling Locations



A 4.9-m (16-foot) otter trawl with a 3.8 cm (1.5 inch) stretch body mesh and 3.2 cm (1.25 inch) stretch mesh in the cod end is used for sampling. The cod end is lined with a 1.3 cm (0.5 inch) knotless stretch mesh net. The headrope is buoyed with several can-shaped molded fish net floats. The bottom of the net's mouth is weighted with a 0.3 cm (0.125 inch) galvanized chain looped along the footrope. The door dimensions are 30.5 cm (12 inches) x 61.0 cm (24 inches) and were constructed of 1.9 cm (0.75 inch) marine plywood with 1.3 cm (0.5 inch) by 5.1 cm (2 inch) steel shoes. The doors are attached to 1.6 cm (0.625 inch) twisted three strand nylon towlines, by a 0.5 cm (0.188 inch) galvanized chain bridle with 1.0 cm (0.375 inch) swivels.

Single ten-minute tows are conducted against the prevailing tide at each station. All stations are sampled once during the second or third week of the month. The engine tow speed is usually set depending on tidal velocity, to maintain a speed-over-ground of approximately 3.9 km/hr (or 2.1 knots). Speed-over-ground, tow distance and depth are monitored using a Garmin 2010 GPS Receiver/Depthfinder. Engine speed is constantly monitored and adjusted during the sampling period to maintain trawl speed. The estimated distance towed (nautical miles) is calculated from the average speed over ground (knots) and multiplying it by the duration (in hours) of each tow (Distance = Speed x Time).

On board the trawl net is manually deployed with 60 feet of towline tied to the stern cleats and retrieved with the towlines being spooled through blocks at the end of a 4.6 m (15 foot) A-frame made of 7.62 cm (3 inch) inside diameter aluminum, marine grade pipe. On retrieval, the A-frame and net are hauled at the transom using a Gearmatic GH5 Hydraulic Winch installed on the mast located aft of the wheelhouse bulkhead. The cod end of the net is manually retrieved and the contents emptied onto a sorting table affixed to the stern of the vessel.

All fish collected are identified to the lowest possible taxonomic level, enumerated and measured to the nearest millimeter. When large numbers (>50) of a single species are taken, fifty individuals were randomly selected and measured. Annual relative abundance (catch per tow = c/t) for all species combined and for each single species are calculated as the total number of individual fish collected over the total number of tows.

8.0 Pennsylvania

The State of Pennsylvania carries out three studies with the funds in waters where NMFS listed species are present. These are: (1) Estimate of Black Bass Population Density; (2) Species Occurrence Determination; and, (3) Long Term Fish Population Monitoring and Management Technique Evaluations.

8.1 Estimate of Black Bass Population Density

The Pennsylvania Fish and Boat Commission has been collecting data on adult black bass from our major rivers nearly annually since 1982. These surveys are conducted to monitor population trends to changes in a variety of biotic and abiotic factors including, but not limited to, changes in angling effort, regulations, pollution events, and climatic events. These data help to inform biologists when making management decisions as well as help managers to inform the public with respect to realistic expectations when it comes to recreational angling activities. The Pennsylvania Fish and Boat Commission conducts this type of sampling on both the Delaware River and Estuary and the Susquehanna River. While the Pennsylvania Fish and Boat

Commission has had minimal contact with shortnose sturgeon in the Delaware system, we have never collected shortnose or Atlantic sturgeon in the Susquehanna River system within the boundaries of Pennsylvania.

The objectives of the study are to:

1) Estimate density of black bass per hour of electrofishing effort (CPE) and per meter of shoreline (or track) sampled. Omissions have been detected in distance sampled in data fields in the ARDB.
2) Document any changes in density or trends in density through time.
3) Estimate age structure and compare to year class strength index. (Draft completed, edits in progress).
4) Waters sample should include waters where historic time series data has been collected and manager indicated they would sample the site/water in 2005 (see Table 1 attached). Sampling should focus upon the Susquehanna Basin with sites on Ohio Basin and Delaware Basin sampled for comparative examination. Sites can be added or expanded without consultation. Randomly selected new sample sites are imperative if other professionally defensible reasons for sampling are not requisite.
5) Area Fisheries Manager (AFM) insights and question should be communicated early and broadly discussed within the Division.
6) Record disease incidence of black bass and other species by length or size group.

Sampling takes place from a flatbottom boat equipped with bow safety railing, outboard, fuel tank, navigation lights, fish collection lights, and oars.
Only waters that have been historically sampled are selected with an emphasis on the waters with the lengthiest series of historic data. Sampling takes place from July through mid-September during the same time under similar sampling conditions as historic collections. Primary target species include all sizes of black bass (smallmouth bass primarily) including young of year. Sampling of other fish species is secondary. Secondary targets included: rock bass, sander spp, and esocids. Any diseased fish of any species (catfish, carp, fallfish) are collected, measured, and anomaly or disease noted as for target species. A total of between 75 and 100 smallmouth bass (Age 1+ and older) are collected and measured per site sampled. A dual set of droppers (4) affixed to two booms is used to make all collections. Voltage, amperage (or watts) and pulse width (for those with variable pulse width) should be adjusted to deliver between 3 and 6 amps of current to the anode array. Two bow netters collect stunned targets and secondary targets.

8.2 Species Occurrence Determination

During the early 1980's the Pennsylvania Fish and Boat Commission structured their Fisheries Management Division into regions. At that time, regional managers were able to focus sampling efforts on more waters in their region of responsibility. As part of the efforts by the regional managers to learn more about the waters with which they were responsible for managing, floating and sinking gill nets were fished in the Delaware Estuary between River Miles 78.83 (Pennsylvania/Delaware state line) and 133.43 (Trenton Falls) from 1982 – 1987. Since 1987 there have been no gill nets fished by the Pennsylvania Fish and Boat Commission in the

Delaware Estuary. No future gillnet surveys by the PA Fish and Boat Commission are proposed for funding by FWS.

8.3 Long Term Fish Population Monitoring and Management Technique Evaluations

As required by the ASMFC, the PFBC began yearly sampling of the Delaware River striped bass spawning stock in 1992. This was done in conjunction with the sampling efforts of Delaware and New Jersey as part of the overall monitoring of the striped bass population recovery along the east coast. Electrofishing index sites were evaluated in 1994 and 1995, with 21 sites established in 1995.

Daytime flatbottom boat electrofishing is conducted in the Delaware Estuary from Rancocas Creek in Burlington County, New Jersey (R.M. 109.76) downstream to the Commodore Barry Bridge in Chester, Pennsylvania (R.M. 81.77). Twenty-one (21) index sites between Rancocas Creek and the Commodore Barry Bridge are used to develop an index of spawning striped bass abundance and are sampled twice during the spawning period.

The electrofishing boat is rigged with a pair of fixed boom electrodes. Each boom supports four dropper style copper anodes arranged in a square array. The electrical power source is a 5,000-watt Honda generator combined with a Smith-Root model GPP electrofisher. The electrofishing unit is typically operated within the range of 6 amps to 7 amps of pulsed DC output and in water typically ranging from 3 to 10 feet in depth. Electrofishing is conducted by traveling in a serpentine pattern with the tidal flow.

Each index site (21) electrofishing run has a duration of 1,000 seconds as recorded on the electrofishing unit. This represents the period of time electric current is discharged into the water. The combined total index site sampling effort is 11.7 hours annually. In instances where striped bass are common at a particular index site and the 1,000-second electrofishing effort is complete additional electrofishing may be conducted as a spatial extension of the index site.

9.0 Delaware

9.1 Delaware Tidal Largemouth Bass Monitoring Program

Largemouth bass have been sampled in freshwater portion of the Nanticoke River via fall (September/October) electrofishing since 1989. Sampling was conducted annually between 1989 and 2004 but was conducted only bi-annually (even number years) beginning in 2006. This is a large system so sampling has been conducted using a stratified random design. During sampling events, the mainstem Nanticoke River from the Delaware/Maryland state boundary to Middleford, Delaware on the Nanticoke Branch and the downstream 1.5 km section of Deep Creek, a headwater tributary, was divided into three segments. Broad Creek was divided into two segments between its junction with the mainstem Nanticoke and the town of Laurel (Figure 2). Each segment was further divided into five sections of similar length, and then separated into the north and south shores. Half of the resulting ten sections within each segment were sampled, resulting in the collection of fish from 25 of the 50 established sections, five per segment. The first shoreline to be sampled within a segment, either north or south shore, was selected randomly by coin toss. Sampling started at that point and continued to the end of the first section. The next section was sampled on the opposite shore. Subsequent sections were then sampled alternating from shore to shore with five sections (one segment) sampled during each day. A pulsed-DC, boat-mounted electrofisher (Smith Root Mark VI-A) cruised the shoreline in three feet of water traveling with the tide, and the pedal operator provided on and off bursts of current between 5-6 amps.

Largemouth bass were collected and held in an on-board, aerated livewell until a station was completed or the number of bass reached the livewell capacity. Fish were then measured for total length (TL in mm) and weight (g).

9.2 Atlantic Menhaden Young-of-the-Year Survey

Atlantic menhaden are sampled at several locations in Delaware's Inland Bays and the data used to calculate a young-of-the-year index. Sampling is conducted with a midwater trawl that fishes from the surface to approximately 1.5 m below the surface. The mouth of the midwater trawl is made of 3.18 cm stretch mesh nylon which opens to approximately 1.53 m by 1.53 m during sampling. The lower body of the net is tapered to a length of 4.6 m and made of 6.35 mm delta knotless nylon netting. Steel trawl doors measuring 38.1 cm long by 30.5 cm wide are attached to the lead of the net. Floats are attached to the top of the doors to keep the net suspended in the water column. The trawl is towed in the firection of the tide by a 6.77 m long fiberglass catamaran powered by a 150 hp outboard motor running at 2000 rpm. The average towing speed is 3 miles per hour.

Ten trawl samples will be taken on each sampling day. The trawl will be towed for five minutes per sample at each trawl site. Captured fish are separated by species, counted and released. Captured Atlantic menhaden are counted and up to 20 per sample are measured to the nearest mm fork length.

9.3 Delaware River Striped Bass Spawning Stock Assessment

This assessment is conducted in the lower Delaware River from the Delaware Memorial Bridge at rkm 110 to the mouth of Big Timber Creek, NJ at rkm 152, which encompassed the main spawning grounds in the Delaware River. The spawning grounds were divided into lower and upper zones. The lower zone had twelve sampling stations and extended from rkm 110 at the Delaware Memorial Bridge to the boundary between the states of Delaware and Pennsylvania. The upper zone had thirteen sampling stations and extended from the Commodore Barry Bridge to rkm 152 at Big Timber Creek. The average station length was approximately 1.6 km and ranged from approximately 1.1 (Station 4P "Mobil Oil") to 2.2 km (Station 2P "Lower Monds Island"). However, the segment within each station sampled varied on any particular day depending on the direction of tidal current and fish abundance. Depth at each station ranged from 0.9 to 9.1 m. In addition to the shoreline stations, sampling was also conducted on Cherry Island Flats, a submerged island in the lower zone, as well as along Little Tinicum and Chester Islands in the upper zone.

Stations within the lower and upper zones of the spawning grounds were grouped into two categories based on average catch rates from the previous three years. Stations with catch rates below average were categorized as "poor" stations, while stations with average or above average catch rates were categorized as "good" stations. On each sampling day, five good stations and two poor stations were randomly selected from a given zone. Each of the upper and lower zones are typically sampled weekly throughout the spawning season, which generally extends from mid-April to late May or early June depending on water temperature. In addition to randomized collections, ancillary collections were made to increase the number of tags released and number of samples obtained for age and growth analysis.

Fish were collected using a Smith-Root, Inc. model 18-E boat electrofisher operated using pulsed direct current at 60 pps and 500 volts. Output amperage was kept within a range of 7.0 to 8.5 amps. The standardized sampling time at each station was 720 seconds of pedal time. The boat was operated moving with the tidal current in a serpentine-shaped pattern. Only fish approximately >200 mm total length (TL) were collected. Fish <200 mm TL, which are typically immature and not yet recruited to the spawning population, generally pass through the mesh of dip nets used aboard the electrofishing boat. Captured fish were held in an onboard, flow-through, 280 liter live-well until the station was completed or the live-well was deemed full.

All sexually mature fish were measured to the nearest mm TL. Sex was determined by the expression of milt by palpation of the gonadal region of the abdomen, obvious outward appearance, or presence of eggs. The condition of females was also noted as gravid or spent when apparent. Only sexually mature fish were included in total catch or catch rate calculations. All fish in good physical condition were tagged with a numbered internal anchor tag as part of the coast-wide tagging program coordinated by the FWS.

9.4 Coastal Finfish Assessment Survey

The Delaware Division of Fish & Wildlife conducts two distinct trawl surveys to monitor fish abundance in the Delaware Estuary and Delaware's Inland Bays (Indian River and Rehoboth Bays). The 16-foot trawl survey, which has been consistently conducted since 1980, is primarily used to monitor juvenile fish abundance. The 30-foot trawl survey, conducted from 1966 – 1971, 1979 – 1984, and from 1990 – present, is primarily used to monitor sub-adult and adult fish abundance. The indices generated from these surveys are used in the development of interstate fishery management plans and stock assessments. Most notably, the surveys are / were used in the weakfish (*Cynoscion regalis*), striped bass (*Morone saxatilis*) and summer flounder (*Paralichthys dentatus*) fishery management plans and stock assessments. In addition, data from the surveys are used in establishing time of year restrictions for beach replenishment, dredging, and other marine work. The surveys also serve as platforms for collecting specimens for researchers studying genetics, tissue contaminants, age and growth, food habits, etc.

Though the size of the nets differs in each survey, both are bottom trawls designed to collect a wide variety of species. Sampling with the 16-foot trawl is conducted monthly from April through October at 39 fixed stations in the Delaware Estuary and 12 fixed stations in the Inland Bays. Sampling with the 30-foot trawl is conducted monthly from March through December at nine fixed station in the Delaware Bay. Occasionally, some sampling is missed due to vessel problems or weather.

9.4.1 Bottom trawl sampling of adult groundfish in Delaware Bay.

The objective of this study is to monitor trends in abundance and distribution; to determine population age/size composition and develop pre-recruitment indices for selected inshore finfish species.

Efforts were made to replicate sampling and gear protocol of previous 30-foot trawl surveys conducted in the Delaware Bay by Abbe (1967), Daiber and Wockley (1968), Daiber and Smith

(1972), and Smith (1987). Retired University of Delaware research vessel captain Tom White served as consultant to the project, making the necessary gear adjustments to ensure consistency. In addition, several members of the biological staff served onboard the previous (1979 – 84) survey and were on hand during the testing phase to further ensure catches were sampled correctly and the gear was fished properly. Data forms from the previous surveys were used, to ensure the data was entered on computer in matching formats and the data base maintained. Early sampling was conducted with the University of Delaware's research vessel "Wolverine" – a 47-foot (14.3- m) A-framed stern trawler. Sampling from March 1990 through July 2002 was conducted using the 65-foot (20-m) research vessel "Ringgold Brothers". The "Ringgold Brothers" was a wooden displacement-hulled skipjack converted to power and was equipped with an eastern-rigged trawling system that deployed and retrieved the trawling gear from the starboard side. The State of Delaware purchased a custom-built stern-rigged research vessel which began service as the survey's research platform in August of 2002. The 62-foot (19-m) deep-'V' semi-displacement hulled research vessel, "First State", is equipped with an 'A'-frame stern trawling rig. A limited number of comparative tows were made using the two vessels; however, analysis has not been completed to date.

Tow durations in some of the previous surveys were 30 minutes; whereas, tow durations in the present survey were 20 minutes. Tows less than 20-minutes were rarely made (due to gear conflicts, etc.); however, in such cases, a 10- minute minimum tow time was required for the tow to be considered valid. Expansion of CPUE (Catch-per-unit-effort) calculations was not necessary for the purposes of this report, since the unit effort was expressed as distance towed.

The net used in the survey consisted of 3-inch (7.6-cm) stretch mesh in the wings and body, and 2-inch (5.1-cm) stretch mesh in the cod end. The trawl had a 30-foot 6-inch (9.3-m) x 1/2-inch (1.2-cm) headrope and a 39-foot 6-inch (12.0-m) x 1/2-inch footrope with 40-foot (12.2-m) leglines. The 54-inch x 28-inch (1.37-m x 0.71-m) doors were constructed of ¾-inch (1.9-cm) virgin pine lumber, bolted to a 2 inch x 4 inch (5.1cm x 10.2cm) strong back. The doors had a 2-inch x ¾-inch (5.1-cm x 1.9-cm) milled steel bottom shoe runner and ¼-inch (0.64-cm) galvanized chain bridles attached to ½-inch (1.3-cm) galvanized swivels at the head.

The lack of towable bottom required a fixed sampling scheme. Station locations from the previous surveys were used (Figure 1-1). There was some randomization in the selection of tow starting sites within each quadrant due to weather, currents and inaccuracy inherent with electronic positioning equipment. Station 51 was permanently relocated in 1998 to approximately 0.5 NM south of the original station location due to repeated gear fouling on a fixed obstruction.

A global positioning system (GPS) was used to determine exact vessel position at the start and conclusion of each tow. Odometer readings from the GPS unit were used to determine distance towed (nautical miles). Mean water depth was determined from fathometer readings taken at five minute intervals including the start and finish points of each tow. A line-out to depth ratio of 6:1 was maintained.

A Yellow Springs Instrument Co. Model 85 oxygen, conductivity, salinity and temperature meter was used to measure surface and bottom temperature (°C), dissolved oxygen (ppm) and salinity (ppt) at the conclusion of each tow.

Upon completion of each tow, the sample was emptied on the deck and sorted by species. Aggregate weights were taken for each species. Species represented by less than 50 individuals were measured for fork length to the nearest half-centimeter. Species with more than fifty individuals were randomly sub-sampled (50 measurements) for length with the remainder being enumerated. Horseshoe crabs (*Limulus polyphemus*) were sexed and measured for prosomal width. Blue crabs (*Callinectes sapidus*) were sexed and measured for carapace width. Certain elasmobranchs were not measured due to difficulty in handling.

Scales and otoliths for selected species were collected from a sample of the catch. Impressions of summer flounder and striped bass scales were made on acetate slides using a roller press or a heated hydraulic press. Weakfish otoliths (used at the recommendation of the ASMFC Weakfish Technical Committee) were cut using a Hillquist® thin sectioning machine and mounted on glass slides using Loctite ultraviolet adhesive (34391). Scale impressions and otoliths were independently aged using a microfiche projector by at least two individuals. Differences in ages were reviewed; if a consensus in age determination was not reached, the sample was discarded. January first birthdates were assumed for each species. Age-length keys were constructed and expanded by the monthly length-frequency distributions for each species. These expansions were applied to the annual relative abundance measures to calculate catch-at-age.

Data were coded, entered in electronic format and analyzed using SAS® software. Fish densities were calculated by dividing the number of individuals for a species by the distance towed (No. /NM) at each station sampled, then calculating arithmetic means and standard errors in the typical fashion.

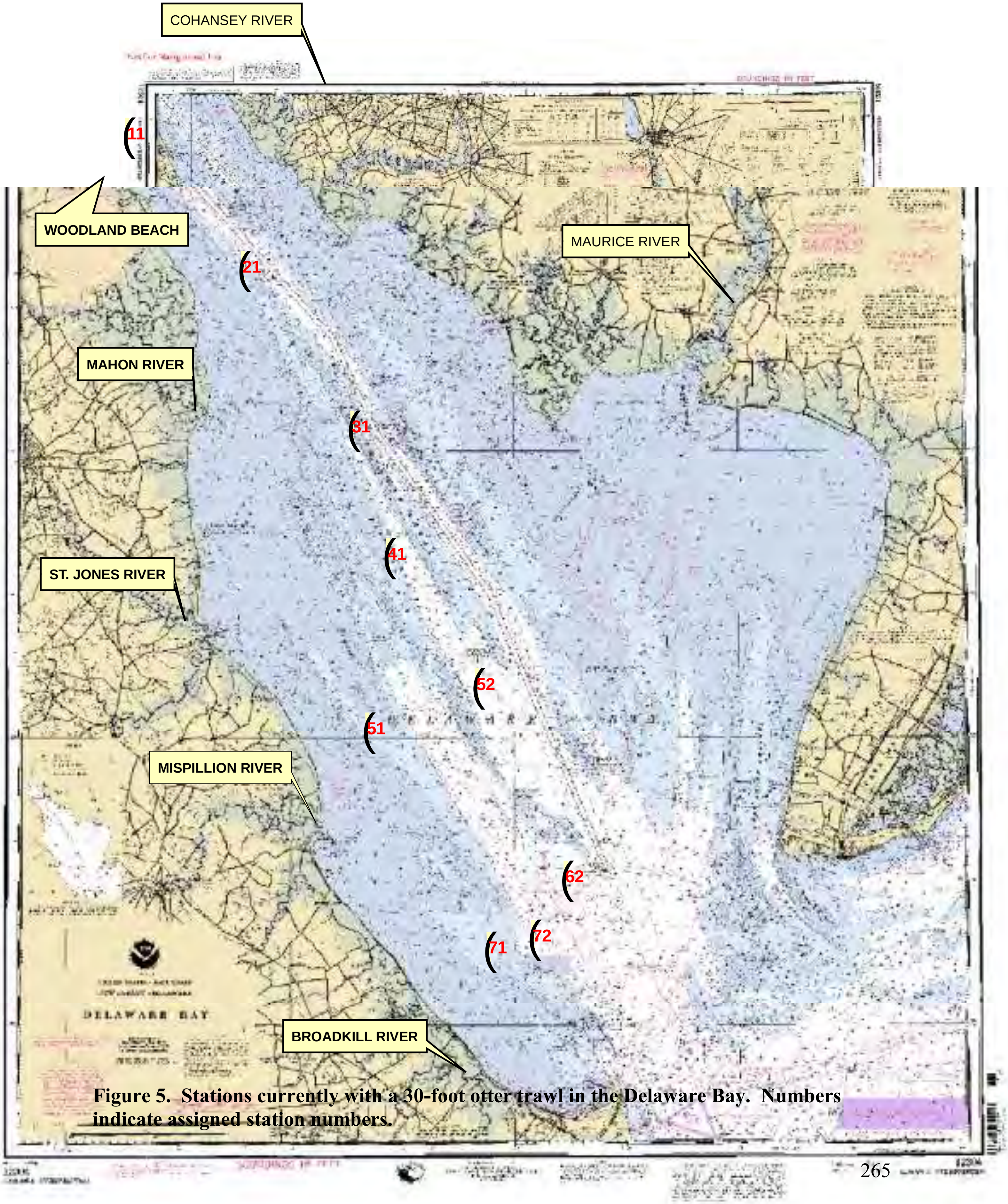


Figure 5. Stations currently with a 30-foot otter trawl in the Delaware Bay. Numbers indicate assigned station numbers.

9.4.2 Bottom trawl sampling of juvenile fishes in Delaware's estuaries.

The objective of this study is to monitor trends in abundance and distribution and to determine year-class strength for a selected group of finfish.

Sampling was generally conducted aboard a 7-m (23-foot) Sea Ark aluminum 'V'-hull boat, powered by a 260-hp diesel Volvo Diesel I/O, from 1990 through 2003. A 7-m Mon Ark aluminum tri-hull boat, powered by a 260-hp Mercruiser I/O, was used from 1980 through 1989. On both vessels, the net was deployed and retrieved from the stern using a hydraulic winder. The R/V "First State", a custom-built 19-m (62-foot) deep-'V' semi-displacement hulled vessel equipped with two 641hp Daewoo V180 TIM, a hydraulic winch and an 'A' - framed boom, was used for the Delaware Estuary sampling in April 2003 and all sampling in subsequent years. The 7-m 'V'-hulled Sea Ark continued to serve as the survey's research vessel for the Inland Bays sampling. In October 1999, a 7-M (23-foot) fiberglass C-Hawk boat, powered by a 130-hp Honda outboard motor was used to complete sampling in the Delaware Estuary and Inland Bays due to mechanical problems with the survey's primary vessel. In this case, the net was deployed and retrieved by hand.

Sampling was conducted monthly from April through October at 33 stations in the Delaware Bay and six stations in the Delaware River above the Chesapeake and Delaware Canal in 2011 (Figure 2-1a and 2-1b). Twelve stations were sampled monthly in the Indian River and Rehoboth Bays (Inland Bays) (Figure 2-2). April sampling was missed in 2003 at station 22 in the Delaware Estuary and was permanently discontinued in July 2003 due to shoaling and draft considerations at the Mahon River entrance. Occasionally some stations have been missed due to extreme low water conditions or other navigational obstructions. There was no missed sampling in the 2011 survey.

The net used was a 4.9-m (16-foot) semi-balloon otter trawl. It consisted of a 5.2-m (17-foot) headrope and a 6.4-m (21-foot) footrope with a 3.8-cm (1.5-inch) stretch mesh number 9 thread body. A 1.3-cm (0.5-inch) knotless stretch mesh liner was inserted in the cod-end. Six evenly spaced 3.8-cm (1.5-inch) X 6.4-cm (2.5-inch) sponge floats were located on the bosom of headrope and 0.3-cm (0.125-inch) galvanized chain was hung loop style on the footrope. The doors measured 30.5-cm (12-inches) X 61-cm (24-inches) and were constructed of 1.9-cm (0.75-inch) marine plyboard with 3.18-cm (1.25-inch) X 0.64-cm (0.25-inch) straps and braces, 1.3-cm (0.5-inch) X 5.1-cm (2-inch) shoes, and 0.5-cm (0.188-inch) galvanized chain bridles, with 1.0-cm (0.375-inch) swivels. The bridle arrangement consisted of a single line of 0.64-cm (0.25-in) stainless cable attached to 30-m (100-foot) bridle warps of no-lay line.

Sampling at each station consisted of a ten-minute trawl tow, usually made against the prevailing tide. Occasionally, tows less than ten minutes were made in cases of unforeseen gear conflicts, draft considerations, etc. In such cases, tows were required to be at least five minutes in duration to be considered valid. Catches from short tows were standardized to ten minutes. Where only one individual of a species was collected in a short tow, no expansion was made. A 10:1 ratio of line-out was continually adjusted according to water depth.

The trawl was hauled over the stern and the catch was emptied on a sorting table upon completion of each tow. Finfish were sorted by species and enumerated. A representative subsample of 30 specimens per species was measured for fork length to the nearest half centimeter; the remainder were enumerated. Hogchoker, bay anchovy, cusk-eels and certain elasmobranches were not measured due to practical constraints in the field. Surface temperature (°C), salinity (ppt) and dissolved oxygen (ppm) were recorded at the beginning of each tow. Tidal stage, weather conditions, water depth and engine speed were recorded for each station at the start of each tow.

Data reduction included monthly and annual summaries of the catch including a listing of species collected, total number of each species taken, mean catch per tow (C/f) and standard deviations. Mean C/f was defined as the sum of the number of individuals for a given species divided by the total number of ten-minute tows in a given month or year.

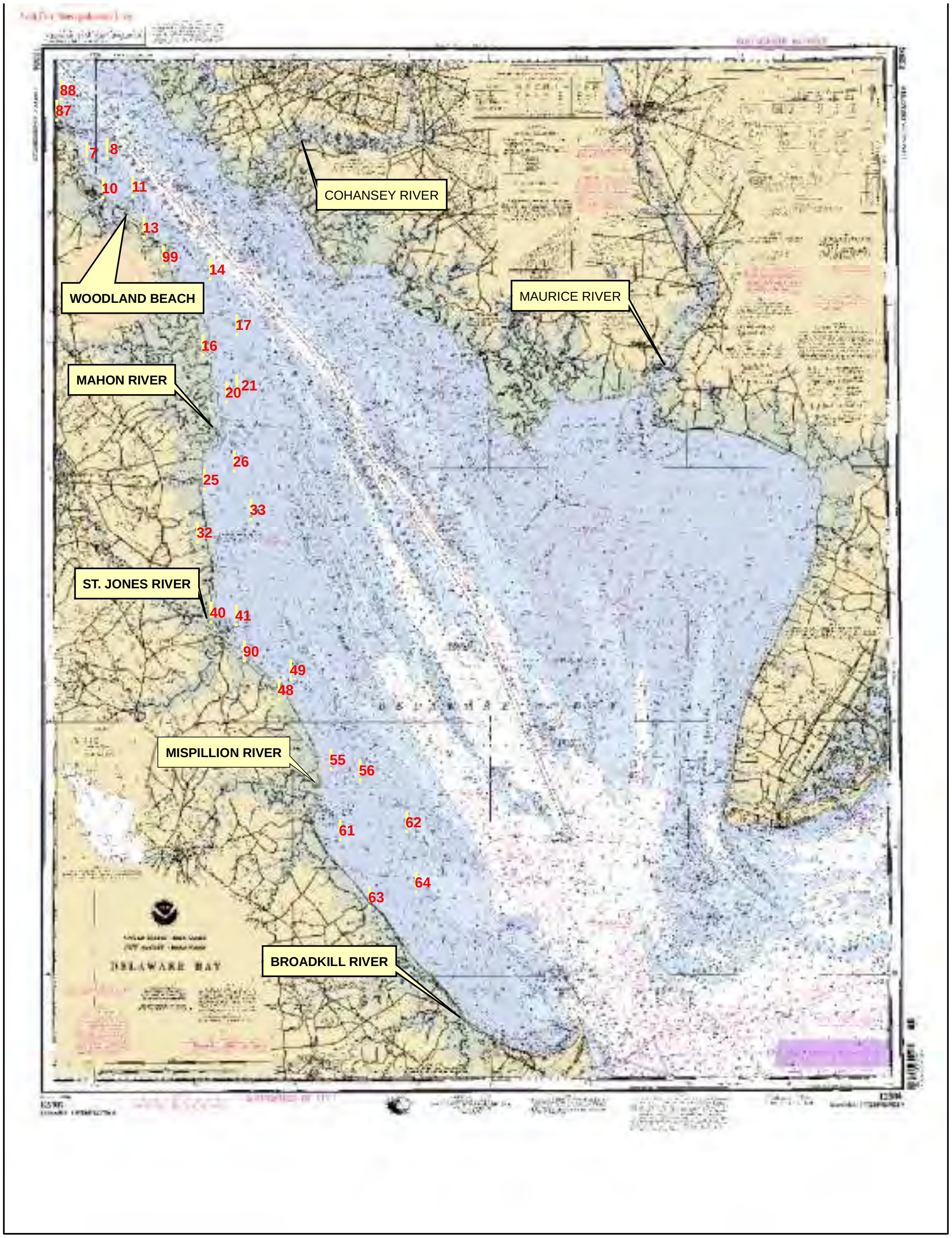


Figure 2-1a. Stations sampled with a 16-foot otter trawl in the lower Delaware Bay during 2011. Numbers indicate station numbers.

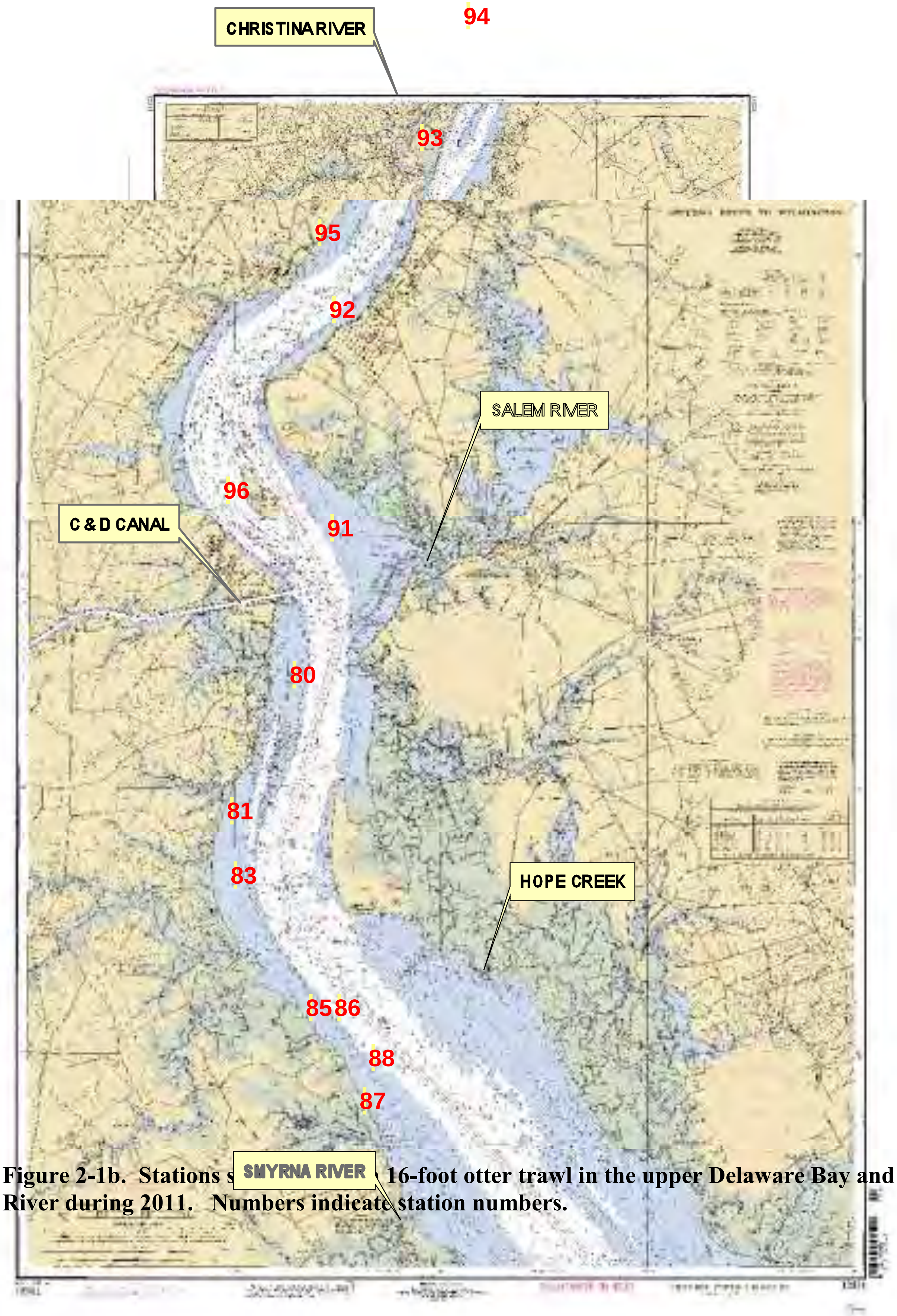


Figure 2-1b. Stations s [illegible] 16-foot otter trawl in the upper Delaware Bay and River during 2011. Numbers indicate station numbers.

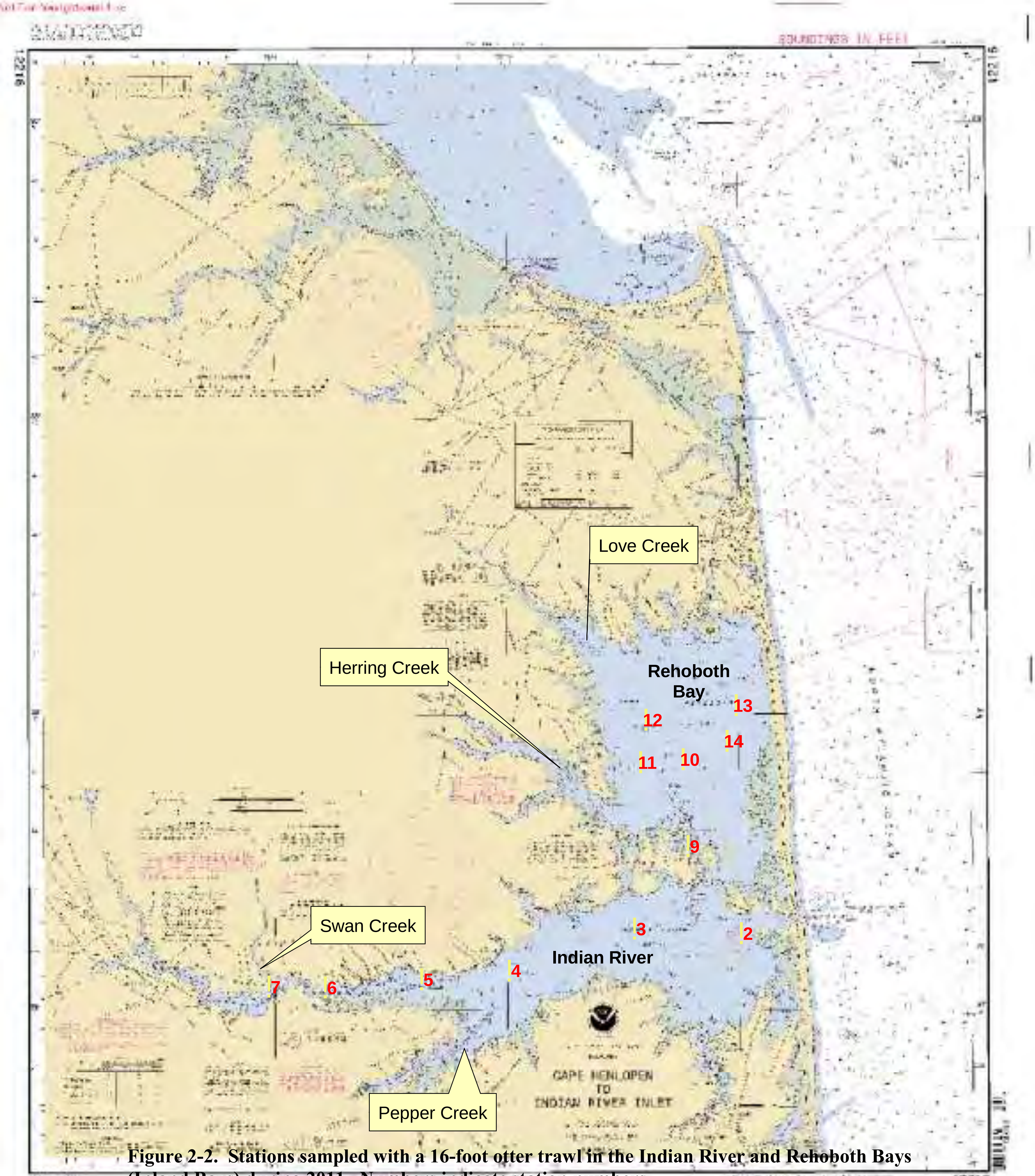


Figure 2-2. Stations sampled with a 16-foot otter trawl in the Indian River and Rehoboth Bays (Inland Bays) during 2011. Numbers indicate station numbers.

10.0 Maryland

This section describes methods or approach for each Wildlife and Sport Fish Restoration (WSFR) grant project managed by Maryland Department of Natural Resources Fisheries Service.

Research summaries are provided for the following grant projects:

1) F-48-R Survey and management of freshwater fisheries resources
2) F-50-R Coastal bay finfish investigation
3) F-53-D Freshwater resources conservation
4) F-57-R American and hickory shad restoration in three Maryland rivers
5) F-61-R Chesapeake Bay finfish and habitat investigations
6) F-63-R Marine and estuarine finfish ecological and habitat investigations
7) F-110-R Health investigations of striped bass and other fishes in Maryland waters

10.1 Survey and Management of Freshwater Fisheries Resources

10.1.1 Largemouth Bass – Tidal Fresh

Largemouth Bass were sampled in targeted drainages using a stratified, random design that has been described by Markham et al. (2002) and Love (2011). In 2011, the sampled drainages were: Potomac River, systems of the upper Chesapeake Bay (Northeast River, Susquehanna River, and the Susquehanna flats), Marshyhope Creek, Wicomico River, and Pocomoke River. Sampling occurred during fall (September – November). The tidal bass survey data were used to: 1) develop drainage-specific indices that reflect the population status of Largemouth Bass; and 2) report some life history traits for river populations.

Habitat variables just prior to time of sampling were recorded and included: water temperature (°C), specific conductivity (µS), dissolved oxygen (mg/L), water clarity (as a Secchi depth in meters), and minimum and maximum depth (in meters). Some of these variables affected catchability of Largemouth Bass and were used in models to remove their influence on catch statistics (see below). Catchability constants that are useful for evaluating gear bias were estimated from mark-recapture studies conducted at two sites in the upper Chesapeake Bay. For each of these studies, Largemouth Bass was collected at a site (pass 1) and a specific fin, clipped. The fish were released at the center of the site. A second pass of the site was conducted and all Largemouth Bass were retained. Recaptures were noted. A different fin was marked for all fish. Fish were then released at the center of the site. This procedure was followed for two more passes. The probability of capturing a Largemouth Bass on the first pass (i.e., catchability) was computed using a Closed-Captures Huggin's Model and MARK (Version 5.1).

Sites were sampled throughout tidal fresh regions of the drainages (Figs. 1 – 5). At each site, approximately 250 m was sampled for Largemouth Bass using boat electrofishing. In most cases, the amount of time that electricity was applied to water was at least 250 seconds. When stunned, Largemouth Bass was removed from the electric field and allowed to recover in a live well with well-aerated and re-circulating water. Once the site had been sampled thoroughly, Largemouth Bass were counted, measured to total length (in mm), and weighed (in grams). Fish were then released to their site of capture.

10.1.2 Tidal Potomac River blue catfish survey methods

Maryland Department of Natural Resources (MDDNR), Inland Fisheries has received reports of Blue Catfish (Ictalurus furcatus) occupying the tidal portion of the Potomac River for many years. Until the 1990s, most of these fish were misidentified as Channel Catfish (Ictalurus punctatus). Although some historical literature states that Blue Catfish were stocked in the Potomac River at the turn of the 20th century, many researchers believe that this information was in error and that the early stockings were juvenile Channel Catfish. It is unclear of when or how Blue Catfish first appeared in the Potomac. The Virginia Department of Game and Inland Fish stocked their main tidal tributaries with Blue Catfish in the 1970's. It is possible that the Potomac fish came from this stocking. The first confirmed documentation of a Blue Catfish in the tidal Potomac occurred in 1987 by Nammack & Fulton (1987). Only recently, however, have Blue Catfish become widespread and abundant enough to be a regular target for the angling and commercial fishing community in the Potomac River.

Blue Catfish are considered an invasive species in Maryland. There is great concern that this top predator will have a negative impact on fish and other aquatic species. Also of concern is the potential for Blue Catfish to spread to other river systems within the Chesapeake Bay either through unauthorized stocking or natural movement in times of low salinity. For example, Maryland DNR has not stocked Blue Catfish yet they can now be found in the Patuxent River, the Upper Bay and some Eastern Shore river systems.

Information on Blue Catfish populations in freshwater river systems and impoundment around the United States is abundant, particularly in the area of the country where they naturally occur (Mississippi River drainage). Less information is available on Blue Catfish occurring in estuarine environments. The Virginia Department of Game and Inland Fish (VDGIF) has the most comprehensive dataset for Blue Catfish occurring in tidal waters and has recently released a report describing the Blue Catfish populations in the James, Rappahannock, Mattaponi and Pamunkey Rivers (Greenlee and Lim, 2011).

Biologists with the MDDNR Inland Fisheries initiated a diet study on Blue Catfish in 2008. The purpose of the study was to determine if Blue Catfish were aggressively utilizing migrating shad and herring for forage and to determine if they were in competition with other major gamefish, such as largemouth bass, for food. As the Blue Catfish population increased, concern of further spread resulted in the desire for a Bay-wide Blue Catfish policy. Maryland DNR set up a routine sampling program for Blue Catfish in the Potomac in 2011 in order to compare catch indices from year to year and to allow managers to compare similar data with the VDGIF.
From October 2008 through December 2011, a Smith-Root SR 18 electrofishing boat equipped with a 9,000 Watt generator was used to collect Blue Catfish from the tidal Potomac River in order to examine gut contents. Water depths ranged from 5 feet in the coves to >50 feet in the main channel. The electrofishing unit was set to low frequency (7.5 – 15 pps, 680 or less volts), the most effective way to sample for Blue Catfish in deep water. In 2008 and 2009 stomach contents were extracted using a gastric lavage method that was adapted from a technique used on largemouth bass in St. Mary's Lake in 2003 (MDDNR, 2003). Later samples were collected from euthanized fish. Large Blue catfish (>610mm) were targeted because fish of this size are primarily piscivorous and more information on fish prey species would be obtained. Sampling was limited to good 'catfishing areas' as reported by anglers familiar with the Potomac River Blue Catfish population. As the study progressed, it became clear that more biological data on the species was needed and fish of all sizes were collected. In the Fall of 2011, the tidal

freshwater portion of the Potomac River from Oxon Creek to Port Tobacco was divided into 509 sites, 1600m2. Sites were randomly selected and coordinates were loaded into a hand-held Garmin Map76 GPS. All catfish, regardless of size, were collected and sacrificed during each electrofishing event in order to remove otoliths for ageing and to document stomach contents, sex, and stage of maturity. Fish length and weight were also noted, along with water temperature, dissolved oxygen, conductivity, pH and salinity.

Catch per unit effort (CPUE) was standardized to number of fish collected per hour and only included the fish collected in the fall of 2011. A subset of all otoliths collected was used for ageing purposes. All other calculations used the entire dataset from 2008 through 2011. Otoliths were used for ageing all catfish. Mean total length at age, coefficient of variation (CV) and confidence intervals (CI=95%) were calculated using the descriptive statistics function in Excels' Analysis Tool Pak program. Proportional size distribution (PSD) was calculated as the number of quality size fish divided by the number of fish that were stock size(Anderson, 1980). PSD was expressed as a percentage. Relative weight (Wr) compared the weight of captured Blue Catfish against a standard and was also expressed as a percent (Muoneke and Pope, 1999) . Potomac growth rates and length at age were compared to four Virginia tidal tributaries, the James, Rappahannock, Pamunkey and Mattaponi. Comparisons were tested using Analysis of Variance (ANOVA) in Excels' Analysis Tool Pak program. Linear regressions were performed on all river systems to compare growth rates (m) among systems. In each regression, age was the independent variable and mean length at age was the dependent variable. The slope of this linear model was m. Von Bertalannfy growth functions and catch curve regressions run using the program Fishery Analysis and Simulation Tools (FAST version 2.1), and were used to estimate growth constants (k) and instantaneous mortality rates (z), respectively, for fish of known age. All aged fish (n=268) were used to determine growth rates. Only fish age-5 (n=234) and older were used to estimate z due to sampling biases. Stomach contents were examined for all Blue Catfish and items identified to genus and species when possible.

10.2 Coastal bay finfish investigation

Research is organized by six project components. Each component will include a description of methods and an interaction summary for the referenced protected species.

Project Components

1. Coastal Bays Fisheries Investigations Trawl and Beach Seine Survey
2. 2010 and 2011 Seafood Dealer Catch Monitoring
3. Maryland Volunteer Angler Summer Flounder Survey (MVASFS)
4. Submerged Aquatic Vegetation Beach Seining Program

10.2.1 Coastal Bays Fisheries Investigations Trawl and Beach Seine Survey

The Maryland Department of Natural Resources (MDNR) Fisheries Service has conducted the Coastal Bays Fisheries Investigations (CBFI) Trawl and Beach Seine Survey in Maryland's Coastal Bays since 1972, sampling with a standardized protocol since 1989. These gears target finfish although bycatch of crustaceans, mollusks, sponges, and macroalgae are common.

Maryland's Coastal Bays are comprised of Assawoman Bay, Isle of Wight Bay, Sinepuxent Bay, Newport Bay, and Chincoteague Bay. Also included are several important tidal tributaries: St. Martins River, Turville Creek, Herring Creek, and Trappe Creek. Covering approximately 363 km^2 (140 mi^2), these bays and associated tributaries average only 0.9 m (3 feet) in depth and are influenced by a watershed of only 453 km^2 (175 mi^2). The bathymetry of the Coastal Bays is characterized by narrow channels, shallow sand bars, and a few deep holes.

Two inlets provide oceanic influences to these bays. Ocean City Inlet is formed at the boundaries of south Fenwick Island and north Assateague Island and is located at the convergence of Isle of Wight Bay and Sinepuxent Bay. Chincoteague Inlet, in Virginia (VA), is approximately 56 km (34 mi) south of the Ocean City Inlet.

The Coastal Bays are separated from the Atlantic Ocean to the east by Fenwick Island (Ocean City) and Assateague Island. Ocean City, Maryland is a heavily developed commercial area and the center of a $2 billion dollar tourism industry catering to approximately 12 million visitors annually. Assateague Island is owned by the State of Maryland and the National Park Service (NPS). These entities operate one state (Assateague State Park) and two national parks (Assateague Island National Seashore and Chincoteague National Wildlife Refuge). These properties have campgrounds, small buildings, dunes, beach front with some Off Road Vehicle (ORV) access, and marshes.

The Coastal Bays western shoreline habitat consists of forest, *Spartina* spp. marshes, small islands, residential development, and marinas. Assawoman Bay is bordered by Maryland and Delaware and is characterized by farmland, *Spartina* spp. marshes, a few small islands, and commercial/residential development. Isle of Wight Bay south into Sinepuxent Bay is a heavily developed commercial/residential area. Two seafood dealers, a public boat launch, and approximately 20 to 50 transient and permanent commercial fishing vessels utilize the commercial harbor located directly west of the Ocean City Inlet. In addition to the commercial harbor, the majority of marinas in Ocean City are located in Isle of Wight Bay. Vast *Spartina* spp. marshes and numerous small islands characterize Chincoteague Bay.

Submerged Aquatic Vegetation (SAV) and macroalgae (seaweeds) are common plants in these bays that provide habitat and foraging sites for fishes and shellfish. Two species of SAV are common in Maryland's Coastal Bays: widgeon grass, *Ruppia maritima*, and eelgrass, *Zostera marina*. Common species of macroalgae include *Chaetomorpha* sp., *Agardhiella* sp., *Gracilaria sp.*, and *Ulva* sp.

A 25 foot C-hawk with a 225 horsepower Evinrude E-tec engine was used for transportation to the sample sites and gear deployment. Latitude and longitude coordinates (waypoints) in decimal degrees, minutes, and fraction of minutes (ddmm.mmm) were used to navigate to sample locations. A GPS was used for navigation, marking sites, and monitoring speed.

Trawl sampling was conducted at 20 fixed sites throughout Maryland's Coastal Bays on a monthly basis from April through October (Table 1; Figure 1). Sampling gear complications due to an over-abundance of macroalgae necessitated moving trawl site T006 and T001 slightly (around one hundred meters) in order to complete the trawls. With the exception of June and September, samples were taken beginning the third week of the month. Occasionally, weather or mechanical issues required sampling to continue into the next month. Sampling began the second week in June and September in order to allow enough time to incorporate beach seine collections.

The boat operator took into account wind and tide (speed and direction) when determining trawl direction. A standard 4.9 m (16 ft) semi-balloon trawl net was used in areas with a depth of greater than 1.1 m (3.5 ft). Each trawl was a standard 6-minute (0.1 hr) tow at a speed of approximately 2.8 knots. Speed was monitored during tows using the GPS. Waypoints marking the sample start (gear fully deployed) and stop (point of gear retrieval) locations were taken using the GPS to determine the area swept (hectares). Time was tracked using a stopwatch which was started at full gear deployment.

Seines were used to sample the shallow regions of the Coastal Bays frequented by juvenile fishes. Shore beach seine sampling was conducted at 19 fixed sites beginning in the second weeks of June and September (Table 2; Figure 1). Occasionally, weather or mechanical issues required sampling to continue into the next month.

A 30.5 m X 1.8 m X 6.4 mm mesh (100 ft X 6 ft X 0.25 in. mesh) bag seine was used at 18 fixed sites in depths less than 1.1 m (3.5 ft.) along the shoreline. A 15.24 m (50 foot) version of the previously described net was used at site S019 due to it is restricted sampling area. However, some sites necessitated varying this routine to fit the available area and depth. GPS coordinates were taken at the start and stop points as well as an estimated percent of net open.

For each sampling method, physical and chemical data were documented at each sampling location. Chemical parameters included: salinity (ppt), temperature (°C), and Dissolved Oxygen (DO; mg/L). Physical parameters included: wind direction and speed (knots), water clarity (secchi disk; cm), water depth (ft), tide state, and weather condition. Data were recorded on a standardized project data sheet printed on Rite in the Rain All Weather paper.

Salinity, water temperature, and DO were taken with a Yellow Springs Instrument (YSI) YSI Pro2030 at two depths, 30 cm (1 foot) below the surface and 30 cm (1 foot) from the bottom, at each trawl site. Chemical data were only taken 30 cm below the surface for each seine site due to the shallow depth (<1.1 m). The YSI was calibrated each week, and the unit was turned on at the beginning of each day and left on from that time until the last site readings were taken. Water turbidity was measured with a secchi disk. Secchi readings were taken on the shaded side of the boat without the user wearing sunglasses. The secchi disk was lowered into the water until it could not be seen. It was then raised until the black and white pattern could just be seen. The biologist marked the position on the string with their fingers and measured the length of the string to the end of the disk. Both beginning and ending depths for each trawl were read on a depth finder and recorded. At seine sites, depth was estimated by the biologists pulling the seine. Wind speed measurements were acquired using a La Crosse handheld anemometer with digital readout. Measurements were taken facing into the wind. Tidal states were estimated checking the published tide tables for the sampled areas.

Fishes and invertebrates were identified, counted, and measured for Total Length (TL) using a wooden millimeter (mm) measuring board with a 90 degree right angle. A meter stick was used for species over 500 mm. At each site, a sub-sample of the first 20 fish (when applicable) of each species were measured and the remainder counted. On occasion, invertebrate species counts were estimated.

Blue crabs were measured for carapace width, sexed, and maturity status was determined. Sex and maturity categories included: male, immature female, mature female (sook), and mature female with eggs. A subsample of the first 50 blue crabs at each site was measured and the rest were counted. Sex and maturity status of non-sub-sampled blue crabs were not recorded Jellyfishes, ctenophores, bryozoans, sponges, SAV and macroalgae were measured volumetrically (liters, L) using calibrated containers with small holes in the bottom to drain the excess water. Small quantities (generally ≤ 10 specimens) of invertebrates were occasionally counted. Slightly larger quantities of invertebrates were sometimes visually estimated. Bryozoans and macroalgae were combined for one volume measurement and a biologist estimated the percentage of each species in the sample.

Table 7. MDNR Coastal Bays Fisheries Investigation Trawl Site Descriptions.

Site Number	Bay	Site Description	Longitude	Latitude
T001	Assawoman Bay	On a line from Corn Hammock to Fenwick Ditch	38 26.243	75 04.747
T002	Assawoman Bay	Grey's Creek (mid creek)	38 25.859	75 06.108
T003	Assawoman Bay	Assawoman Bay (mid-bay)	38 23.919	75 05.429
T004	Isle of Wight Bay	St. Martin's River, mouth	38 23.527	75 07.327
T005	Isle of Wight Bay	St. Martin's River, in lower Shingle Ldg. Prong	38 24.425	75 10.514
T006	Isle of Wight Bay	Turville Creek, below the race track	38 21.291	75 08.781
T007	Isle of Wight Bay	mid-Isle of Wight Bay, N. of the shoals in bay (False Channel)	38 22.357	75 05.776
T008	Sinepuxent Bay	#2 day marker, S. for 6 minutes (North end of Sinepuxent Bay)	38 19.418	75 06.018
T009	Sinepuxent Bay	#14 day marker, S. for 6 minutes (Sinepuxent Bay N. of Snug Harbor)	38 17.852	75 07.310
T010	Sinepuxent Bay	#20 day marker, S. for 6 minutes (0.5 mile S. of the Assateague Is. Bridge)	38 14.506	75 09.301
T011	Chincoteague Bay	Newport Bay, across mouth	38 13.024	75 12.396
T012	Chincoteague Bay	Newport Bay, opp. Gibbs Pond to Buddy Pond, in marsh cut	38 15.281	75 11.603
T013	Chincoteague Bay	Between #37 & #39 day marker	38 10.213	75 13.989
T014	Chincoteague Bay	1 mile off village of Public Landing	38 08.447	75 16.043
T015	Chincoteague Bay	Inlet Slough in Assateague Is. (AKA Jim's Gut)	38 06.370	75 12.454
T016	Chincoteague Bay	300 yds off E. end of Great Bay Marsh, W. of day marker (a.k.a. S. of #20 day marker)	38 04.545	75 17.025
T017	Chincoteague Bay	Striking Marsh, S. end about 200 yds	38 03.140	75 16.116
T018	Chincoteague Bay	Boxiron (Brockatonorton) Bay (mid-bay)	38 05.257	75 19.494
T019	Chincoteague Bay	Parker Bay, N end.	38 03.125	75 21.110
T020	Chincoteague Bay	Parallel to and just N. of the MD/VA line, at channel	38 01.328	75 20.057

Table 8. MDNR Coastal Bays Fisheries Investigation Beach Seine Site Descriptions.

Site Number	Bay	SITE DESCRIPTION	Latitude	Longitude
S001	Assawoman Bay	Cove behind Ocean City Sewage Treatment Plant, 62nd St.	38 23.273	75 04.380
S002	Assawoman Bay	Bayside of marsh at Devil's Island, 95th St.	38 24.749	75 04.264
S003	Assawoman Bay	Small cove, E. side, small sand beach; Sandspit, bayside of Goose Pond	38 24.824	75 06.044
S004	Isle of Wight Bay	N. side, Skimmer Island (AKA NW side, Ocean City Flats)	38 20.259	75 05.299
S005	Isle of Wight Bay	Beach on sandspit N. of Cape Isle of Wight (AKA in cove on marsh spit, E. and S. of mouth of Turville Creek)	38 21.928	75 07.017
S006	Isle of Wight Bay	Beach on W. side of Isle of Wight, St. Martins River (AKA Marshy Cove, W. side of Isle of Wight, N. of Rt. 90 Bridge)	38 23.708	75 06.855
S007	Isle of Wight Bay	Beach, 50th St. (next to Seacrets)	38 22.557	75 04.301
S008	Sinepuxent Bay	Sandy beach, NE side, Assateague Is. Bridge at Nat'l. Seashore	38 14.554	75 08.581
S009	Sinepuxent Bay	Sand beach 1/2 mile S. of Inlet on Assateague Island,	38 19.132	75 06.174
S010	Sinepuxent Bay	Grays Cove, in small cove on N. side of Assateague Pointe development's fishing pier	38 17.367	75 07.977
S011	Chincoteague Bay	Cove, 800 yds NW. of Island Pt.	38 13.227	75 12.054
S012	Chincoteague Bay	Beach N. of Handy's Hammock (AKA N. side, mouth of Waterworks Cr.)	38 12.579	75 14.921
S013	Chincoteague Bay	Cove at the mouth of Scarboro Cr.	38 09.340	75 16.426
S014	Chincoteague Bay	SE of the entrance to Inlet Slew	38 08.617	75 11.105
S015	Chincoteague Bay	Narrow sand beach, S. of Figgs Ldg.	38 07.000	75 17.578
S016	Chincoteague Bay	Cove, E. end, Great Bay Marsh (AKA Big Bay Marsh)	38 04.482	75 17.597
S017	Chincoteague Bay	Beach, S. of Riley Cove in Purnell Bay	38 02.162	75 22.190
S018	Chincoteague Bay	Cedar Is., S. side, off Assateague Is.	38 02.038	75 16.619
S019	Chincoteague Bay	Land site - Ayers Cr. At Sinepuxent Rd.	38 18.774	75 09.414

Table 9. Total Number of Coastal Bays Fisheries Investigations Trawl and Beach Seine Survey Samples by Gear Type from 1972-2011, n=5,375.

Gear	Total Number of Samples	Years Used
16’ Trawl	3,945	1972-present
25’ Trawl	134	1975, 1980-1981,1984-1985, 1988, 1993-1994
50’ Beach Seine	41	1991-present
100’ Beach Seine	1,155	1972-present

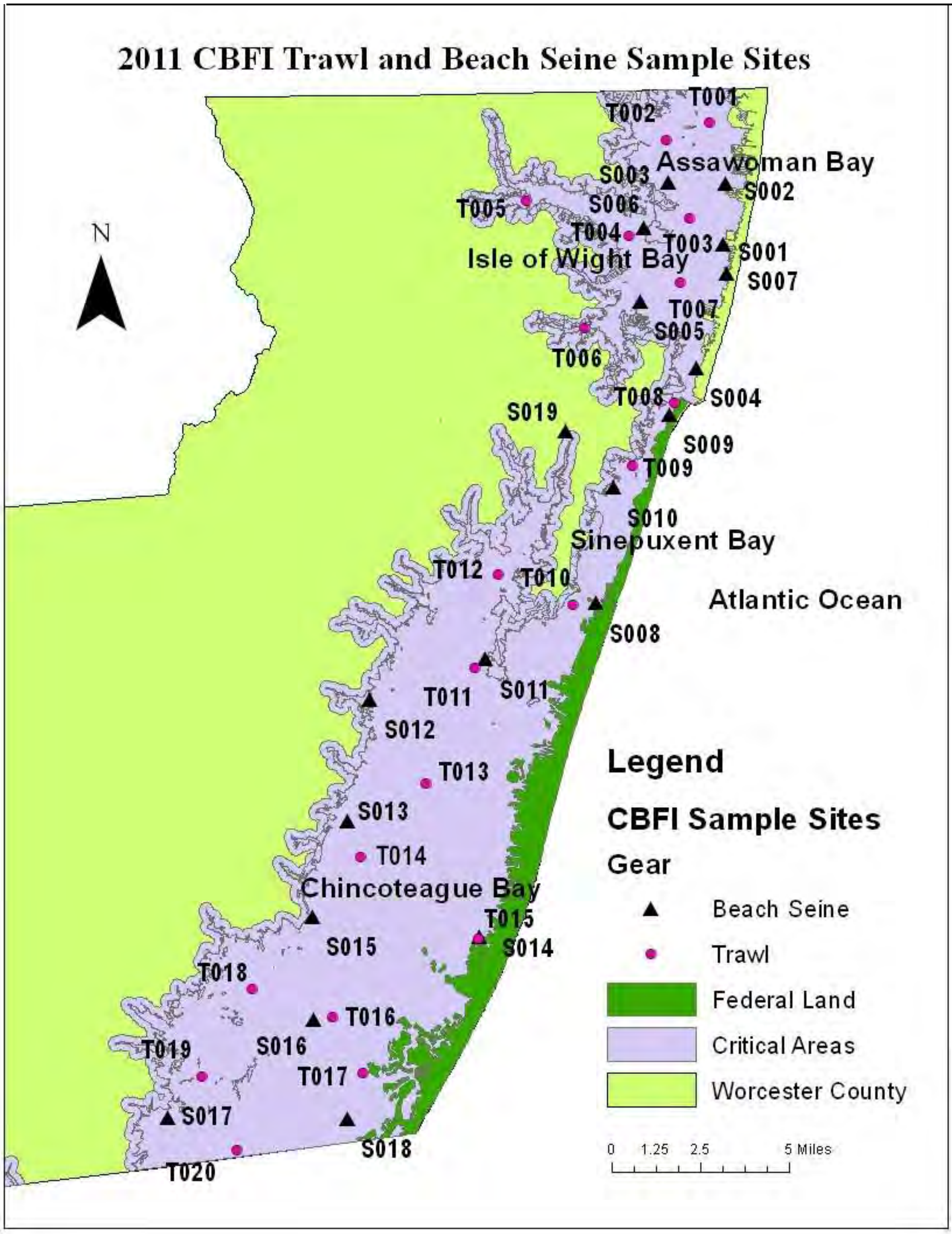


Figure 10. Site locations for the 2011 Coastal Bays Fishery Investigations Trawl and Beach Seine Survey.

10.2.2 Seafood Dealer Catch Monitoring
Dockside data have been collected since 1993 to fulfill compliance requirements of the Atlantic States Marine Fisheries Commission (ASMFC) for use in stock assessments.

Fish were obtained from Martin's Fish Market or Southern Connection Ocean City. Target species included: Striped Bass, Weakfish, and Croaker. Only one box was worked up at a time.

All fish were re-packed in their original boxes with ice below and on top of each layer of fish. Fish were measured for total length (TL; mm) and weight (kg). Ageing parts such as scales or otoliths were collected as needed. The date of capture, gear type and general catch location (ocean or coastal bays) were recorded.

10.2.3 Maryland Volunteer Angler Summer Flounder Survey (MVASFS)

The MVASFS began in 2002 after anglers expressed dissatisfaction with the Marine Recreational Fisheries Statistical Survey (MRFSS) harvest numbers which resulted in an increase in the minimum size and a creel reduction. Data collected from this survey have been used by the Maryland Department of Natural Resources (MDNR) Fisheries Service for the following:

- to fulfill the Atlantic States Marine Fisheries Commission reporting requirements in conjunction with other recreational flounder harvest data;
- to determine whether a certain size and creel limit affected the Chesapeake Bay differently than the Atlantic Coast;
- characterize the recreational catch of Summer Flounder in Maryland; and
- promote public participation in fisheries management and data collection.

In addition to Maryland's direct use of this survey, these data also influence management decisions along the Atlantic Coast. Fisheries managers in Virginia and Delaware have used these data for estimating creel and size limits. Until the state of Connecticut started a similar program, the MVASFS was one of the only sources of discard data for the recreational summer flounder fishery along the Atlantic Coast.

The survey operated from April through the end of October. Anglers continued to submit data of released fish after the recreational season was closed. Anglers were requested to complete a survey for trips targeting summer flounder even if no fish were caught. Recreational anglers, charterboat captains, and partyboats were asked to count the total number of fish caught, measure only the first 20 summer flounder to the nearest ¼ of an inch, and indicate fate of fish (kept or released). Data collected included: number of anglers, time spent fishing, area fished, mode (such as shore or party boat), and method used (Figure 4). All survey information was required to be submitted online or mailed by November 1st. Anglers were reminded not to submit the same information twice (i.e. use multiple reporting methods). Survey forms received in the mail were entered into the online survey to simplify data storage. In 2010, the survey became online only; paper forms were no longer distributed.

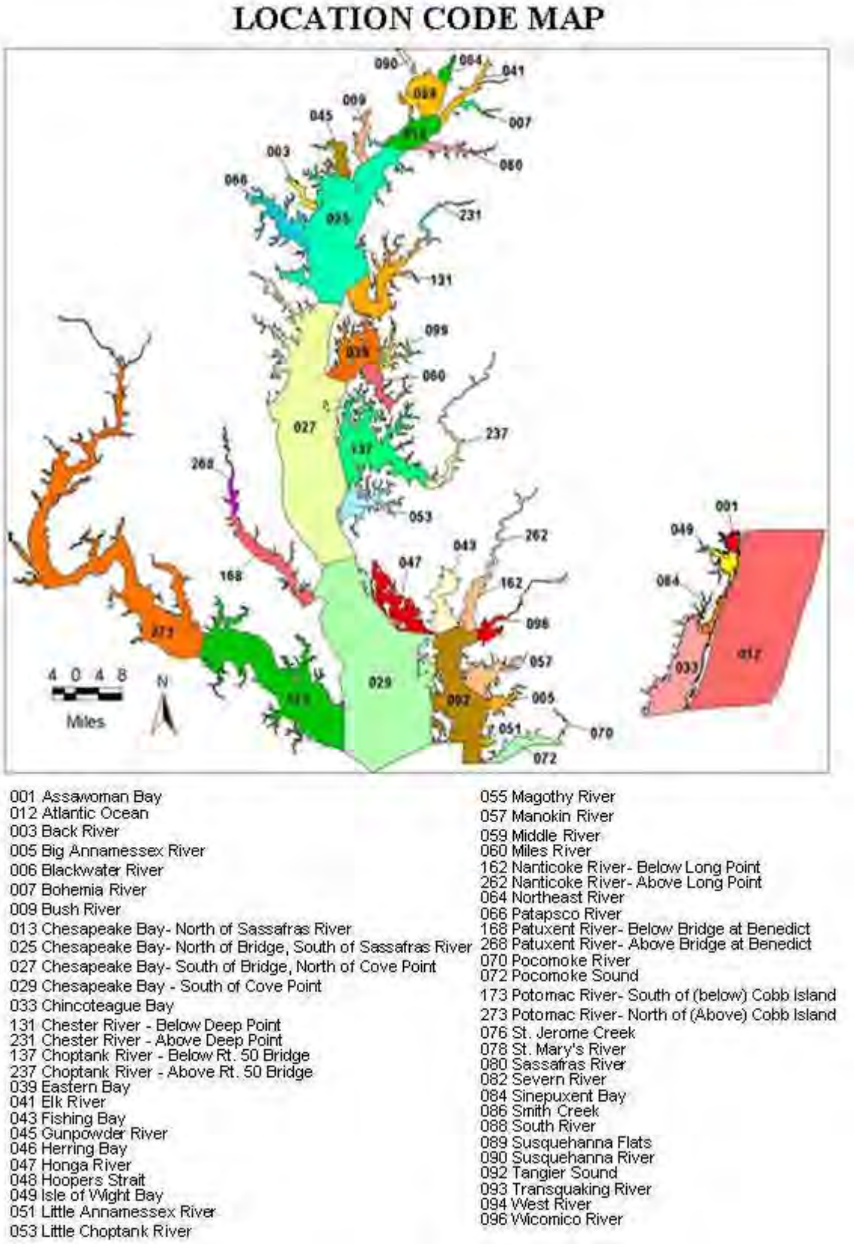


Figure 4. NOAA code map used for the Maryland Volunteer Angler Summer Flounder Survey.

10.2.4 Submerged Aquatic Vegetation Beach Seining Program

This component will begin in May 2012. The Coastal Bays Fisheries Investigation (CBFI) has a combined total of 39 trawl and beach seine sites; however, this survey rarely samples in Submerged Aquatic Vegetation (SAV). Use of SAV beds as habitat for nekton (fish and crustaceans) is well documented. With SAV playing such a significant role in the life cycle of many fishes and decapods and it's susceptibility to anthropogenic perturbations, the characterization of nekton assemblages in SAV is vital. This project has two goals: 1) identify areas of primary habitat in Maryland's Coastal Bays; and 2) use project data for recommending prioritized management decisions.

For this project, there are four zones: Northern Bays (north of the route 50 bridge), Sinepuxent West (Which includes South Point into Newport Bay), Sinepuxent East and Chincoteague (everything south of South Point). Sixteen random seine sites will be sampled from May to September. The sites will be chosen using the Excel Random Number Generator and 305 m x 305 m grids overlaying areas where SAV beds have been present for at least five years. Eight sites will be chosen for each zone each month. The first four sites will be the primary sample sites and the next four will be alternates. Alternate sites will be used in the event that there is not enough SAV at a primary sample site or a site is inaccessible.

For each sample physical and chemical data will be collected prior to gear deployment. Physical parameters include: wind direction and speed (knots), water clarity (secchi disk; cm), water depth (ft), tide state, and weather condition. Chemical parameters will include salinity (ppt), temperature (°C), and dissolved oxygen (DO; mg/L) and will be measured with a Yellow Springs Instrument (YSI) Pro 2030 at 30 cm (1 foot) below the surface. The YSI will be turned on at the beginning of each day and remains on until the last site readings are taken. The weight will be used to keep the probe at the proper depth and as vertical as possible. Data will be recorded on a standardized data sheet printed on Rite in the Rain All Weather paper.

A 15.24 m X 1.8 m X 6.4 mm mesh (50 ft X 6 ft X 0.25 in. mesh) bag seine will be used. GPS coordinates will be taken at the start and stop points as well as an estimated percent of net open. The distance of the seine haul will be 35 yards. This exact measurement will be verified using a rangefinder. Ideally, there will be four samplers for this project: two on each side of the seine, one walking behind the seine to assist with snags and carrying the sample back to the boat and one in the boat marking the distance to ensure 35 yards. The sampler still on the boat will use the rangefinder to target one of the samplers dragging the seine. Once that person is 35 yards from the starting point they will announce that the sample is finished. If only three samplers are available, the person walking behind the seine can use the rangefinder and the boat as a point of reference to ensure a 35 yard seine. Once the seine is finished, both samplers will pick the seine up and hold it horizontally to prevent organisms from escaping. Both samplers should continually lift the seine and work the sample down into the bag section of the seine. Once the sample is confined and secured, it will be walked back to the boat for processing.

Fishes and invertebrates will be identified, counted, and measured for Total Length (TL) using a wooden millimeter (mm) measuring board with a 90 degree right angle. A meter stick will be used for species over 500 mm. At each site, a sub-sample of the first 20 fish (when applicable) of each species will be measured and the remainder counted. Broken fish, when the majority of the animal can be recovered, will be added to counts and not measured (either heads or tails will be used when counting parts).

Blue crabs will be measured for carapace width, sexed, and maturity status is determined. Sex and maturity categories include: male, immature female, mature female (sook), and mature female with eggs. A subsample of the first 50 blue crabs at each site will be measured and the rest counted. Sex and maturity status of non-sub-sampled blue crabs will not be recorded. Jellyfishes, ctenophores, bryozoans, sponges, and macroalgae will be measured volumetrically (liters, L) using calibrated containers with small holes in the bottom to drain the excess water. Small quantities (generally ≤ 10 specimens) of invertebrates will be occasionally counted. Slightly larger quantities of invertebrates are sometimes visually estimated. Bryozoans and macroalgae will be combined for one volume measurement and a biologist estimates the percentage of each species in the sample.

Horseshoe crabs will be sexed and measured for prosomal width. Horseshoe crabs less than 200 mm must be manually sexed as described in the species identification handbook.

10.3 Freshwater resources conservation

This project works primarily in freshwater systems and includes freshwater fish production, stocking and maintenance of facilities and freshwater lakes. Some tidal species are produced for stocking into freshwater or tidal-fresh systems, including striped bass and largemouth bass. Hatchery staff collect brood stock from tidal habitats where Atlantic sturgeon, shortnose sturgeon or sea turtles could occur. All brood stock collection takes place during sampling activities associated with federal grant projects already described elsewhere in this document.

10.4 American and hickory shad restoration in three Maryland rivers

10.4.1. Summer juvenile seine survey methods

Funding obtained through Sportfish Restoration Act (F-57-R) has supported a Maryland Department of Natural Resources (MDNR) restoration project since 1999. MDNR restoration work thus far indicates that American shad restoration will likely occur over decades, rather than years. Reintroduction of juvenile American shad began in the Patuxent River in 1994. Choptank River American shad stocking began in 1996. Intermittent Nanticoke River stocking began in 1995, with consistent stockings of Marshyhope Creek beginning in 2002. Marshyhope Creek is a large tributary of the Nanticoke River. MDNR began a pilot project in 1993 to assess the resiliency of American shad adult broodstock during collection, handling and captive holding. In 1994, experimental spawning was conducted using timed-release hormone implants. The success of these trials encouraged development of a long-term spawning, culture, stocking and assessment program. In 1995, a non-funded, full-scale hatchery production effort was conducted with positive results. The project continued over the next three years through various short-term funding sources. In 1998, it was determined that a long term funding source would be required since it would take several years of additional stocking and assessment to successfully support restoration. Federal Aid in Sport Fish Restoration funds were utilized to conduct this long-term effort. Choptank River work includes the large tributary of Tuckahoe Creek. The Nanticoke River drainage is comprised of the mainstem Nanticoke and the large tributary of Marshyhope Creek. The state of Delaware contributes culture and sampling resources to the mainstem Nanticoke River and MDNR conducts the culture and assessment of the Marshyhope Creek portion of the watershed. The Patuxent River watershed is heavily urban-impacted, but has been the subject of numerous mitigation efforts due to its designation as a targeted watershed (i.e. sewage treatment upgrades). The Choptank River watershed is influenced by agriculture and low density development. The Nanticoke River watershed is predominated by agriculture in the middle and lower river. The upper Nanticoke River is urban and industrial-impacted.

The anadromous restoration project samples juvenile American and hickory shad by beach seine in the summer between August and October. The objective is to assess the contribution of hatchery-produced American shad on the resident/pre-migratory stock in the Patuxent River, Choptank River, and Marshyhope Creek and monitor the abundance and mortality of larval and juvenile American shad using marked hatchery-produced fish. (Figures 1, 2, 3)

A seine 61.0 meters long, 3.1 meters deep, with 6.4mm stretch mesh, was deployed by boat and pulled to shore by hand at established seine sites. Juvenile American shad were picked from the seine collection, placed in plastic bags, labeled, and stored on ice. Upon return to the lab, the samples were frozen to -9 °C.

In an effort to increase juvenile American shad recaptures on the Patuxent River in 2009, MDNR experimented with a boat mounted push net supplied by District of Columbia Fisheries and Wildlife biologists. D.C. biologists successfully use a push net, one meter long, 2.7 meters deep, with 6.4 mm mesh to capture juvenile shad in the Potomac and Anacostia Rivers. The net was attached to an aluminum frame that rotates from the center of the boat and rests on the bow of the boat to deploy the net. Trawls are conducted with the tide and after sunset. Trawls are typically eight to ten minutes. (Joe Swann, D.C. Fisheries pers.comm.). Seine sites historically sampled by MDNR were sampled with the boat mounted push net for the presence of American shad.

10.4.2 Spring adult electrofishing survey methods

The anadromous restoration project samples adult American and hickory shad by electrofishing in the spring between March and June. The objective is to analyze the contribution of hatchery origin American shad and hickory shad to the adult spawning population and monitor the recovery of naturally produced stocks.

Patuxent River and Choptank River spawning ground surveys commenced in 1999 to collect adult American shad (Figure 4). Restorative stocking of American shad in these two target tributaries began in 1994 and 1996 respectively. Marshyhope Creek restorative stocking and the associated spawning ground surveys began in 2002 (Figure 5). Three quantifiable population variables have been determined for evaluation of restoration progression of adult American shad spawning stocks in the targeted rivers.

1) Estimate catch-per-unit effort (CPUE) in each targeted river using arithmetic and geometric means.
2) Estimate the contribution of hatchery produced fish to the adult spawning populations.
3) Estimate the frequency of virgin and repeat spawning.

Sampling was conducted in historical spawning areas described by anecdotal data and concentrated in river sections where shad were encountered during previous sampling. The survey was conducted with a Smith-Root (Vancouver, WA) electrofishing boat model SR18-E. Target tributaries were sampled weekly from March to June. The survey was usually accomplished with three people. One person piloted the boat and two people netted shad from the bow. Each river was sampled from upstream to downstream with constant voltage applied for the entire run. Total sample time (secs.) and total shock time (secs.) was recorded for CPUE calculations. Water temperature (°C), dissolved oxygen (mg/L), and conductivity (µS/cm) were obtained using a YSI 85 water quality meter (Yellow Springs, OH) and a secchi disk was used to quantify turbidity (cm).

Adult shad were encountered in all three rivers in areas that displayed similar physical characteristics. Sites are generally characterized as encompassing from the uppermost areas just below the fall line to the lowermost areas near the salt wedge. In the Patuxent River, this encompasses the area from the wastewater treatment plant located north of the intersection of Bayard Road and Sands Road (4500 block of Sands Road) to approximately 2.44 miles upstream just above the Patuxent River 4H Center. In the Choptank River, shad were captured from just above the Route 313 Bridge in Greensboro, Maryland to approximately 1.28 miles upstream. Adult shad were captured in Marshyhope Creek from the Federalsburg Marina to approximately 1.04 miles upstream. In all of the targeted rivers it is likely that shad also utilize tidal freshwater areas downstream of our collection sites, but increasing river width and depth reduced capture efficiency with electrofishing gear. Sampling upstream habitat is precluded by electrofishing boat access but anecdotal evidence indicates that substantial spawning habitat and fish movement exists upstream of currently sampled stream sections (Table 1.)

Table 1. *Maryland DNR adult American shad electrofishing survey starting and ending coordinates for target tributaries.*

River	**Starting latitude/longitude**	**Ending latitude/longitude**
Patuxent River	38° 53’ 08.24” N 76° 40’ 29.53” W	38° 51’ 05.09” N 76° 41’ 33.04” W
Choptank River	38° 59’ 11.91” N 75° 47’ 11.29” W	38° 58’ 36.79” N 75° 48’ 06.79” W
Marshyhope Creek	38° 42’ 15.13” N 75° 46’ 27.06” W	38° 41’ 26.24” N 75° 46’ 14.17” W

American shad were generally sub-sampled to no more than 20 individuals per day for otolith and CWT analysis. All other observed shad were counted for CPUE and other analyses. Fish collected were processed in the following manner: TL (mm), FL (mm) and sex determination. The fish were scanned for CWT that were implanted and stocked as late juveniles. CWT data allow for analysis of specific stocking events, origin and age validation studies.

Scale samples were taken for age and spawning mark analysis and otoliths were extracted to identify hatchery OTC marks. All hatchery origin American shad are marked with OTC and/or CWT, which allow for collection of data on hatchery contribution to the adult spawning stock. Shad scales were cleaned, mounted between glass slides, and aged using a microfiche reader. Scales were aged using methods described by Cating (1953).

10.4.3 Spring American shad gill net brood stock collection

American shad were originally produced utilizing tank spawn culture methods developed by the project. Declining production success of American shad from tank spawn operations dictated that an additional source of larvae be developed.

In 2001, the decision was made to collect ripe fish on the spawning grounds and manually strip eggs and milt from mature brood fish. The Potomac River was chosen as the source population due to its strong American shad spawning population (Figure 6). The project hired a commercial fisherman to assist in egg collections that year. In 2002, it was determined that project personnel could perform these collections more efficiently and economically and this method is still utilized. Different areas along the Potomac River were evaluated for their ability to concentrate American shad. The channel in front of Fort Belvoir concentrates the greatest amount of American shad. The collections were carried out aboard a 7.0 m flat-bottom, center console skiff equipped with an outboard motor.

Weather and temperature conditions in late March and early April greatly influence the timing of American shad spawning on the Potomac River. It is essential to begin sampling in early April to ensure that collections occur during peak shad spawn. Sampling should normally begin in early April when water temperatures are 14 to 16°C. Gill nets were set parallel to the channel edge at depths varying between approximately 7.0 and 18.0 m. The time of net set depended exclusively on tide. Nets were ideally set at the beginning of slack tide. Past efforts indicated that setting nets at or near slack tide had a tendency to collect more shad. Nets were allowed to fish for approximately one hour. American shad are predisposed to spawn near, or just after sundown (Mansueti and Kolb 1953). For that reason, nets were set during the period from 1530 to 2130. Collecting shad before or after this six-hour window was deemed ineffective.

Catch per unit effort (CPUE) is used as an index of relative abundance. Gill net CPUE is established by dividing the number of fish caught per net, by the square footage of net fished per hour of soak time. A hand tally counter (tallycounterstore.com) is used to keep accurate count of all American shad caught from each net. Although trends in overall American shad catch rates can be monitored using CPUE ,the use of non-standardized gear through the years makes it difficult to establish an accurate relative abundance over time. CPUE has been an accurate tool in evaluating the most efficient gear to collect American shad. CPUE of a net differs greatly based on the net construction (monofilament vs. multifilament), net mesh size, and net depth.

Various nets were evaluated to study catch efficiency using different net mesh size and net depth. Gill nets with smaller mesh size have the tendency to catch smaller fish while nets with larger mesh sizes have a tendency to catch larger fish. In 2011, MDNR staff fished three different types of floating gill nets to determine catch efficiency for each net. Three to five nets were set per night, depending on weather conditions and boat traffic. In 2011, the 127 mm stretch mesh, 5.49 m deep, 100 m long monofilament net was determined to be the most effective net for catching American shad.

10.4.4 Spring hickory shad electrofishing broodstock collection

MDNR's American shad hatchery based restoration project incorporated hickory shad into the project in 1996. The project continued over the next three years through various short-term funding sources. In 1998 it was determined that a long term funding source would be required since it would take an estimated minimum five to ten years additional stocking and assessment to successfully support restoration. Federal Aid in Sport Fish Restoration funds was utilized to conduct this long-term effort. Hickory shad broodstock were collected from the Susquehanna River. Since the mid-1990s, hickory shad numbers have increased in the upper Chesapeake Bay and its tributaries (ASMFC 1999).

Prior to 2005, hickory shad broodstock were collected by hook and line either immediately downstream of Deer Creek or at Shure's Landing, near the base of Conowingo Dam. In 2005, MDNR staff began using an electrofishing boat to collect hickory shad brood. The sample area was along the western shore of the Susquehanna River, from just downstream of Deer Creek at

Rock Run Mill down to the Lapidum boat launch (Figure 7). Electrofishing was used for its ability to efficiently collect larger numbers of hickory shad than could be collected by hook and line collection. Electrofishing for hickory shad brood stock requires less project staff and reduces handling stress to the fish. During brood collection, immobilized hickory shad were netted and placed in the electrofishing boat's hull-mounted live well (220L). The live well water was recirculated, oxygenated, and treated with anesthetic (0.26 ml/L) 2-Phenoxyethanol, 99% (Acros Organics, www.acros.com), to reduce stress and injury.

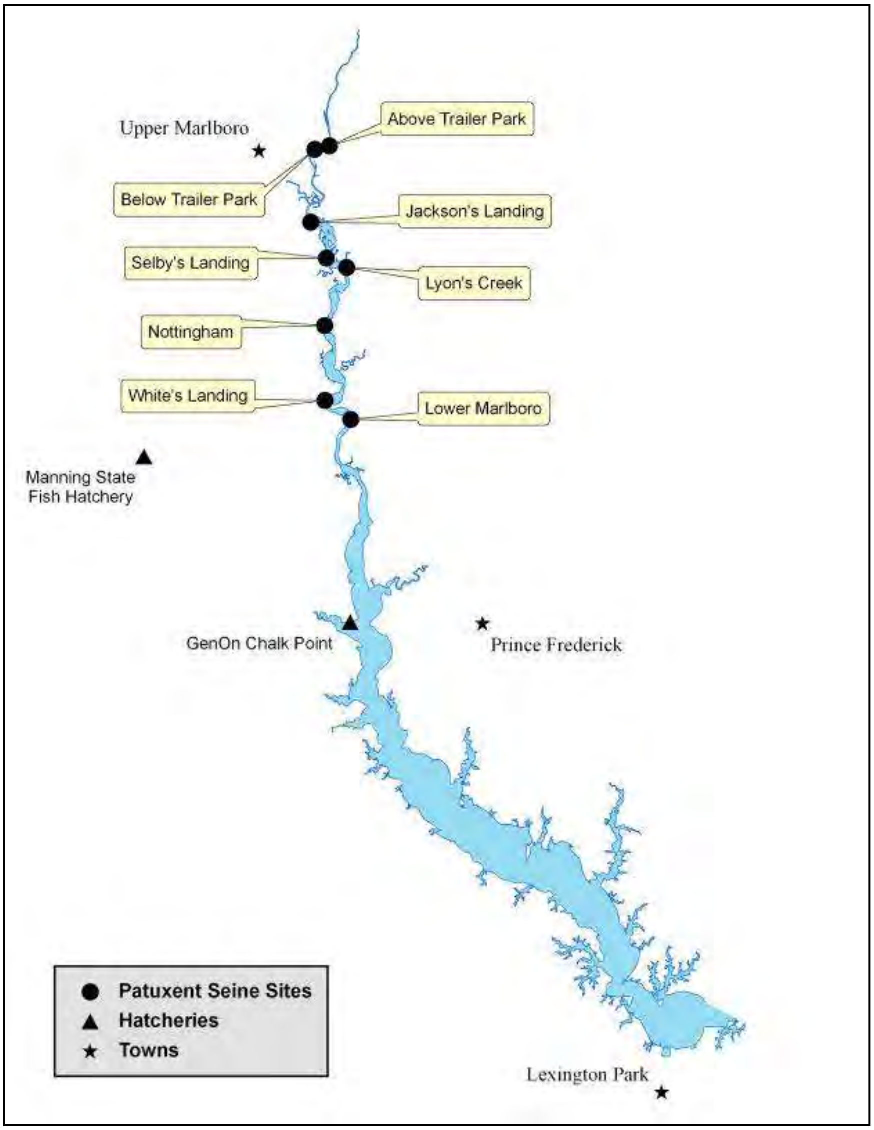


Figure 1. Maryland DNR Patuxent River juvenile American and hickory shad survey seine sites.

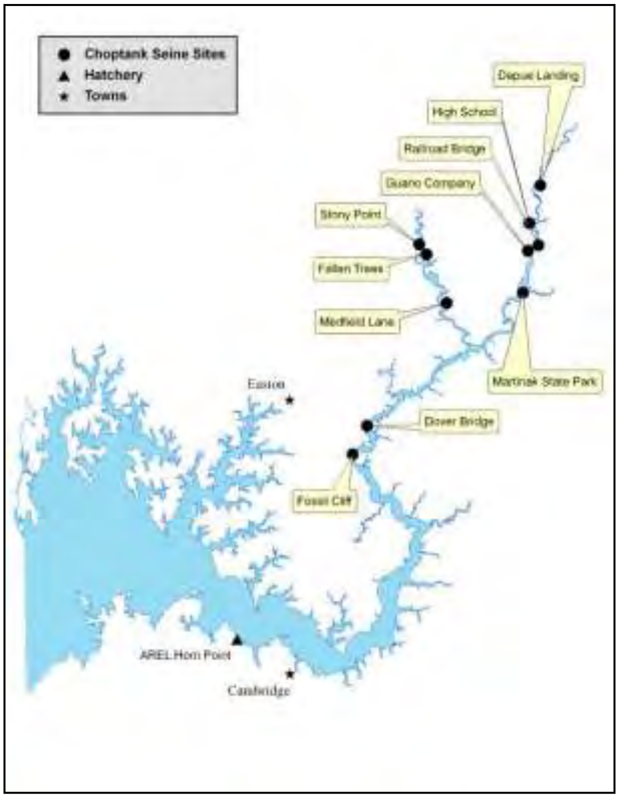


Figure 2. Maryland DNR Choptank River juvenile American and hickory shad survey seine sites.

Figure 3. *Maryland DNR Marshyhope Creek juvenile American and hickory shad survey seine sites.*

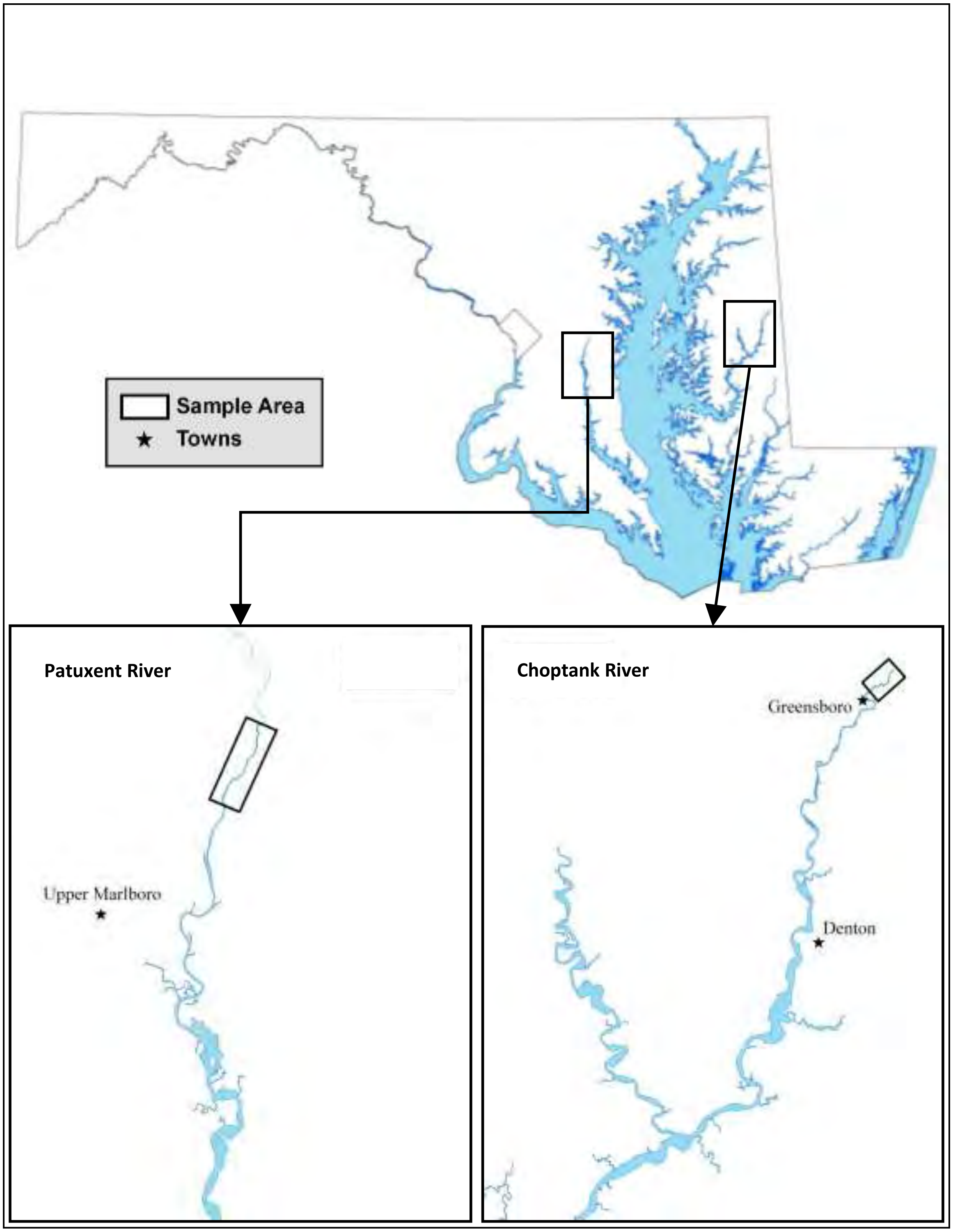


Figure 4. *Maryland DNR adult American and hickory shad electrofishing survey areas sampled*

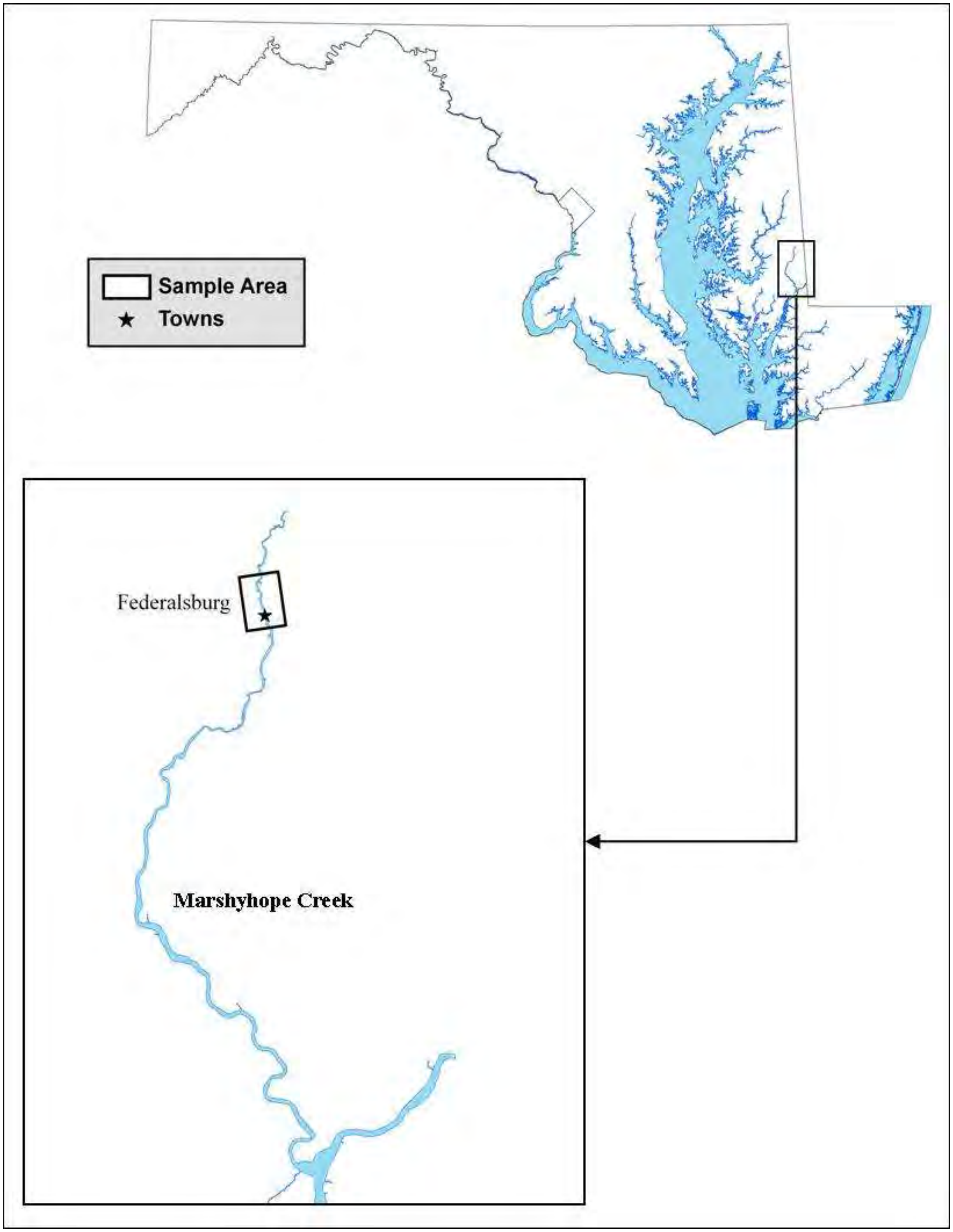


Figure 5. *Maryland DNR adult American and hickory shad electrofishing survey areas sampled*

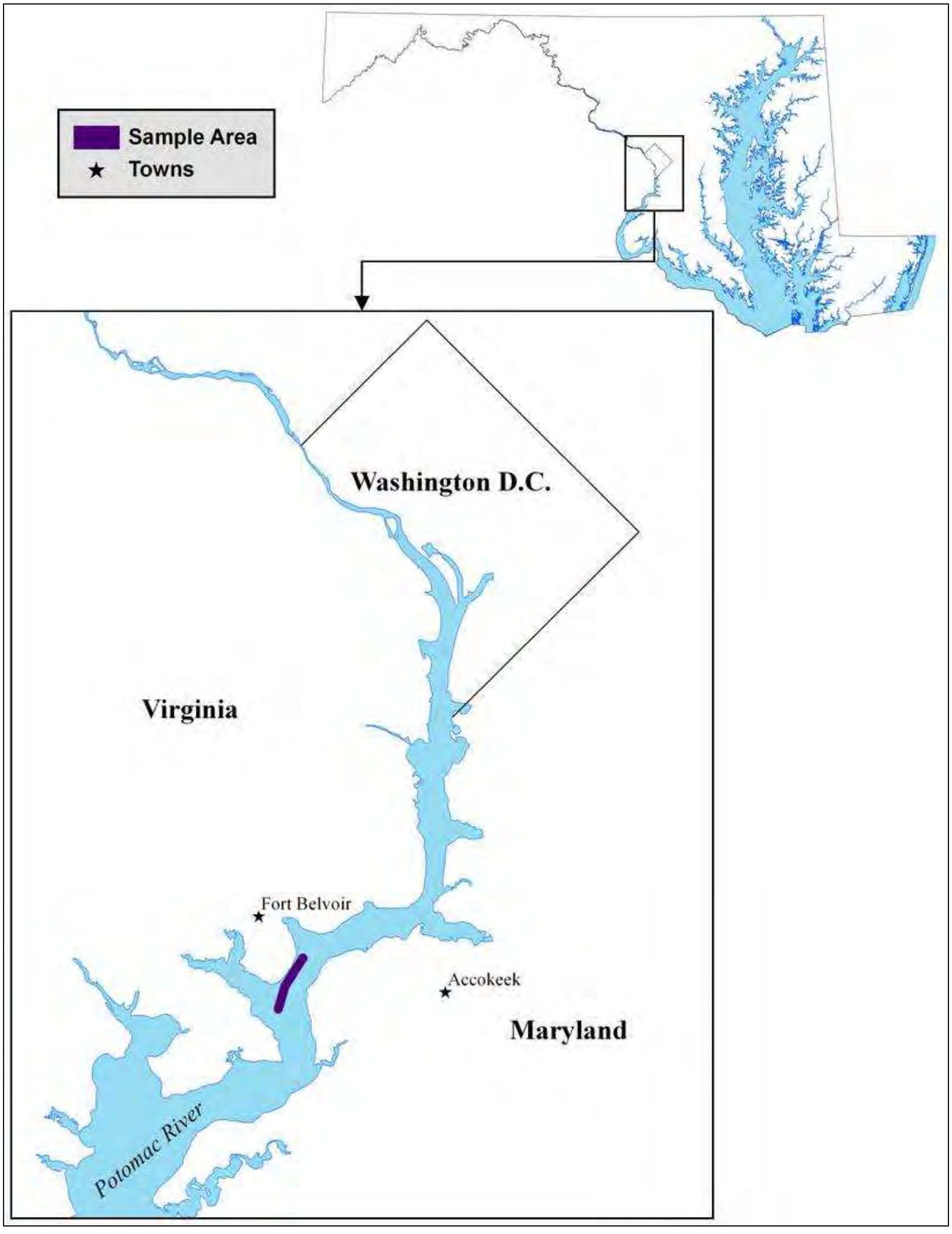


Figure 6. *Maryland DNR American shad brood stock collection site on the Potomac River.*

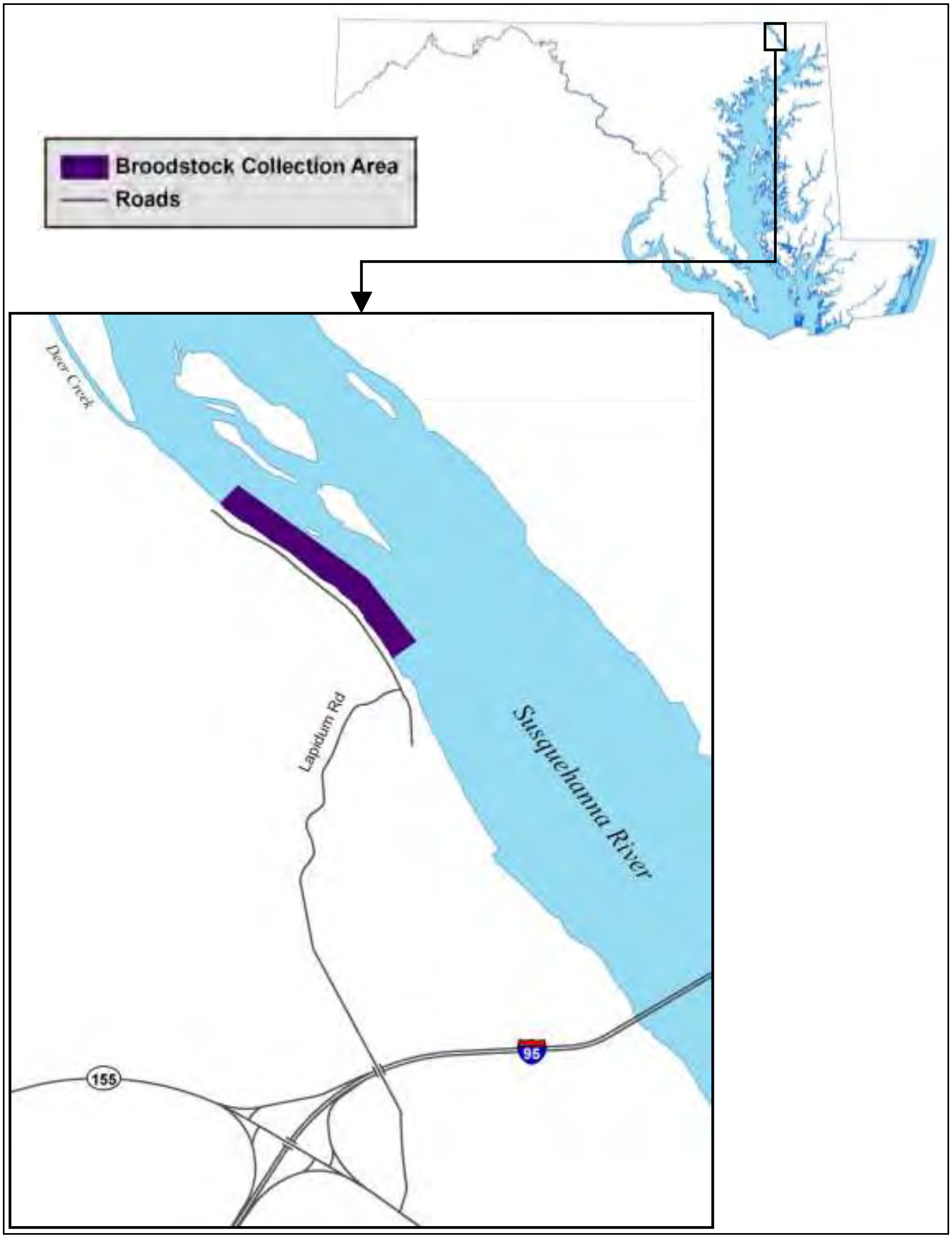


Figure 7. *Maryland DNR hickory shad brood stock collection site on the Susquehanna River.*

10.5 Chesapeake Bay finfish and habitat investigations

The primary objective of the Chesapeake Bay Finfish Investigations Survey, F-61-R, was to monitor and biologically characterize resident and migratory finfish species in the Maryland portion of the Chesapeake Bay. The F-61-R Survey provides information regarding recruitment, relative abundance, age and size structure, growth, mortality, and migration patterns of finfish populations in Maryland's Chesapeake Bay. The data generated are utilized in both intrastate and interstate management processes and provides a reference point for future fisheries management considerations**.**

10.5.1 Resident Species Stock Assessment

This project includes two components: (1) Population vital rates of resident finfish in selected tidal areas of Maryland's Chesapeake Bay; and, (2) Population assessment of yellow perch in Maryland with special emphasis on the Head-of-Bay stocks.

The objective of Project 1, Job 1 is to determine population vital rates (relative abundance, age, growth, mortality, and recruitment) of yellow perch, white perch, and catfish species in tidal regions of Chesapeake Bay. Job 2 is a rotational, triennial stock assessment of yellow perch (integrated analysis), white perch (catch survey analysis) or channel catfish (surplus production modeling). As such, all data collections and surveys are performed under Job1, which includes two components: (1) Upper Chesapeake Bay Winter Trawl and (2) Fishery Independent Choptank River Fyke Net Survey.

Upper Chesapeake Bay Winter Trawl

The upper Chesapeake Bay winter bottom trawl survey is designed to collect fishery-independent data for the assessment of population trends of white perch, yellow perch, channel catfish, and white catfish. For 2011, upper Chesapeake Bay was divided into four sampling areas; Sassafras River (SAS), Elk River (EB), upper Chesapeake Bay (UB), and middle Chesapeake Bay (MB). Eighteen sampling stations, each approximately 2.6 km (1.5 miles) in length and variable in width, were created throughout the study area (**Figure 1; Table 1**). Each sampling station was divided into west/north or east/south halves by drawing a line parallel to the shipping channel. Sampling depth was divided into two strata; shallow water (< 6 m) and deep water (>6 m). Each site visit was then randomized for depth strata and the north/south or east/west directional components.

The winter trawl survey employed a 7.6 m wide bottom trawl consisting of 7.6 cm stretch-mesh in the wings and body, 1.9 cm stretch-mesh in the cod end and a 1.3 cm stretch-mesh liner. Following the 10-minute tow at approximately 3 knots, the trawl was retrieved into the boat by winch and the catch emptied into either a culling board or large tub if catches were large. A minimum of 50 fish per species were sexed and measured. Non-random samples of yellow perch and white perch were sacrificed for otolith extraction and subsequent age determination. All species caught were identified and counted. If catches were prohibitively large to process, total numbers were extrapolated from volumetric counts. Volumetric subsamples were taken from the top of the tub, the middle of the tub, and the bottom of the tub. Six sampling rounds were scheduled from early December 2010 through February 2011.

Trawl sites have been consistent throughout the survey, but weather and operational issues caused incomplete sampling in some years. The 2003 survey was hampered by ice conditions such that only one of six rounds was completed. Retirement of the captain of the R/V Laidly during 2004 led to no rounds being completed. Only 1-½ rounds of the scheduled six rounds were completed in 2005 because of catastrophic engine failure. Ice-cover prevented the final two rounds of the 2007 survey and one round of the 2009 from being completed. Ice conditions also affected the 2010 and 2011 sample years where only 56 and 66 of the scheduled 108 trawls were completed, respectively (**Table 2**).

10.5.2 Fishery Independent Choptank River Fyke Net Survey

In 2011, six experimental fyke nets were set in the Choptank River to sample the four resident species from this system. Nets were set at river kilometers 63.6, 65.4, 66.6, 72.5, 74.4 and 78.1 and were fished two to three times per week from 21 February through 6 April (**Figure 2; Table 3**). These nets contained a 64 mm stretch-mesh body and 76 mm stretch-mesh in the wings (7.6 m long) and leads (30.5 m long). Nets were set perpendicular to the shore with the wings at 45°angles. Annual effort has varied from 40 fyke net days early in the time series to 353 fyke net days in 1999. More recently, fyke net effort has ranged from 200 – 250 fyke net days (**Table 4**).

Net hoops were brought aboard first to ensure that all fish were retained. Fish were then removed and placed into a tub and identified. All yellow perch and a subsample of up to 30 fish of each target species were sexed and measured. All non-target species were counted and released. Otoliths from a subsample of white and yellow perch were removed for age determination.

Table 1. General location of upper Chesapeake Bay Trawl Survey sites. Coordinates are for each site for the first round of the 2011 sampling season. Other rounds do not vary substantially.

SITENAME	LAT START	LONG START
EB1	39 27.8455	75 58.281
EB2	39 29.3914	75 56.4148
EB3	39 30.1579	75 55.1354
EB4	39 30.3733	75 54.2504
MB1	39 16.1559	76 14.2227
MB2	39 14.5882	76 14.3344
MB3	39 13.3743	76 14.9061
MB4	39 11.1943	76 16.7796
SA1	39 22.4793	76 01.2645
SA2	39 22.3325	75 59.1757
SA3	39 22.6005	75 57.7054
SA4	39 22.2418	75 55.8333
UB1	39 26.0095	76 00.6761
UB2	39 25.1319	76 02.892
UB3	39 23.2094	76 06.6192
UB4	39 21.6272	76 09.1285
UB5	39 20.3601	76 10.1529
UB6	39 19.2385	76 13.374

Table 2. Effort (Number of bottom trawl tows) for Upper Chesapeake Bay Winter Trawl Survey.

Year	# FykeNet Days	# Atlantic Sturgeon	# Shortnose Sturgeon	# Sea Turtles
2000	79	0	0	0
2001	114	0	0	0
2002	110	0	0	0
2003	0	0	0	0
2004	20	0	0	0
2005	43	0	0	0
2006	108	0	0	0
2007	71	0	0	0
2008	108	0	0	0
2009	90	0	0	0
2010	56	0	0	0
2011	66	0	0	0

Table 3. Coordinates for Choptank River Fyke Net Survey locations.

Site Name	Coordinates	
Kings Landing	38 46 44.5N	75 57 15.9W
Quidas Farm	38 47 09.4N	75 56 12.8W
Turkey Creek	38 48 25.4N	75 54 50.4W
Robins Marsh	38 49 22.9N	75 52 23.2W
Mill Creek	38 49 28.3N	75 51 30.9W
Lyphord Landing	38 50 21.3N	75 51 58.9W

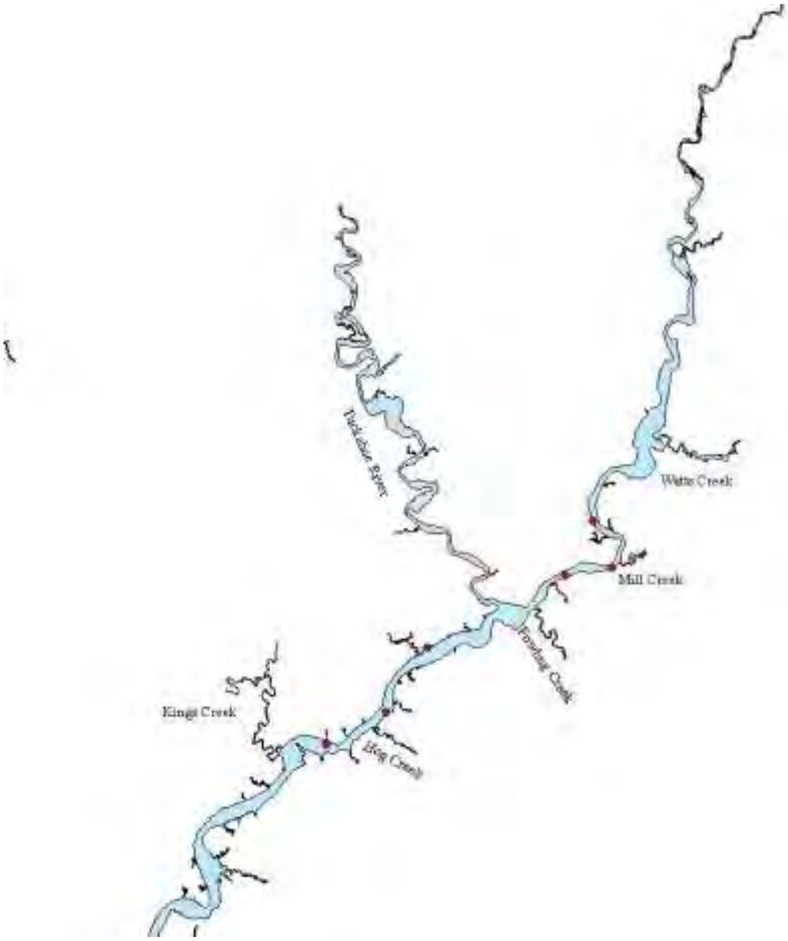
Table 4. Effort (Number of fyke net days) for Choptank River Fyke Net Survey.

Year	# Fyke Net Days	# Atlantic Sturgeon	# Shortnose Sturgeon	# Sea Turtles
1989	80	0	0	0
1990	87	0	0	0
1991	40	0	0	0
1992	188	0	0	0
1993	343	0	0	0
1994	271	0	0	0
1995	298	0	0	0
1996	330	0	0	0

1997	330	0	0	0
1998	321	0	0	0
1999	359	0	0	0
2000	310	0	0	0
2001	310	0	0	0
2002	306	0	0	0
2003	261	0	0	0
2004	251	0	0	0
2005	235	0	0	0
2006	236	0	0	0
2007	203	0	0	0
2008	248	0	0	0
2009	210	0	0	0
2010	223	0	0	0
2011	242	0	0	0

Figure 1. Upper Chesapeake Bay Trawl Survey sites for 2011.

Figure 2. Fyke net locations for the Choptank River Fyke Net Survey, 2011. Circles indicate fyke net locations.


Tuckahoe River
Watts Creek
Mill Creek
Fowling Creek
Kings Creek
Hog Creek

10.5.3 Interjurisdictional Species Stock Assessment

10.5.3.1 Alosa Species: Stock assessment of adult and juvenile anadromous Alosa in the Chesapeake Bay and select tributaries: Juvenile Trawl and Seine Survey

MD DNR has conducted a juvenile survey for alosines in the Chester River since 2005. Collected data are used to contribute to our knowledge of juvenile alosine abundance. Data are also used by the Fisheries Habitat and Ecosystems Program at MDNR to understand how urbanization affects fish habitat.

Juvenile alosine species are sampled in the Chester River using a 30.5 x 1.2m x 6.4mm mesh haul seine and a 16' headrope bottom trawl. Sampling in this system begins in early July and continues bi-weekly through late September. There are 4-8 stations upriver of Shell Point: each station consists of one seine haul and one bottom trawl. Surface and bottom water quality (temperature, salinity, specific conductance, dissolved oxygen) is recorded at each trawl site. Only surface water quality is recorded for seine sites.

All seines are pulled with the tide. One person remains on shore holding one end of the seine. The person on shore "feeds" their end of the seine out as the other person pulls the seine. The other person pulls the seine straight out (perpendicular) from the beach until it is fully extended. When the seine is fully extended, it is pulled back toward the beach in an arc. Once both ends of the seine are on shore, the two individuals pull the seine toward each other and meet as closely as possible. The net is brought onshore by pulling evenly on the float and lead line of the seine, making sure the lead line remains on the bottom. When the net is fully retrieved, all of the fish are shaken down into a common area. Twenty of all alosine species, white and yellow perch, and striped bass are measured; any fish in excess of 20 are counted. The numbers of all other fishes and crabs captured in the seine net are recorded.

Trawls are towed with the tide at two knots for six minutes. The trawl is deployed by hand over the gunwale. After completion and retrieval of the trawl, fish captured in the upper part of the trawl are shaken down toward the cod end and released into a culling box or sorting tub. Twenty of all alosine species, white and yellow perch, and striped bass are measured; any fish in excess of 20 are counted. The numbers of all other fishes and crabs captured in the trawl net are recorded.

10.5.3.2 Striped Bass: Stock assessment of adult and juvenile striped bass in Maryland's Chesapeake Bay and selected tributaries: Characterization of striped bass spawning stocks in Maryland - Spring Striped Bass Experimental Drift Gill Net Survey

The primary objective of Project 2, Job 3, Task 2 is to generate estimates of relative abundance-at-age for striped bass in Chesapeake Bay during the spring spawning season. A secondary objective of Task 2 was to characterize the striped bass spawning population within the Chesapeake Bay. Length distribution, age structure, average length-at-age, and percentage of striped bass older than age 8 present on the spawning grounds were examined. In addition, an Index of Spawning Potential (ISP) for female striped bass, an age-independent measure of female spawning biomass within the Chesapeake Bay, was calculated.

Since 1985, the Maryland Department of Natural Resources (MD DNR) has employed multi-panel experimental drift gill nets to monitor the Chesapeake Bay component of the Atlantic coast striped bass population. Because Chesapeake Bay spawners produce up to 90% of the Atlantic coastal stock (Richards and Rago 1999), indices derived from this effort are important in the coastal stock assessment process. Indices produced from this study are currently used to guide management decisions concerning recreational and commercial striped bass fisheries from North Carolina to Maine.

Multi-panel experimental drift gill nets were deployed in the Potomac River and in the Upper Chesapeake Bay in 2011 (Figure 1). Gill nets are fished 6 days per week, weather permitting, from late March through May. Individual net panels were 150 feet long, and ranged from 8.0 to 11.5 feet deep depending on mesh size. The panels were constructed of multifilament nylon webbing in 3.0, 3.75, 4.5, 5.25, 6.0, 6.5, 7.0, 8.0, 9.0 and 10.0-inch stretch-mesh. In the Upper Bay, all 10 panels were tied together, end to end, to fish the entire suite of meshes simultaneously. In the Potomac River, because of the design of the fishing boat, the gang of panels was split in half, with two suites of panels (5 meshes tied together) fished simultaneously end to end. In both systems, all 10 panels were fished twice daily unless weather prohibited a second set. The order of panels within the suite of nets was randomized with gaps of 5 to 10 feet between each panel. Overall soak times for each panel ranged from 6 to 105 minutes.

Sampling locations were assigned using a stratified random design. The Potomac River and Upper Bay spawning areas were each considered a stratum. One randomly chosen site per day was fished in each spawning area. Sites were chosen from a grid superimposed on a map of each system. The Potomac River grid consisted of 40, 0.5-square-mile quadrants, while the upper Bay grid consisted of 31, 1-square-mile quadrants. GPS equipment, buoys, and landmarks were used to locate the appropriate quadrant in the field. Once in the designated quadrant, air and surface water temperatures, surface salinity, and water clarity (Secchi depth) were measured.

All striped bass captured in the nets were measured for total length (mm TL), sexed by expression of gonadal products, and released. Scales were taken from 2-3 randomly chosen male striped bass per 10 mm length group, per week, for a maximum of 10 scale samples per length group over the entire season. Scales were also taken from all males over 700 mm TL and from all females regardless of total length. Scales were removed from the left side of the fish, between the lateral line and the first dorsal fin. Additionally, if time and fish condition permitted, U.S. Fish and Wildlife Service internal anchor tags were applied.

10.5.3.3 Maryland juvenile striped bass survey

The primary objective of Project 2, Job 3, Task 3 was to document annual year-class success for young-of-the-year (YOY) striped bass (Morone saxatilis), and all other fish species encountered in Chesapeake Bay. Annual indices of relative abundance provide an early indicator of future adult stock recruitment (Schaefer 1972; Goodyear 1985) and document annual variation and long-term trends in abundance and distribution.

Juvenile indices for striped bass and all other fish species sampled are derived from sampling at 22 fixed stations within Maryland's portion of the Chesapeake Bay (Figure 1). Sample sites were divided among four of the major striped bass spawning and nursery areas; seven sites each in the Potomac River and Head of Bay areas and four each in the Nanticoke and Choptank rivers.

Stations have been sampled continuously since 1954. From 1954 to 1961, Maryland's juvenile surveys included inconsistent stations and rounds. Sample sizes ranged from 34 to 46. Indices derived for this period include only stations which are consistent with subsequent years. In 1962, stations were standardized and a second sample round was added for a total of 88 samples. A third sample round, added in 1966, increased sample size to 132.

Sites are sampled monthly, with rounds (sampling excursions) occurring during July (Round I), August (Round II), and September (Round III). Replicate seine hauls, a minimum of thirty minutes apart, were taken at each site in each sample round. This protocol produced a total of 132 samples from which Bay-wide means were calculated.

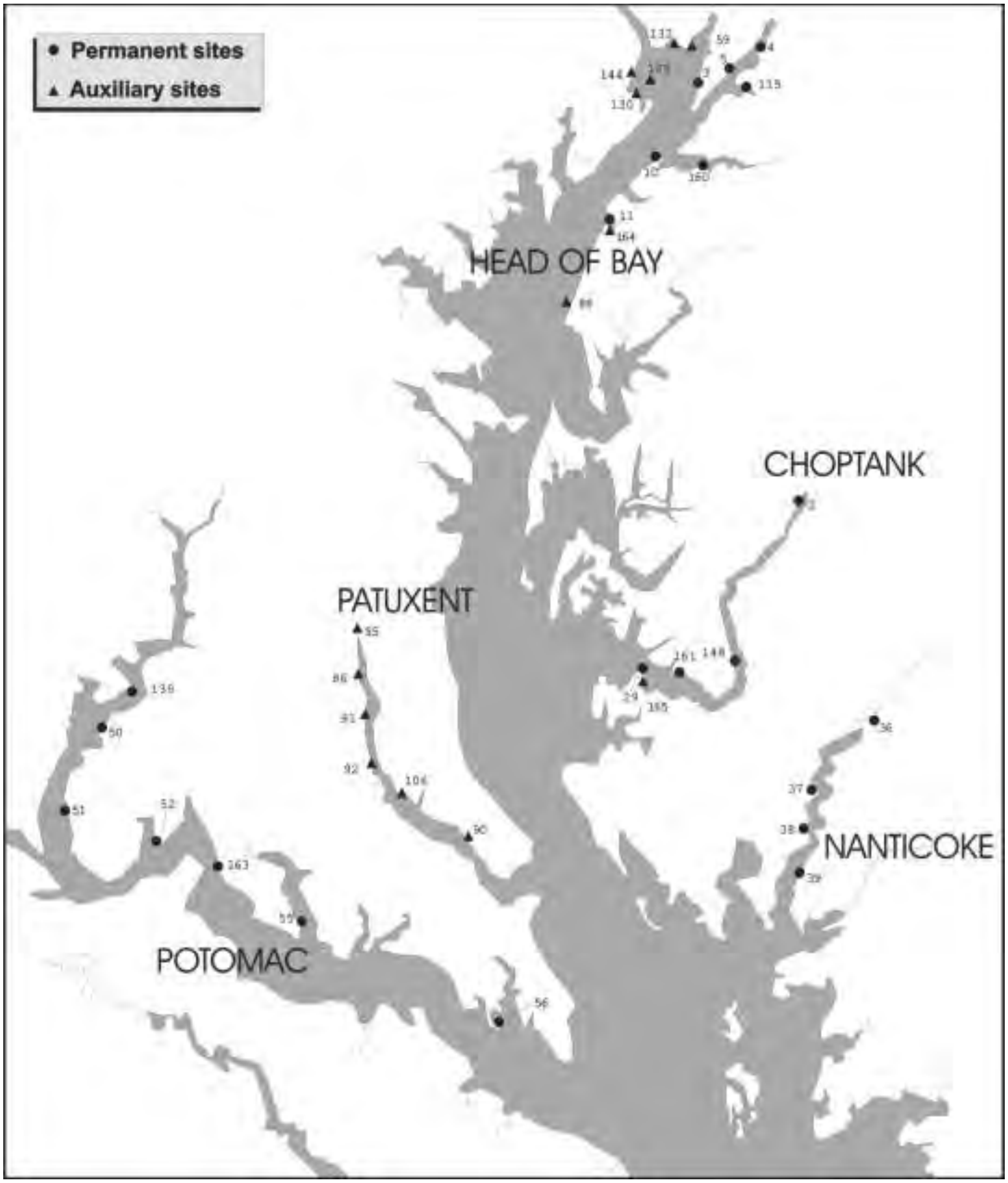
Auxiliary stations have been sampled on an inconsistent basis and were not included in survey indices. These data enhance geographical coverage in rivers with permanent stations or provide information from other river systems. They are also useful for replacement of permanent stations when necessary. Replicate hauls at auxiliary stations were discontinued in 1992 to conserve time and allow increased geographical coverage of spawning areas. Auxiliary stations were sampled at the Head of Bay (Susquehanna Flats and one downstream station) and the Patuxent River (Figure 1).

A 30.5-m x 1.24-m bagless beach seine of untreated 6.4-mm bar mesh was set by hand. One end was held on shore while the other was fully stretched perpendicular from the beach and swept with the current. Ideally, the area swept was equivalent to a 729 m^2 quadrant. When depths of 1.6-m or greater were encountered, the offshore end was deployed along this depth contour. An estimate of distance from the beach to this depth was recorded.

Striped bass and selected other species were separated into 0 and 1+ age groupings. Ages were assigned from length-frequencies and verified through scale examination. Age 0 fish were measured (mm total length) from a random sample of up to 30 individuals per site and round. All other finfish were identified to species and counted.

Additional data were collected at each site and sample round. These included: time of first haul, maximum distance from shore, weather, maximum depth, surface water temperature (^{o}C), tide stage, surface salinity (ppt), primary and secondary bottom substrates, and submerged aquatic vegetation within the sample area (ranked by quartiles). Dissolved oxygen (DO), pH, and turbidity (Secchi disk) were added in 1997.

Figure 1. Maryland Chesapeake Bay juvenile striped bass survey site locations.



10.6 Marine and estuarine finfish ecological and habitat investigations

Project F-63-R, Marine and Estuarine Finfish Ecological and Habitat Investigations, was created in 2010. It existed as separate a Job in the Chesapeake Bay Finfish/Habitat Interactions Project during 2003-2009. Activities are aimed at defining the impact of development and other human activities on target fish species populations and habitats. Activities consist of spring stream anadromous fish icthyoplankton collections, spring yellow perch larval presence-absence sampling, and sampling of summer estuarine fish communities. Multiple systems have been surveyed during March-September, 2003-2011 (Figure 1). A subset of subestuaries have been sampled each year, depending on need for information. Target finfish consist of anadromous (American shad, alewife herring, blueback herring, striped bass), estuarine (white perch, yellow perch), marine migrant (Atlantic menhaden and spot), and fresh-tidal forage species (spottail shiner, silvery minnow, gizzard shad). These species are or were common enough to support recreational fisheries directly or through their role as abundant forage. Habitat loss and alteration have been cited as potential causes of declines in some of these species and their recovery could be limited by habitat suitability.

Yellow perch larvae are sampled twice a week in several sub-estuaries during March-April. Towed 0.5 m conical plankton nets collect larvae at up to 10 sites per system 2 days each week in the upper tidal portion of these estuaries. Up to eight systems have been sampled in a year. Samples are generally processed in the field for presence or absence of larvae, but some composite samples are held for larval gut analysis and RNA to DNA ratios.

Maryland DNR inventoried its anadromous fish spawning streams in the 1970s-1980s. These surveys have been repeated since 2003 in Severn, South, Magothy, Bush, and Corsica rivers and Langford, Mattawoman, Nanjemoy, and Piscataway creeks (1-3 systems per year) using citizen volunteers overseen by DNR professionals. The main task of this effort is to sample historical sites with historically consistent techniques to determine intensity of spawning of anadromous fish. Ichthyoplankton samples were collected at each site using stream drift nets constructed of 360-micron mesh material, attached to a square frame with a 300 • 460 mm opening. Nets were placed in the stream for five minutes with the opening facing upstream. The nets were then retrieved and rinsed in the stream and preserved with formalin. Sorting occurred in the laboratory. Small wire traps were set in some streams in some years to collect adult anadromous fish.

Trawling and seining are used to sample juvenile and adult fish during July-September. Up to four evenly spaced sample sites are located in the upper two-thirds of each tributary. Sites are not located near the subestuary's mouth to reduce influence of Bay waters on measurements of watershed water quality. Sites on a subestuary are sampled once every two weeks.

A 4.9 m semi-balloon otter trawl is used to sample fish in the mid-channel bottom habitat. The trawl is constructed of treated nylon mesh netting measuring 38 mm stretch-mesh in the body and 33 mm stretch-mesh in the codend, with an untreated 12 mm stretch-mesh knotless mesh liner. The headrope is equipped with floats and the footrope is equipped with a 3.2 mm chain. The net uses 0.61 m long by 0.30 m high trawl doors attached to a 6.1 m bridle leading to a 24.4 m towrope. Trawls are towed in the same direction as the tide. The trawl is set up tide to pass the site halfway through the tow, allowing the same general area to be sampled regardless of tide direction. A single tow is made for six minutes at 3.2 km / hr (2.0 miles / hr) per site on each visit. The contents of the trawl are emptied into a tub for processing.

An untreated 30.5 m • 1.2 m bagless knotted 6.4 mm stretch mesh beach seine, the standard gear for Bay inshore fish surveys, is used to sample inshore habitat of subestuaries. Seine sites are located in the same vicinity as trawl sites. The float-line is rigged with 38.1 mm by 66 mm floats spaced at 0.61 m intervals and the lead-line rigged with 57 gm lead weights spaced evenly at 0.55 m intervals. One end of the seine is held on shore, while the other is stretched perpendicular to shore as far as depth permits and is then pulled with the tide in a quarter-arc. The open end of the net is moved towards shore once the net is stretched to its maximum. When both ends of the net are on shore, the net is retrieved by hand in a diminishing arc until the net is entirely pursed. The section of the net containing the fish is then placed in a washtub for processing. All fish captured are identified to species and counted. Striped bass and yellow perch were separated into juveniles and adults.

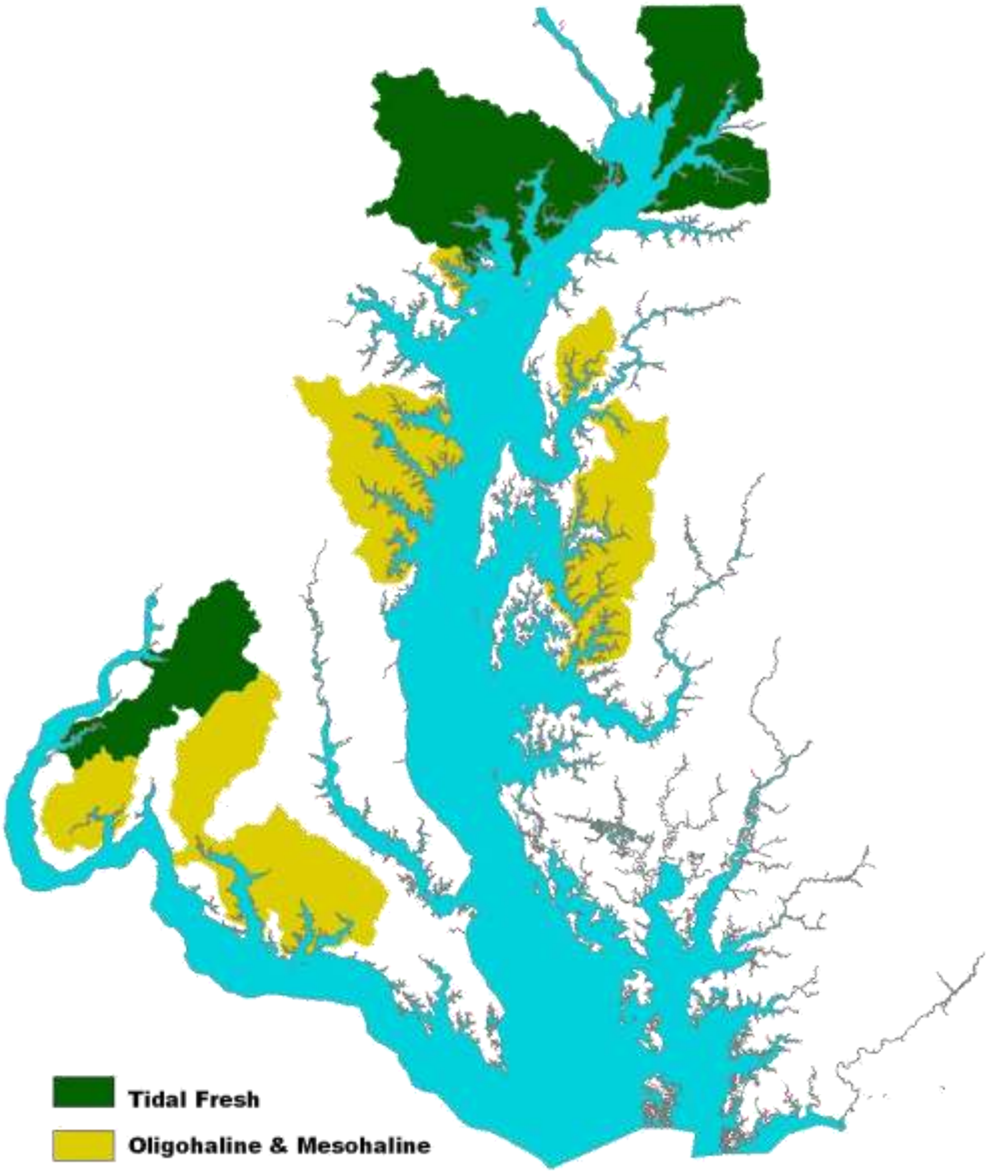


Figure 1. Watersheds and subestuaries sampled by Project F-63-R during 2003-2011.

10.7 Health investigations of striped bass and other fishes in Maryland waters

10.7.1Mycobacteriosis in striped bass resident to Chesapeake Bay

The DNR Fish & Wildlife Health Program (FWHP) collect striped bass annually using fishing charter boats, commercial pound nets and beach seine (Table 1). Fishing charters target resident striped bass based on the time year chosen to sample, type of lures or bait used and method of angling. Angling by-catch is almost exclusively bluefish and croaker. Striped bass are sub-sampled from commercial pound nets concomitant with striped bass stock assessment surveys. Young-of year striped bass are targeted by beach seining in the fall at select sites. Seine by-catch consists of a variety of small fishes including mummichogs, killifish, anchovies, Atlantic menhaden, white perch, croaker and others.

Table 1.

Region	Technique	Frequency*	Target
Upper Bay[1]	Hook-and-line	5 cruises	1-5 year old fish
	Pound net	3 nets	1-5 year old fish
	Beach seine	3 sites	YOY fish
Middle Bay[2]	Hook-and-line	5 cruises	1-5 year old fish
	Pound net	3 nets	1-5 year old fish
	Beach seine	3 sites	YOY fish
Lower Bay[3]	Hook-and-line	5 cruises	1-5 year old fish
	Pound net	3 nets	1-5 year old fish
	Beach seine	3 sites	YOY fish

*Number of cruises or sampling trips during June-November.

[1] Above Bay Bridge

[2] Between Cove Point and Bay Bridge

[3] South of Cove Point

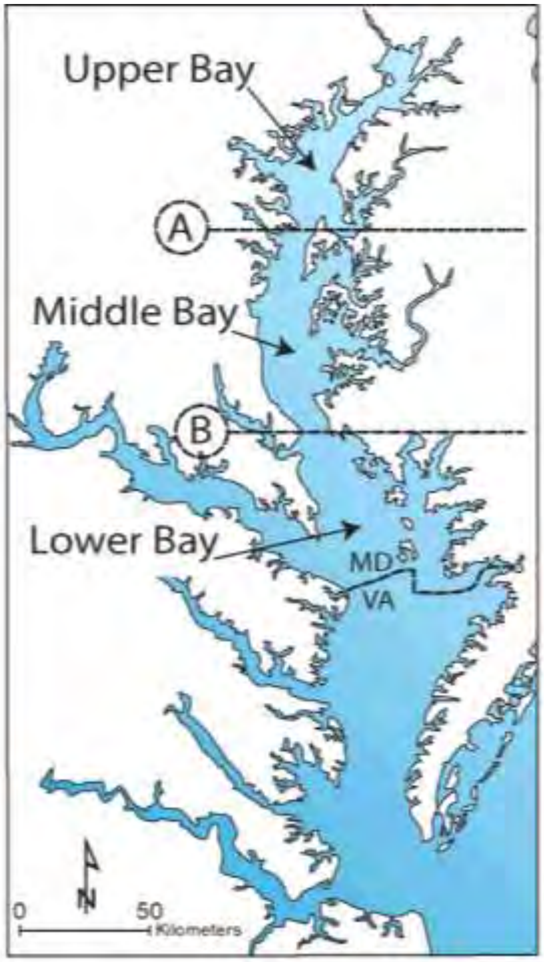


Figure 1. Regions of Striped bass collected from Maryland's Chesapeake Bay, 2011.
Regions are demarcated by Bay Bridge (A), Cove Point (B) and the VA/MD state line.

10.7.2 Fish Disease Diagnostics

Investigation of the morbidity/mortality events is responsive in nature. Fish health events are reported to either Maryland Department of the Environment, Fish Kill Investigation Unit (MDE), or Maryland Department of Natural Resources, Fish and Wildlife Health Project (DNR). Once the information is received, MDE or DNR initiate an investigation. Biologists proceed as soon as possible to the site of the fish-kill event and determine the scope and magnitude of the event, including a preliminary assessment of the environmental and physical conditions. This may include measurement of water quality parameters, detection of unusual conditions such as discoloration of the water or presence of noxious odors, location of the source or the area of the event, and estimation of the number of dead fish by conducting transects. Based on the initial investigation the biologist collects all pertinent samples for diagnostics such as water (algal composition and contaminants), fish samples (microbiology, parasites, histopathology, tissue contaminants), and other samples as warranted. Following the initial assessment, the biologist will attempt to collect moribund and seemingly healthy fish from the affected area if possible. Collection techniques to sample for moribund fish include bottom trawl, trot-line, hook-and-line, cast net, and beach seine. Sampling may be repeated 1-3 times over a period of days to weeks following the initial investigation. Fish-kill events resulting from contaminant spills or other activities that violate state or local laws are referred to the MDE compliance office and local jurisdictions and Department of Health are notified.

11.0 Virginia

The Virginia Department of Game and Inland Fisheries used the Dingell-Johnson funds to carry out four projects: Tidal River Fish Community Monitoring; Tidal River Catfish Surveys; American Shad Restoration Brood Stock Collection; and, Northern Snakehead Monitoring in Virginia.

11.1 Tidal River Fish Community Monitoring

The Virginia Department of Game and Inland Fisheries (VDGIF) conducts boat electrofishing surveys in tidal fresh-oligohaline reaches of Virginia tidal systems, assessing status and trends in fish species assemblage and, monitoring population parameters of recreationally important species. Results of this work inform development and implementation of science-based fisheries management strategies. The VDGIF began its fisheries survey work on Virginia tidal systems with an intensive, and extensive, boat electrofishing survey in the York drainage in 1990, sampling reaches of the Pamunkey River and Mattaponi River (Table 1). This effort was followed by an extensive seasonal baseline survey of the tidal Chickahominy system in 1994 – 1995, and a subsequent two year seasonal survey of the mainstem tidal James River and its tidal tributaries outside the Chickahominy sub-watershed during 1998 – 1999. Additional ad hoc boat electrofishing occurred on the James and York systems throughout the 1990s.

Current survey methodology is based on a stratified-random fixed station survey design. Sampling is conducted in the fall (generally October through mid-November) along shorelines and in shallow water habitat of rivers (Chickahominy, James, Mattaponi, Pamunkey, Piankatank, and Rappahannock) and their major tidal tributaries (Figure 1). Water depth at sample sites is generally 1 – 1.25 meters and never exceeds 2 meters. Effort consists of a single electrofishing run per station. With the exception of the tidal Rappahannock system, standard run time is 1000 seconds/run. Otoliths are collected from a random subsample to assess age and growth of recreationally important species such as largemouth bass and black crappie. Otolith sampling schedules in a given system for a given species are at the lead biologist's discretion.

Time series under current survey design are as follows: 1998 – present for the tidal James system, 2000 – present for the tidal Chickahominy, 2003 – present for the York (Mattaponi and Pamunkey), and 2004 – present for the tidal Rappahannock system.

11.2 Tidal River Catfish Surveys

In the period 1993 – present, low frequency (LF) electrofishing techniques have been used to sample catfish species (primarily introduced blue catfish and channel catfish, and native white catfish) in tidal fresh-oligohaline sections of four Virginia tidal river systems: the James, Pamunkey, Piankatank, Mattaponi, and Rappahannock (Figure 2). Since 2001, survey methodology has been standardized to the following protocol. Sampling is conducted in the late July–August timeframe, and occurs at fixed stations – either where the river channel cuts close to shoreline structure or where submerged structure (e.g., sunken boats and barges) occurs within or adjacent to the channel. Channel depth at sample locations is generally at least 6 meters. Effort consists of a single LF (15 pulses per second) electrofishing run per station. Since 2003 effort has been standardized to 600 seconds per run. Not all rivers are surveyed each year, and, in any given survey, some stations may be omitted. Sampling consists of two netters on the front of an electrofishing boat, and two netters on a chase boat, who attempt to maximize catch of catfish species that surface during these efforts. Additional netters assist in capture of unusually large fish (≈ ≥ 20 kg). In the years since 2002, otoliths have been collected from blue catfish for age and growth analyses. During 2002–2004, otoliths were collected based on a number of fish per cm-group sub-sampling strategy. Since 2004, otoliths have been collected from large random sub-samples of fish, stratified based on length, with larger size-groups being more intensively sampled in an effort to adequately sample older age-classes.

Since 2007, LF electrofishing has been used to conduct targeted sampling of flathead catfish in the tidal upper reaches of the James River (Figure 3), with the goal of assessing trends in this expanding introduced population. Survey methodology is as above, including the use of otoliths for age and growth analyses, except this sampling effort is conducted in June and station location is not fixed – efforts are ongoing through exploratory sampling to select sites for incorporation into an eventual fixed station design.

11.3 American Shad Restoration

The VDGIF American shad restoration efforts involve three main activities: 1) brood fish/egg collection operations on the Pamunkey and Potomac rivers; 2) intensive hatchery rearing, tagging, and stocking efforts on the James and Rappahannock rivers, as well as on the Pamunkey and Potomac rivers for mitigation; and 3) monitoring adult shad spring spawning runs to determine relative abundance of hatchery fish in these runs, relative run strength, and age composition.

Production goals are to annually stock the Rappahannock and James river systems with a minimum of 5 million and 7 million oxytetracycline (OTC) tagged shad fry, respectively, and to annually stock 1 million American shad fry into the Pamunkey and Potomac river systems as mitigation for using brood stock from these systems for stocking the James and Rappahannock rivers. Early brood fish and egg collections efforts (1992-1993) focused on the James River; however, not enough spawning adults could be collected to support hatchery operations. Following protocol established during the striped bass restoration effort in the 1980's, the closest river system to the James that could supply American shad eggs was chosen to support hatchery operations. That river was the Pamunkey, a tributary of the York River. Since 1994, VDGIF has contracted with skilled watermen to collect spawning adult shad (brood fish) from the Pamunkey at Rockahock Bar (Figure 4). Watermen set 5 ¼ - 5 ¾ inch mesh floating gillnets on a slack tide just before or following sunset. Once collected, the brood fish are artificially spawned and fertilized eggs are sent to hatcheries. The shad fry are held for about 4 to 7 days and their otoliths are marked with OTC. The OTC mark(s) are used as a tag to identify hatchery fish in the wild. Similar protocol is being followed for the Rappahannock River stockings by using the Potomac River as a source of brood fish for egg collection. Brood fish from the Potomac are collected off Fort Belvoir (Figure 4). Timing of brood collection is water temperature dependant, but efforts on the Pamunkey can run from late March – May, and efforts on the Potomac typically run from early April – May. After being tagged, the fry are released into the James or Rappahannock rivers for restoration and into the Pamunkey and Potomac rivers as mitigation for brood fish losses. On average, 1,800 to 2,200 adult shad are needed annually to achieve fry stocking goals for both restoration efforts. Fry stocking locations in the James River system are primarily above Bosher's Dam at six locations, as well as in the Appomattox, Rivanna, and Slate rivers. These locations cover a 122 RKM section of the mainstem and extend as far west as Bent Creek, 51RKM upstream from Lynchburg, Virginia. Stockings on the Rappahannock River system occur at Kelly's Ford Boat Landing near the Town of Remington and in the Hazel River. The Pamunkey River is stocked at one location in the tidal portion of the river, and the Potomac River system is stocked at Pohick Bay and in the tidal portion at of the Occoquan River.

Stocking success and population status is being evaluated by monitoring adult shad each spring during their spawning runs in the James, Rappahannock, and York (Appendix A). Otoliths and biological information are being collected from a sub-sample of adults during this effort as well as from a subsample of brood fish. Adult monitoring efforts on the James River and Rappahannock River are conducted using boat electrofishing in the vicinity of the fall line, on the Rappahannock this occurs in the near Fredericksburg, Virginia and on the James this occurs in Richmond, Virginia. OTC analysis of otoliths from these fish is used to determine the hatchery contribution to these spawning populations. VDGIF and USFWS personnel coordinate and conduct egg taking and hatchery operations, as well as programs associated with hatchery product evaluations.

11.4 Northern Snakehead Monitoring in Virginia

Following a period of intensive survey work to identify the range extent of northern snakeheads in Virginia tributaries of the Potomac River, the VDGIF developed a standard sampling regime which, since 2004, includes twice monthly sampling of tributaries known to hold reproducing adult snakeheads. On each of these twice monthly monitoring events 6,000 seconds of electrofishing effort is expended – exclusively in shallow water habitats (< 1 m water depth). This standardized sampling regime is primarily directed at tributaries from Little Hunting Creek downstream to Aquia Creek (Figure 5). To document range expansion, additional electrofishing effort has been expended periodically in fresh-mesohaline reaches in lower tributaries of the Potomac. In coming years, this effort is expected to expand to headwaters of the Great Wicomico, lower tributaries of the Rappahannock, and Dragon Run/Swamp in the Piankatank drainage.

Table 1. Summary of boat electrofishing sampling to monitor trends in fish assemblage and population parameters of important recreational species in Virginia tidal rivers and major tributaries.

Tidal River System	Year	Runs	Effort (s)	Effort (hrs)	Atlantic Sturgeon	Shortnose Sturgeon	Sea Turtles
Chickahominy	1994	10	16,354	4.5	0	0	0
	1996	1	3,436	1.0	0	0	0
	1997	4	4,565	1.3	0	0	0
	2001	11	13,653	3.8	0	0	0
	2006	3	1,800	0.5	0	0	0

	Total	**29**	**39,808**	**11**	**0**	**0**	**0**
James	1993	1	1,280	0.4	0	0	0
	1994	2	7,515	2.1	0	0	0
	1995	11	11,993	3.3	0	0	0
	1996	15	21,561	6.0	0	0	0
	1997	11	18,424	5.1	0	0	0
	1998	6	6,366	1.8	0	0	0
	1999	8	20,951	5.8	0	0	0
	2001	21	19,758	5.5	0	0	0
	2002	13	10,423	2.9	0	0	0
	2004	7	4,200	1.2	0	0	0
	2006	16	11,611	3.2	0	0	0
	2007	5	4,650	1.3	0	0	0
	2008	15	8,100	2.3	0	0	0
	2010	13	7,800	2.2	0	0	0
	2011	11	7,492	2.1	0	0	0
	Total	**155**	**162,124**	**45**	**0**	**0**	**0**
Piankatank	2000	3	11,386	3.2	0	0	0
	2003	7	5,800	1.6	0	0	0
	2004	4	10,094	2.8	0	0	0
	2005	3	2,400	0.7	0	0	0
	2006	1	1,300	0.4	0	0	0
Piankatank	2007	2	1,600	0.4	0	0	0
	2010	1	1,200	0.3	0	0	0
	2011	3	2,100	0.6	0	0	0
	Total	**24**	**35,880**	**10**	**0**	**0**	**0**

Table 1 continued.

Rappahannock	2000	16	24,026	6.7	0	0	0
	2001	20	19,127	5.3	0	0	0
	2002	9	6,162	1.7	0	0	0
	2004	7	8,800	2.4	0	0	0
	2005	7	4,200	1.2	0	0	0
	2007	6	3,600	1.0	0	0	0
	2009	8	4,800	1.3	0	0	0
	2011	13	7,800	2.2	0	0	0
	Total	**86**	**78,515**	**22**	**0**	**0**	**0**
York	1999	14	15,873	4.4	0	0	0
	2000	26	34,553	9.6	0	0	0
	2002	26	17,600	4.9	0	0	0
	2003	24	16,200	4.5	0	0	0
	2004	11	8,980	2.5	0	0	0
	2005	7	4,200	1.2	0	0	0
	2006	18	10,500	2.9	0	0	0
	2008	27	15,600	4.3	0	0	0
	2010	12	7,000	1.9	0	0	0
	2011	8	4,800	1.3	0	0	0
	Total	**173**	**135,306**	**38**	**0**	**0**	**0**
Grand Total		**467**	**451,633**	**125**	**0**	**0**	**0**

Table 2. Summary of specialized, low frequency, electrofishing sampling targeting catfish species in Virginia tidal rivers and major tributaries.

Tidal River System	Year	Runs	Effort (s)	Effort (hrs)	Atlantic Sturgeon	Shortnose Sturgeon	Sea Turtles
Chickahominy	1994	50	73,741	20.5	0	0	0
	1995	32	54,702	15.2	0	0	0
	1996	3	7,850	2.2	0	0	0
	1997	2	6,811	1.9	0	0	0
	2000	20	35,721	9.9	0	0	0
	2001	55	90,857	25.2	0	0	0
	2002	19	20,400	5.7	0	0	0
	2003	27	30,000	8.3	0	0	0
	2004	14	17,160	4.8	0	0	0
	2005	16	16,186	4.5	0	0	0
	2006	31	31,700	8.8	0	0	0
	2007	32	29,300	8.1	0	0	0
	2008	30	27,800	7.7	0	0	0
	2009	14	14,000	3.9	0	0	0
	2010	10	9,000	2.5	0	0	0
	2011	18	17,500	4.9	0	0	0
	Total	373	482,728	134	0	0	0
James	1994	4	6,995	1.9	0	0	0
	1995	6	10,566	2.9	0	0	0
	1996	22	66,570	18.5	0	0	0
	1997	7	16,554	4.6	0	0	0
	1998	153	223,725	62.1	0	0	0
	1999	51	82,019	22.8	0	0	0
	2000	4	8,223	2.3	0	0	0
	2001	36	50,536	14.0	0	0	0
	2002	22	24,104	6.7	0	0	0
	2003	31	35,917	10.0	0	0	0
	2004	15	17,910	5.0	0	0	0
	2005	16	15,888	4.4	0	0	0
	2006	19	18,800	5.2	0	0	0
	2007	17	17,000	4.7	0	0	0
	2008	20	19,765	5.5	0	0	0
	2009	32	32,000	8.9	0	0	0
	2011	21	21,000	5.8	0	0	0
	Total	476	667,572	185	0	0	0

Table 2 continued.

Rappahannock	2000	5	9,178	2.5	0	0	0
	2001	5	3,611	1.0	0	0	0
	2002	6	4,700	1.3	0	0	0
	2004	32	52,400	14.6	0	0	0
	2005	38	54,224	15.1	0	0	0
	2006	34	48,188	13.4	0	0	0
	2007	36	52,680	14.6	0	0	0
	2008	22	39,800	11.1	0	0	0
	2009	39	55,100	15.3	0	0	0
	2011	41	56,400	15.7	0	0	0
	Total	258	376,281	105	0	0	0
York	1990	46	55,731	15.5	0	0	0
	1994	6	20,214	5.6	0	0	0
	1995	4	10,545	2.9	0	0	0
	1998	1	7,000	1.9	0	0	0
	1999	8	59,414	16.5	0	0	0
	2003	1	1,200	0.3	0	0	0
	2004	37	43,900	12.2	0	0	0
	2006	37	41,704	11.6	0	0	0
	2007	26	31,200	8.7	0	0	0
	2008	17	17,000	4.7	0	0	0
	2009	16	16,000	4.4	0	0	0
	2010	9	9,000	2.5	0	0	0
	2011	9	9,000	2.5	0	0	0
	Total	217	321,908	89	0	0	0
Grand Total		**1,301**	**1,797,009**	**499**	**0**	**0**	**0**

Table 3. Summary of American shad brood collection activities in the tidal Pamunkey River and Potomac River.

River	Year(s)	Average Nights / Year	Estimated Nights in Time Series	Average Net Sets / Night	Average Net Sets / Year	Approximate Total Net Sets in Time Series
Pamunkey	1994 - 2008	32	480	16	512	7,680
Pamunkey	2009	20	20	6	120	120
Pamunkey	2010	17	17	8	136	136
Pamunkey	2011	14	14	8	112	112
Pamunkey	2012	22	22	8	176	176
Potomac	2003 - 2012	16	160	4	64	640

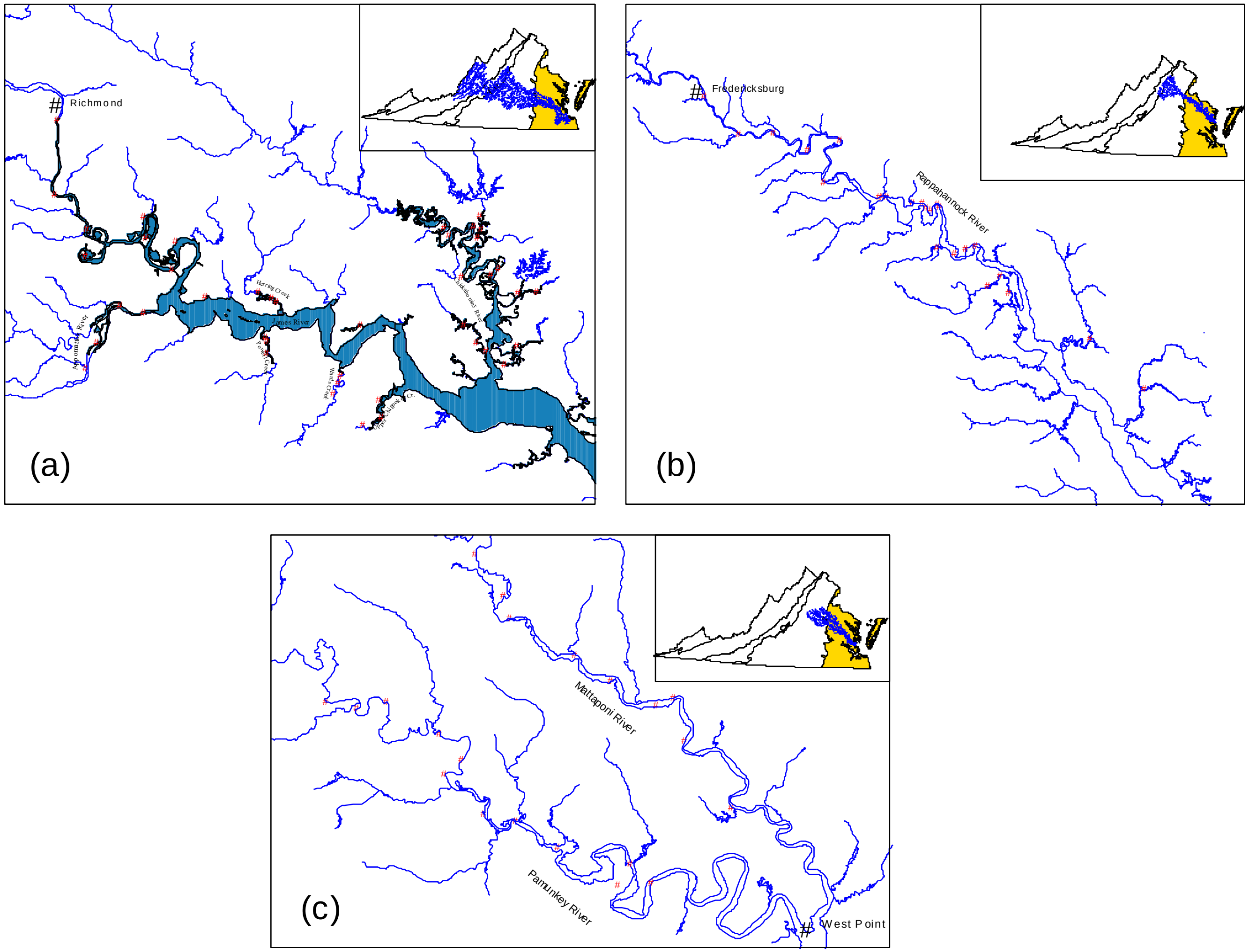


Figure 1. Fall boat electrofishing sites for monitoring fish assemblages and recreationally important species in the James River (a), Rappahannock River (b), and York River systems.

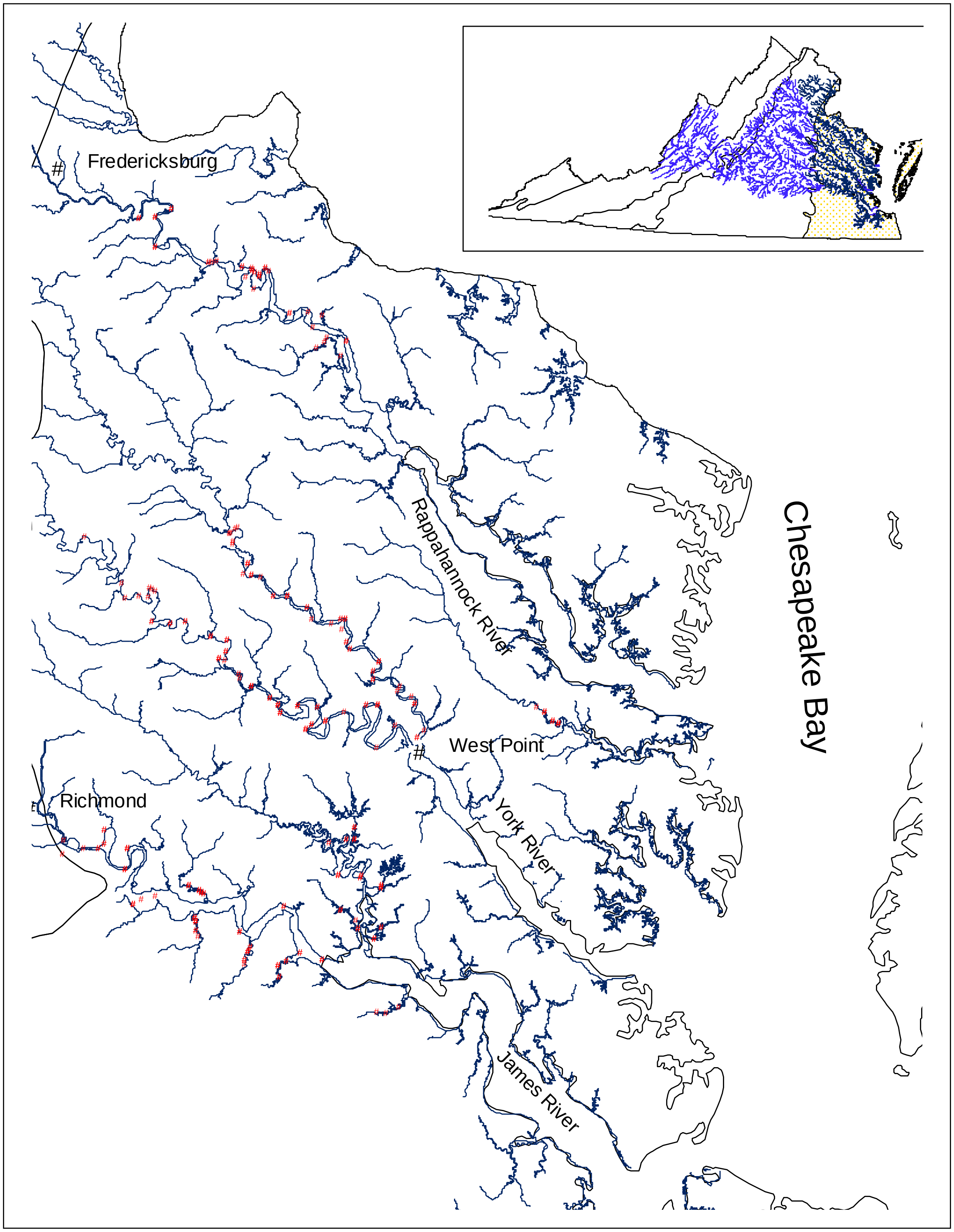


Figure 2. Map of stations sampled during low frequency (15 pulses per second) electrofishing surveys of catfish species in Virginia tidal river systems.

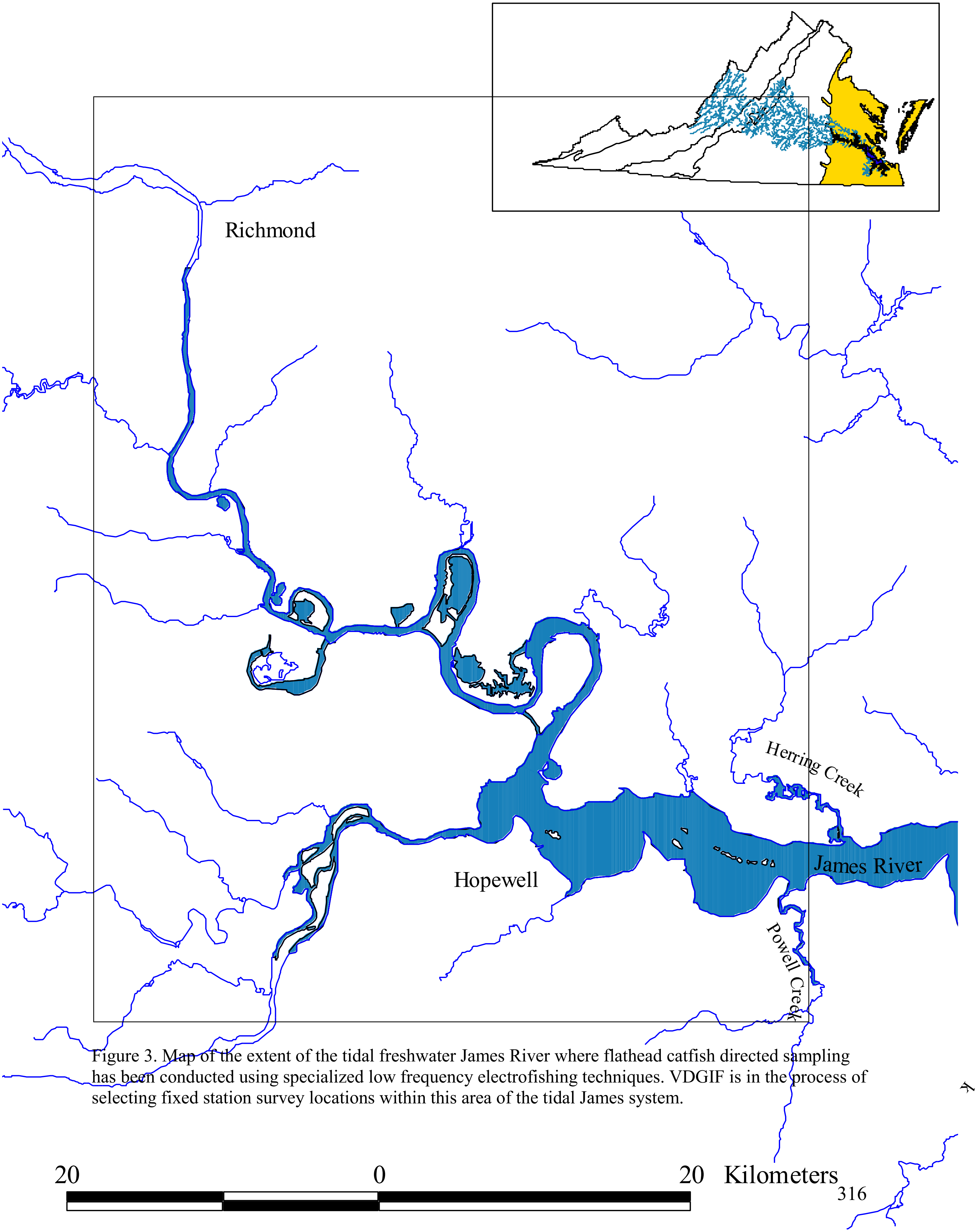


Figure 3. Map of the extent of the tidal freshwater James River where flathead catfish directed sampling has been conducted using specialized low frequency electrofishing techniques. VDGIF is in the process of selecting fixed station survey locations within this area of the tidal James system.

a.

b.

Figure 4. Collection locations for American shad brood fish from the Pamunkey (a) and the Potomac (b).

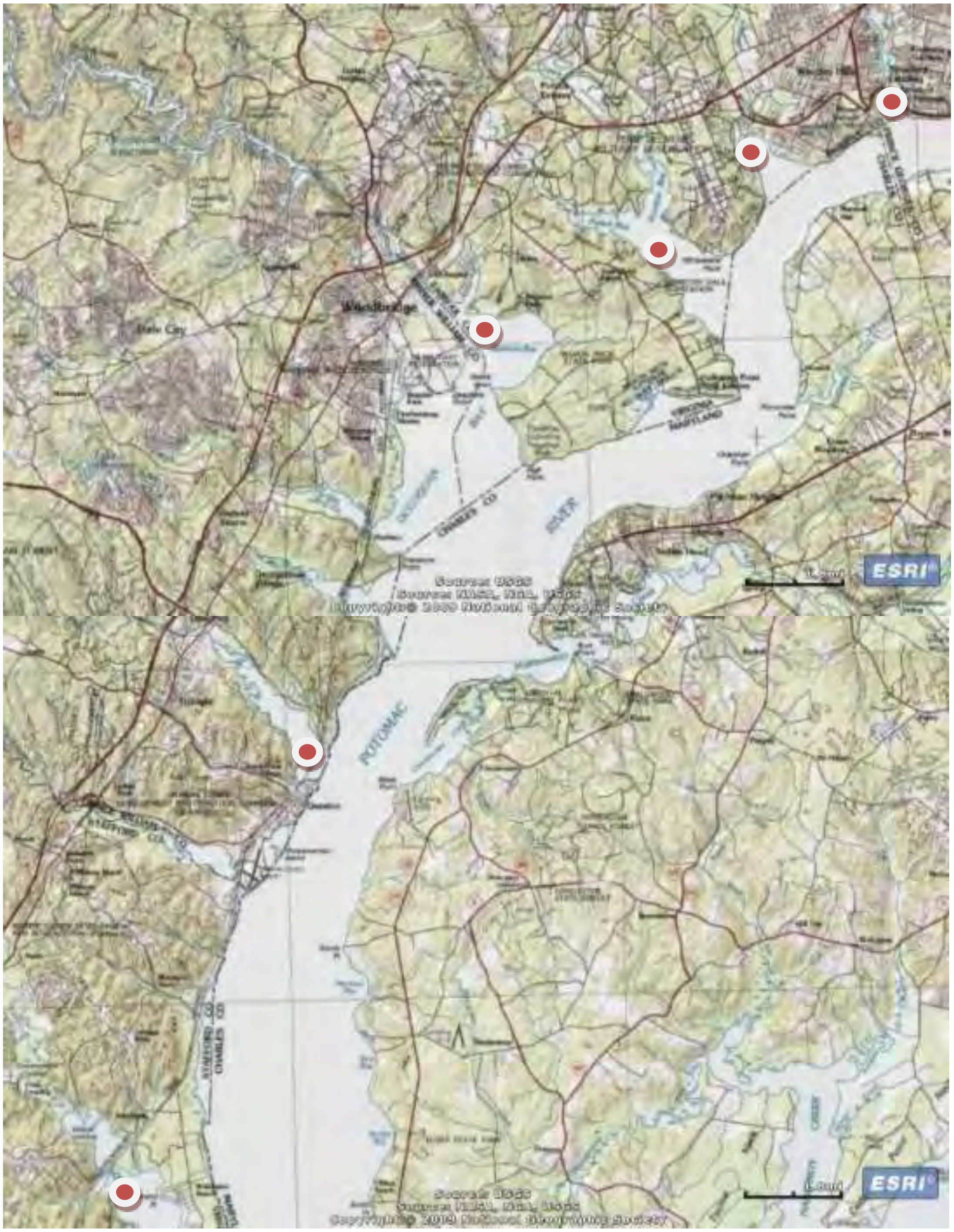


Figure 5. Map of Virginia tributaries from Little Hunting Creek downstream to Aquia Creek where boat electrofishing has been used to regularly monitor an introduced northern snakehead population.

Appendix A. Summary of spring electrofishing monitoring for adult American shad in the James River, Rappahannock River, and York River systems.

River	Year	Runs	Effort (s)	Effort (hrs)	Atlantic Sturgeon	Shortnose Sturgeon	Sea Turtles
Appomattox River	1995	4	3300	0.92	0	0	0
Appomattox River	1996	4	8472	2.35	0	0	0
Appomattox River	1997	11	7255	2.02	0	0	0
Appomattox River	1998	6	4943	1.37	0	0	0
Appomattox River	1999	5	4494	1.25	0	0	0
Appomattox River	2000	17	10970	3.05	0	0	0
Appomattox River	2001	27	20797	5.78	0	0	0
Appomattox River	2002	25	12675	3.52	0	0	0
Appomattox River	2003	3	1696	0.47	0	0	0
Appomattox River	2004	11	5680	1.58	0	0	0
Appomattox River	2005	9	6704	1.86	0	0	0
Appomattox River	2006	3	2300	0.64	0	0	0
Appomattox River	2007	10	6205	1.72	0	0	0
Appomattox River	2009	4	2550	0.71	0	0	0
Appomattox River	2010	10	7100	1.97	0	0	0
Chickahominy River	1999	1	222	0.06	0	0	0
Chickahominy River	2000	1	425	0.12	0	0	0
Chickahominy River	2001	2	1814	0.50	0	0	0
Chickahominy River	2007	2	2400	0.67	0	0	0
Chickahominy River	2008	3	2700	0.75	0	0	0
James River	1994	4	6677	1.85	0	0	0
James River	1995	18	10084	2.80	0	0	0
James River	1996	8	7181	1.99	0	0	0
James River	1997	1	500	0.14	0	0	0
James River	1999	6	3874	1.08	0	0	0
James River	2000	21	16551	4.60	0	0	0
James River	2001	9	6950	1.93	0	0	0
James River	2002	108	51050	14.18	0	0	0
James River	2002	1	600	0.17	0	0	0
James River	2003	67	42154	11.71	0	0	0
James River	2004	96	56477	15.69	0	0	0
James River	2005	98	56815	15.78	0	0	0
James River	2006	131	74477	20.69	0	0	0
James River	2007	107	59050	16.40	0	0	0
James River	2008	119	73560	20.43	0	0	0
James River	2009	102	56650	15.74	0	0	0
James River	2010	101	52650	14.63	0	0	0
Mattaponi River	2000	5	5456	1.52	0	0	0
Mattaponi River	2001	4	3600	1.00	0	0	0

Appendix A continued

Mattaponi River	2002	3	2700	0.75	0	0	0
Mattaponi River	2004	6	5400	1.50	0	0	0
Mattaponi River	2005	3	2700	0.75	0	0	0
Mattaponi River	2006	8	7200	2.00	0	0	0
Mattaponi River	2006	1	300	0.08	0	0	0
Mattaponi River	2007	9	8100	2.25	0	0	0
Mattaponi River	2008	3	2700	0.75	0	0	0
Mattaponi River	2009	3	2700	0.75	0	0	0
Mattaponi River	2010	6	5400	1.50	0	0	0
North Anna River	2001	1	1000	0.28	0	0	0
North Anna River	2004	3	1982	0.55	0	0	0
North Anna River	2005	4	3075	0.85	0	0	0
Pamunkey River	1998	1	900	0.25	0	0	0
Rapidan River	2007	3	3600	1.00	0	0	0
Rapidan River	2008	2	1725	0.48	0	0	0
Rapidan River	2009	1	900	0.25	0	0	0
Rapidan River	2010	1	800	0.22	0	0	0
Rappahannock River	1994	2	1366	0.38	0	0	0
Rappahannock River	1995	6	4379	1.22	0	0	0
Rappahannock River	1996	3	3004	0.83	0	0	0
Rappahannock River	1997	10	9392	2.61	0	0	0
Rappahannock River	1998	7	5564	1.55	0	0	0
Rappahannock River	1999	3	2577	0.72	0	0	0
Rappahannock River	2000	12	13867	3.85	0	0	0
Rappahannock River	2001	20	16769	4.66	0	0	0
Rappahannock River	2002	28	21947	6.10	0	0	0
Rappahannock River	2003	13	13400	3.72	0	0	0
Rappahannock River	2004	34	25871	7.19	0	0	0
Rappahannock River	2005	34	25851	7.18	0	0	0
Rappahannock River	2006	37	29674	8.24	0	0	0
Rappahannock River	2007	33	29300	8.14	0	0	0
Rappahannock River	2008	64	59318	16.48	0	0	0
Rappahannock River	2009	32	30034	8.34	0	0	0
Rappahannock River	2010	38	31100	8.64	0	0	0
Rivanna River	2004	1	750	0.21	0	0	0
South Anna River	1994	2	1651	0.46	0	0	0
South Anna River	1996	4	4354	1.21	0	0	0
South Anna River	1998	3	1635	0.45	0	0	0
South Anna River	1999	2	1955	0.54	0	0	0
South Anna River	2000	9	8032	2.23	0	0	0
South Anna River	2001	10	5557	1.54	0	0	0

Appendix A continued

South Anna River	2002	13	7135	1.98	0	0	0
South Anna River	2003	2	1800	0.50	0	0	0
South Anna River	2004	3	1475	0.41	0	0	0
South Anna River	2005	3	2430	0.68	0	0	0
South Anna River	2007	7	3900	1.08	0	0	0
South Anna River	2008	2	1600	0.44	0	0	0
South Anna River	2009	5	3900	1.08	0	0	0

11.5 American shad monitoring program

A moratorium on the taking of American shad in the Chesapeake Bay and its tributaries was established by the Virginia Marine Resources Commission (VMRC) beginning 1 January 1994. Concern about the decline in landings of American shad along the Atlantic coast generally prompted the development of an interstate fisheries management plan (FMP) under the auspices of the Atlantic States Marine Fisheries Management Program (ASMFC 1999). Legislation enables imposition of federal sanctions on fishing in those states that fail to comply with the FMP. To be in compliance, coastal states are required to implement and maintain fishery-dependent and fishery-independent monitoring programs as specified by the FMP. For Virginia, these requirements include spawning stock assessments, the collection of biological data on the spawning run (e.g., age-structure, sex ratio, and spawning history), estimation of total mortality, indices of juvenile abundance, biological characterization of permitted by-catch and evaluation of restoration programs by detection and enumeration of hatchery-released fish. The adult spawning stock monitoring program began in 1998 and consists of sampling techniques and locations that were consistent with, and directly comparable to, those that generated historical logbook data collected by VIMS during the period 1980-1992 in the York, James and Rappahannock rivers.

The primary objectives of the American shad monitoring program are: (1) to establish a time series of relative abundance indices of adult American shad during the spawning runs in the James, York and Rappahannock rivers; (2) to relate contemporary indices of abundance of American shad to historical logbook data collected during the period 1980-1992 and older data if available; (3) to assess the relative contribution of hatchery-reared and released cohorts of American shad to adult stocks; (4) to relate recruitment indices (young-of-the-year index of abundance) of American shad to relative year-class strength and age-structure of spawning adults.

One staked gillnet (SGN), 900 ft (approximately 274 m) in length, is set on the York and James rivers and one SGN, 912 ft (approximately 277 m) in length, is set on the Rappahannock River. Locations of the sets are consistent over the time series and are as follows: lower James River near the James River Bridge at river mile 10; middle York River near Clay Bank at river mile 14; and middle Rappahannock River near the Rappahannock River bridge (at Tappahannock, Virginia) at river mile 36. Each week during the spawning run (typically late February to early May), nets are fished on two succeeding days (two 24-h sets) and then hung in a non-fishing position until the next sampling episode. Surface water temperature and salinity are recorded at each sampling event. Catch data from each river are used to calculate a standardized catch index. The catch index, the duration of the run in days, the maximum daily catch rate in each year and the mean catch rate in each year were compared to summaries of historical logbook data to provide a measure of the relative size of the current shad runs. In 2011, annual fyke net sampling for juvenile American shad began on the York River. This juvenile sampling occurs between early June and late September. The sampling gear consists of five fyke nets constructed from ¼" Ace mesh. Each net includs four hoops, two throats, and one cab, with a 15.2 m leader and 7.6 m wings. Each fyke net is set for one day (24-h set) and after fishing each net was removed from the sampling site.

Adult American shad collected from the spawning stock monitoring sites are measured and weighed. Catches of all other species are recorded and enumerated on log sheets by observers on each river and released. Separate records are kept of the number of live and dead striped bass in the nets and released (if alive) or returned to the laboratory (if dead). Random subsamples of dead striped bass from each river were analyzed for sex, fork length and total weight. Sagittal otoliths are removed from samples of adult American shad, placed in numbered tissue culture trays, and stored for subsequent screening for hatchery marks. Scales for age determination are removed from a mid-lateral area on the left side posterior to the pectoral-fin base of each fish. For the juvenile sampling, all species present in the catch are identified and counted; all alosines are returned to the laboratory for further analysis. Individual juvenile alosines collected from monitoring stations are measured and weighed using the same equipment and guidelines as for adult fish. Sagittal otoliths from subsamples are removed and stored in individual collection vials for ageing and hatchery analysis. Otoliths are mounted on slides, then ground and polished by hand using wet laboratory-grade sandpaper. Daily ages are determined by counting daily incremental rings.

In 2009, VIMS American shad program personnel began tagging Atlantic sturgeons that were captured in good condition during this survey. All sturgeon are processed according to USFWS tagging protocols in the following manner: fork and total lengths (mm) are recorded, they are scanned for PIT tags. Fish without PIT tags present are tagged using T-Bar and PIT tags provided by the USFWS, fin clipped and then released alive (depending on specific circumstances, e.g., animal condition, only a subset of the above processing may take place). Note: VIMS would like to continue tagging Atlantic sturgeon during this project if possible.

11.6 Juvenile Fish Trawl Survey

The juvenile fish trawl survey conducted by VIMS is the oldest continuing monitoring program (56 years) for marine and estuarine fishes in the United States. This survey provides a monthly assessment of abundance of juvenile marine and estuarine fishes and crustaceans in the tidal rivers and main stem of Chesapeake Bay.

We use a 30' (9.14m) semi-balloon otter trawl, with 1.5" (38.1mm) stretched mesh and 0.25" (6.35mm) cod-end liner, that is towed along the bottom for 5 minutes during daylight hours. Sampling in the Bay occurs monthly except during January and March, when few target species are available. Sampling in the tributaries also occurs monthly, at both the random stratified and historical fixed (mid-channel) stations. The stratification system is based on depth and latitudinal regions in the Bay, or depth and longitudinal regions in the rivers. Each Bay region spans 15 latitudinal minutes and consists of six strata: western and eastern shore shallow (4-12 ft), western and eastern shoal (12-30 ft), central plain (30- 42 ft), and deep channel (> 42 ft). Each tributary is partitioned into four regions of approximately ten longitudinal minutes, with four depth strata in each (4-12 ft, 12-30 ft, 30-42 ft, and > 42 ft; Figure 1). Strata are collapsed in areas where certain depths are limited. Fixed stations were assigned to a stratum according to their location and depth.

With the exception of the fixed river stations, trawling sites within strata are selected randomly from the National Ocean Service's Chesapeake Bay bathymetric grid, a database of depth records measured or calculated at 15-cartographic-second intervals. Between two and four trawling sites are randomly selected for each Bay stratum each month, and the number varies seasonally. Exceptions include the shallow water strata where only a single station is sampled each month. For most river strata, one to two random stations are selected per month. Sampling in the York River has been altered slightly as of 1991 to make the deeper depth strata (30 ft +) similar to those in the James and Rappahannock rivers and main stem Bay. The stratification scheme for the tributaries was modified in January 1996 to create separate depth strata of 30-42 ft and > 42 ft (Geer and Austin, 1996). Because tributary sampling had occurred at these depths prior to 1996, samples collected previously were reassigned to the new strata established in 1996.

Fixed stations were sampled monthly (nearly continuously) since 1980 with sites in each tributary spaced at approximately 5-mile intervals from the river mouth up to the freshwater interface. From the mid-1950's (York River) and early-1960's (James and Rappahannock rivers) to 1972, fixed stations were sampled monthly using an unlined 30' trawl (gear code 010). During 1973-79, semi-annual random stratified sampling was performed by the VIMS Ichthyology Department, while the VIMS Crustaceology Department continued monitoring the fixed tributary stations on a limited monthly basis (May - November). Area-based weightings for the tributaries were previously assigned by dividing each river into two approximately equal length ‘strata’ by assuming that the stations in each stratum were representative of the channel areas in those reaches (see Lowery and Geer, 2000). As of 1996, all three tributaries were sampled with a random stratified design; the fixed stations were assigned to a stratum based on location and depth. The current design (combined fixed and random stations) provides greater spatial coverage and a long-term historical reference.

At the completion of each tow, all fishes are identified to species, counted, and measured to the nearest millimeter fork length (FL), total length (TL), or total length centerline (TLC, black sea bass only). Species that have varying size ranges are measured and counted by size class and large catches of a particular species are randomly subsampled, measured, and the remaining unmeasured catch is counted. In instances of extremely large catches (e.g., bay anchovy), subsampling is performed volumetrically.

11.7 Juvenile Striped Bass Beach Seine Survey

The primary objective of the Virginia Institute of Marine Science juvenile striped bass survey is to monitor the relative annual recruitment success of juvenile striped bass in the major Virginia nursery areas of lower Chesapeake Bay. The U.S. Fish and Wildlife Service initially funded the survey from 1967 to 1971. Beginning in 1980, funds were provided by the National Marine

Fisheries Service under the Emergency Striped Bass Study program. Commencing with the 1989 annual survey, the work was jointly supported by Wallop-Breaux funds (Sport Fish Restoration Act), administered through the U.S. Fish and Wildlife Service, and the Virginia Marine Resources Commission.

Field sampling is conducted during five biweekly periods from mid-July through mid-September. During each round, seine hauls are conducted at 18 historical sites (index stations) and 21 auxiliary stations within the James, York and Rappahannock river systems. Auxiliary sites were added in 1989 to provide better geographic coverage, increase sample sizes within each river system, and to permit monitoring of trends in juvenile abundance within each river system. Such monitoring was desirable in light of increases in stock size and nursery ground expansion.

Collections are made by deploying a 100 ft (30.5 m) long, 4 ft (1.2 m) deep, 0.25 in (6.4 mm) mesh minnow seine perpendicular to the shoreline until either the net is fully extended or a depth of approximately 4 ft (1.2 m) is encountered and then pulling the offshore end down-current and back to the shore. During each round a single haul is made at each auxiliary station and duplicate hauls, with a 30-minute interlude, are made at each index station. Every fish collected during a haul is removed from the net and placed into water-filled buckets. All striped bass are measured to the nearest mm fork length and a sub-sample of up to 25 individuals is measured to the nearest mm fork length (or total length if appropriate) for all other species. At index stations, fish collected during the first haul are held until the second haul was completed. All captured fish, except those preserved for life history studies, are returned to the water at the conclusion of sampling.

At each sampling location sampling time, tidal stage and weather conditions are recorded for each haul. Salinity, water temperature and dissolved oxygen concentrations are measured after the first haul using a YSI water quality sampler.

11.8 Chesapeake Bay Multispecies Monitoring and Assessment Program (ChesMMAP)

The ChesMMAP survey conducts five research cruises annually (March, May, July, September, November) throughout the main stem of Chesapeake Bay. During each cruise, up to 80 sites are sampled according to a stratified random design.

Each tow is made using a 13.7m (headrope length), 4-seam, semi-balloon bottom trawl net that is constructed of 152mm stretch mesh in the wings and body and 76mm stretch mesh in the cod-end. At each sampling site, this gear is towed along the bottom for 20 minutes at approximately 3.0 knots and in the same general direction as the prevailing current. Sampling locations are selected using a stratified random design prior to each cruise and the order in which sites are sampled depends on weather, tides, and other logistical considerations.

At each sampling site, the catch is sorted by species (and size-class, where appropriate) and a subsample is taken from each for full processing. The data collected from each of these subsampled specimens include length and weight, as well as sex and maturity stage (determined macroscopically). Stomachs are removed and those containing prey items are preserved onboard for post-cruise examination at the VIMS shore-based laboratories. Otoliths or other appropriate aging structures are also removed from each subsampled specimen for age determination. Aggregate weights are recorded by species/size-class for all specimens not selected for the full processing, and either all or a representative subsample are enumerated and measured for length.

Single-species assessment models typically require information on (among others) age- and length-structure, sex ratio, and maturity stage. Quality control procedures are implemented at the conclusion of each research cruise to ensure that the data collection were accurate and complete, and these data are then be used to generate a variety of population-level information. Data are synthesized to characterize age- and length- frequency distributions across a various spatial and temporal scales (e.g., by year, season, or region of the bay) for each species. Sex ratio and maturity data are also available to support sex-specific analyses.

In addition to the population-level information described under Task 2, multispecies assessment models require information on predator-prey interactions across broad seasonal and spatial scales. Accordingly, stomachs collected in the field are processed following standard diet analysis procedures (Hyslop 1980). In general, these protocols involve identifying each prey item to the lowest possible taxonomic level; counts and weights of the various items are then recorded. Several diet indices are calculated to identify the main prey types for each species: percent by weight, percent by number, and percent frequency-of-occurrence. These indices can be coupled with the information generated from tasks above such that age-, length-, and sex-specific diet characterizations can be developed for each species. Efforts are also focused on characterizing spatial and temporal variability in these diets.

Time-series of relative abundance information can easily be generated from the basic catch data of a monitoring survey and is an integral component of both single and multispecies assessments. For each species, a variety of relative abundance trends are generated according to year, season, and location within the bay. Minimum trawlable abundance estimates can be calculated for each species by combining the catch data with estimates of the total survey area and the area swept by the trawl. Area swept by the net is calculated for each tow by multiplying tow distance (provided by GPS equipment) by average net width (provided by trawl monitoring gear). Because catch data from fishery-independent trawl surveys tend to follow log-normal distributions for most species, stratified geometric mean of catch per standard area swept indices would also be generated. Area swept would again be calculated using the procedures and variables described above. This method of calculating abundance indices was approved for use by, and currently is used by, the NEAMAP Mid-Atlantic/Southern New England Near Shore Trawl Survey, a coastal fishery-independent monitoring program that samples many of the same species in much the same way as ChesMMAP, albeit in a different geographic location (ASMFC 2009).

11.9 Striped bass spawning stock assessment

The striped bass spawning stock assessment programs documents the annual size, age and sex composition of the striped bass spawning stock within defined spawning areas of the James and Rappahannock rivers of the Chesapeake Bay in Virginia. Sampling of striped bass is done from multiple mesh size gill nets in the James and Rappahannock rivers. These data are used to meet

Atlantic State Marine Fishery Commission (ASMFC) compliance criteria of the Interstate Fishery Management Plan for striped bass.

The James and Rappahannock gill net surveys consist of twice-weekly samples of two 300’ gill nets (24 hr set time) in each river. Each gill net is 6’ in depth and consists of 10 30’ panels of varied mesh sizes (3, 3 ¾, 4 ½, 5 ¼, 6, 6 ½, 7, 8, 9 and 10” stretched). The order of the meshes was chosen randomly for each net. The nets are located approximately 100 m apart at mile 48 on the Rappahannock River and mile 60 on the James River. Data collected consist of lengths (fork and total, in mm), weight (in grams), sex and gonad maturity/ripeness. Scales samples are taken from each specimen and otoliths are extracted from a subsample for subsequent ageing.

12.0 District of Columbia

12.1 Fish Population Surveys: Electrofishing and Seining

Electrofishing surveys are performed monthly beginning in March and running through November. Seining surveys are performed bi-monthly from June through October. The electrofishing survey specifically targets adult fish while the seining survey is aimed primarily at juvenile fish. The electrofishing surveys are conducted monthly at eight sites throughout the District of Columbia. Using a Smith-Root electrofishing vessel, DDOE biologists intermittently sample two separate lines at each site with intervals totaling ten minutes per line. As disabled fish float to the surface of the water, DDOE biologists capture as many fish as possible before the disabling effect of the shock diminishes. At each sampling site the first fifty (50) fish of each species are measured and all subsequent captures are counted and recorded. Additionally, all game fish (e.g., largemouth bass, smallmouth bass, and striped bass) are captured, measured, and weighed and a scale sample is collected and used to calculate age and growth rates. Although length and abundance data is taken for all species captured during our surveys, for the age and growth studies, weight and a scale sample are taken from each striped bass, largemouth bass, and smallmouth bass we capture.

Electrofishing takes place at four sites on the Potomac River, two on the Anacostia River, one in the Washington Channel, and one at the mouth of Rock Creek. Each monthly electrofishing sample contains two 600-second shocking repetitions. On a bimonthly basis from May through November, four additional sampling sites are added; three sites on the Potomac River, and one site on the Anacostia River. During the sampling repetition the electrofishing boat is moved parallel to the shoreline in three to six feet of water.

There are six seining sites sampled bi-monthly within District waters. Seining is a sampling technique that uses a continuous column or wall of netting to encircle fish. The top of the netting is fitted with floatation devices which keep the netting at the water’s surface to keep fish from swimming over the net. The bottom of the netting is fitted with weights to keep fish from swimming under the net. Four of the sites are on the Potomac River and two sites are located on the Anacostia River. The seine survey utilizes a 100 ft x 4 ft beach seine with ¼” mesh. One end of the net is held stationary at the shoreline while the other end is pulled out into the water. A semi-circular shape is made as the entire net is pulled through the water and then back to the shoreline. Seining surveys are conducted bi-weekly from May through October at four sites on the Potomac River and at two sites on the Anacostia River. Using a one-hundred (100) foot by four (4) foot seine with a one quarter (1/4) inch mesh, DDOE biologists perform one haul of maximum allowable length, based on terrain, at each site. All fish collected are identified, measured and enumerated.

All surveys are conducted on the Potomac River, the Anacostia River, the Washington Channel, or Rock Creek.

Rock Creek is a primary freshwater tributary to the Potomac River and a secondary tributary to the Chesapeake Bay. It is approximately 33 miles in length of which 9.3 miles flow within the District of Columbia. This entire 9.3-mile stretch lies within Rock Creek Park, which is federal land that is regulated by the National Park Service. The Rock Creek watershed has a surface area of 77 square miles.

The Potomac and Anacostia rivers are two bodies of water that flow within the District of Columbia. The two rivers are tidal, freshwater (0.14ppt) and approximately 200 miles from the Atlantic Ocean. The Potomac River is the second largest tributary to the Chesapeake Bay, and one of the largest rivers in the Atlantic drainage of North America.

12.2 Fish Tagging Surveys

DDOE annually tags black bass to assess the population size in certain stretches of District waters, monitor movement patterns, and examine growth rates.

Striped bass tagging in the District is a cooperative effort with the U.S. Fish and Wildlife Service (FWS). DDOE implants USFWS tags in striped bass that are encountered during routine and special sampling outings. The majority of striped bass tagged in the District are tagged during night electrofishing in the spring. Striped bass tagging takes place across several sampling regimes but the most concentrated effort is focused at special sampling events in the spring when the adult fish migrate up the river in search of spawning grounds and food. Fish are collected by electrofishing in the upper stretches of the District's portion of the Potomac River. DDOE biologists wait until after dark and begin drifting perpendicular to the shore in the fast moving river, shocking just off the bank in about 10-15 feet of water. When a striped bass is shocked it is collected in a large dip net and placed in an onboard live well. Once the live well is reasonably full but not overcrowded electrofishing is temporally halted. DDOE biologists then take a total length (mm) and weight (g) of the fish, remove a scale sample for aging and implant an external body anchor tag.

Snakehead tagging in the District began in 2009 as part of a multijurisdictional effort among neighboring agencies within the Potomac River watershed. Snakeheads are captured, generally by electrofishing, and inserted with a T-bar style Floy tag with a unique identification number and a phone number for the USFWS. In addition, biologists record the length, weight, and capture location of each fish. Once the live well is full or tagging for the day in finished the fish are released at a known location. For this study the Potomac River and its tributaries were divided into 5 sections. The upper section (Woodrow Wilson Bridge north to the District line around Chain Bridge and the Anacostia from its confluence with the Potomac up to Bladensburg, MD) is the section the District is responsible for tagging snakeheads.

Over 500 blue catfish were tagged between 2007 and 2010 with only one recapture. The survey has been conducted at five sampling locations in District waters: three on the Potomac (P1LF- Wilson Bridge, P2LF-14th Street Bridges, and P3LF- Key Bridge) and two sites on the Anacostia (A1LF- South Capitol Street Bridge and A2LF-the railroad bridge just north of Pennsylvania Avenue). All the sites were set up at bridges because of the constant structure they provide.

All catfish species are collected using a low frequency electrofishing technique which has proven to be extremely effective. A Smith-Root Inc.; Model GPP 7.5 is utilized with the following settings: pulsed DC, 0.8-1.5 A, at 7.5 pulses/second. The survey is conducted from April through October when water temperatures are at least 18 degree Celsius and then stopped before temperatures fall below that threshold. When the water temperature falls below 18 degrees Celsius the effectiveness of the low frequency technique is greatly reduced. Each sampling site is shocked for 600 seconds or until live wells have reached capacity. Two boats are used at each site; one to apply the electricity and another as a chase boat to collect fish. Total lengths (mm) and weights (g) are taken from all blue catfish and lengths only are collected from all other catfish species at each site. All blue catfish greater than 400 mm are tagged with a Floy harpoon style tag.

12.3 Push Net Survey

DDOE conducts a yearly push net survey to assess the spawning success of the various alosine species found in District waters, including American shad, hickory shad, blueback herring, and alewives. DDOE conducts push net sampling during August and September at five locations on the Potomac River. The sites are P5PN (Fletchers Boathouse), P4PN (upstream of Key bridge/adjacent to three sisters island), P3PN (adjacent to Theodore Island), P2PN (adjacent to National Airport), P1PN (upstream from the Woodrow Wilson Bridge), and A1PN (downstream of Pennsylvania Ave. Bridge). Site A1PN was added to the sampling regime in 2005. This site is located on the Anacostia River.

Samplings are done after sunset and performed eleven times a year, July through September. A 50"x 38" x8" (width x depth x length) mesh net (1/8 inch mesh) is hung on a pivoting tubular metal frame and fished from the bow of the boat for a ten minute period. A 0.83-mile long transect is covered at each station. Transects are performed at a constant speed of 5 mph. Because weather conditions vary which subsequently affects water conditions and the vessels' ability to consistently cover distances over time, the distance traveled during each push is recorded. Additionally, an in line flow meter is mounted at mouth of the push net to monitor the volume of water that passes through the net during each push. Sampling at most of the sites (P5PN, P4PN, P3PN, and P2PN) is performed starting from an upstream position and moving downstream. P1PN and A1PN are fished in the opposite direction. All alosines are collected, enumerated, measured and saved for otolith extraction.

12.4 American Eel Studies

The status of American eels, *Anguilla rostrata* stocks are inadequately understood and current information suggests that populations have declined significantly. In response to the insufficient data, the Atlantic States Marine Fisheries Commission (ASMFC) has established an American Eel Fishery Management Plan to restore, protect and enhance the abundance of the American eels along the east coast. For the last several years DDOE, along with other partnering jurisdictions, have participated in the ASMFC elver surveys. The surveys are conducted to assess American eel young of year (YOY) abundance. Elvers shorter than 85 mm are considered YOY. Eels of this size represent the first year class of eels migrating back from the ocean.

In 2011, the DDOE also participated in a study that entailed the assessment of adult American eels. This survey is conducted to assess adult eel abundance. Adult eels are considered to be anything over 152 mm in length, typically a yellow or silver eel.

The YOY survey is conducted in Rock Creek. The adult eel survey is carried out on the Potomac and Anacostia rivers.

The elver survey is carried out by following a protocol provided by the ASMFC. This protocol requires sampling at minimum, one site four days per week for six weeks. The sampling gear consists of an Irish elver ramp trap. The dimensions of the wood trap are approximately 61 cm wide x 122 cm long. Each trap consists of a narrow interior ramp that is covered with enkmat, a plastic erosion control material. The ramp runs three-fourths of the length of the trap and ends in a small well at the top of the ramp. Fresh water is fed into the trap through a tube next to the well. The water fills the well and trickles down the ramp, attracting elvers. Elvers climb the ramp, fall into the well, and are carried into a mesh bag that is attached to the well. Elvers are then collected from the bag, counted, measured, and weighed. Traps are tied to trees with padlocks in case of floods and to deter theft.

Traps are set in early April and are fished until the end of May. The traps are set on Mondays and checked every day throughout the week and removed on Fridays. All traps are set in Rock Creek and are accessible by wading.

As an alternate method to capturing elvers, backpack electrofishing is also done. At selected sites a 50-meter stretch of Rock Creek was shocked at 200 to 300 volts, depending on water conditions, for just over 500 seconds. A typical crew consists of at least two biologists. A three person crew is ideal, with one person responsible for shocking and two people trailing behind on each side of the shocker netting the eels. A fine mesh (1/32 inch) dip net is used to capture the eels. The backpack shocker is started at its lowest setting (voltage, pulse rate and pulse width) and gradually increased to the point where the eels become immobilized and are netted. Settings vary according to water conditions. Biologists document basic biological information and eels are measured and weighed and their pigment stage is recorded. This method is repeated for a twenty week sampling period.

Adult eels are collected using commercial grade eel pots that are hand-made of fine mesh wire with nylon funnels sewn in them. These pots have a single entrance. Each set contains ten eel pots strung together with two weights at each end to anchor the pots and two buoys at each end so they can be easily retrieved. In 2011, four sets of eel pots were set, between the Potomac

River and the Anacostia River. Pots were set on Mondays, checked and re-baited on Wednesdays and checked and retrieved on Fridays. All pots were set in ten feet or less of water. At each station collected eels are measured, weighed, and then released. Sampling is conducted during the months of May, July and September.

12.5 Fish Passage on Rock Creek

Several man-made in-stream barriers (e.g., dams, culverts and sewer outfalls) used to impede alosine spawning runs. Since 2006, all migration barriers have been removed. Monitoring is now focused on the return of anadromous fish to their ancestral spawning grounds, previously inaccessible due to in-stream barriers.

Rock Creek fish monitoring is conducted to gather baseline data on species diversity and abundance. Monitoring consist of two sampling techniques--backpack electrofishing and ichthyoplankton sampling. Monitoring efforts are carried out to develop a comprehensive understanding of the fishery dynamics. Collected and compiled data serve as one of the components for analysis in the biological database. The data are used to support responsive and responsible management decisions relevant to the local fishery resources.

Backpack electrofishing is conducted monthly at six different sites on the Rock Creek. The sites are Rock Creek 6 (RC6), Rock Creek 5 (RC5), Rock Creek 4 (RC4), and Rock Creek 3 (RC3). These sites are located above Pierce Mill Dam. The two remaining sites are below the dam and are identified as Pierce Mill (PM) and Lower Zoo Barrier (LZB). The standard sampling method for backpack shocking consists of walking a 50-meter stretch of the creek. Each site is shocked once for 500 seconds. Settings vary according to water conditions. Once netted, fish are put in a live well and processed. They are identified, measured, and numbered then immediately released back to the creek. For analysis purposes only gamefish are weighed.

At station P3AE sampling consist of two 600-second repetitions starting at the mouth of Rock Creek. This station is sampled using an electrofishing boat and is part of a larger biodiversity sampling regime, which includes eleven additional sites on the Potomac and Anacostia Rivers.

Another study site in lower Rock Creek is P3AE. This is the only site that is tidally influenced and the sampling method used at this station is boat electrofishing. This site shows the full spectrum of anadromous, gamefish, and non-gamefish species that inhabit the creek. (See Figure.1 for sampling sites)

Ichthyoplankton sampling is conducted in early spring to coincide with the herring spawns. There are five stations for data collection. The stations are (RC5), (RC3), (PM), (LZB) and Thompson Boathouse (TBH). TBH is another site located below Pierce Mill. Sampling takes place April through May and is primarily dependent on water flow. Ichthyoplankton sampling is conducted using a 50-centimeter diameter conical plankton net with a 350 micrometer (um) Nitex mesh. Nets are fished for a period of five minutes. Water currents suspend the nets slightly above the sediment. Ichthyoplankton samples are preserved in 5% formalin, and then analyzed in house by staff biologists.

Stocking occurs in the springtime and alosines are released at Picnic Area 10, which is located well above the Pierce Mill Dam. For stocking to occur blueback herring and hickory shad are collected from the Potomac River using an electrofishing boat. Alosines are measured, sexed and then stripped of their eggs and milt into a collection bowl, where they are gently stirred to obtain highest possible fertility. The fertilized eggs are then brought back to the Aquatic Education Resource Center (AREC), where the hatchery is located, and placed in hatching jars. Eggs are incubated and hatched in a process that takes approximately 5 to 7 days. After all eggs have hatched the larvae are chemically marked then stocked. Alosines are marked with oxytetracycline. Over the last four years, approximately 1,000,000 hickory shad fry have been released in Rock Creek.

12.6 Stock Enhancement

Adult American shad typically begin to arrive in District waters in early April as part of their annual spring spawning run. The run usually lasts from early April to mid May when water temperatures range from 12 to 20 degrees C. DDOE biologists conduct evening and night sampling in an effort to capture pre-spawn adults. The fish are captured through the use of gill nets.

In order to maximize the catch of ripe American shad, gill netting efforts have taken place outside of DDOE's jurisdiction near the mouth of Pohick Bay. For this reason a collection permit is required and obtained from the Potomac River Fisheries Commission (PRFC). It is well known that gillnetting in this section of river for spawning American shad is very productive. Gillnetting typically consists of fishing three nets that are approximately 300ft in length and 20 – 24 feet in depth with 5 - 5 ½ inch stretch mesh. The nets are fished for roughly an hour each. The nets are set during the evening slack tide in an effort to prevent the nets from drifting too far during the soak. The nets are set parallel to the shoreline along sharp edges on the river bottom. This is done in an effort to catch spawning fish as they come up from the deeper channel at night to spawn. After an hour the nets are retrieved and all by-catch is identified, counted and released. American shad are sexed, measured, and the eggs of ripe females are stripped for incubation at the hatchery.

Effort Summary Tables

Table 1: General Electrofishing Effort Summary

Year	Number of Sites Sampled	Sampling Reps	Duration (sec)	Total Effort (sec)	Sturgeon Encountered
1990	7	108	600	64800	**0**
1991	6	120	600	72000	**0**
1992	6	114	600	68400	**0**
1993	12	138	600	82800	**0**
1994	12	178	600	106800	**0**
1995	12	152	600	91200	**0**
1996	12	176	600	105600	**0**
1997	12	179	600	107400	**0**
1998	12	184	600	110400	**0**
1999	12	203	600	121800	**0**
2000	12	176	600	105600	**0**
2001	12	176	600	105600	**0**
2002	12	176	600	105600	**0**
2003	12	176	600	105600	**0**
2004	12	143	600	85800	**0**
2005	12	176	600	105600	**0**
2006	12	176	600	105600	**0**
2007	12	176	600	105600	**0**
2008	12	176	600	105600	**0**
2009	12	176	600	105600	**0**
2010	12	176	600	105600	**0**
2011	12	176	600	105600	**0**

Table 2: Seining Summary 1990-2011

Year	Number of Sites Sampled	Reps	Net Size (Sq. Ft.)	Total Effort (Sq. Ft.)	Sturgeon Encountered
1990	6	96	400	38400	0
1991	6	108	400	43200	0
1992	6	54	400	21600	0
1993	6	54	400	21600	0
1994	6	60	400	24000	0
1995	6	54	400	21600	0
1996	6	54	400	21600	0
1997	6	60	400	24000	0
1998	6	57	400	22800	0
1999	6	58	400	23200	0
2000	6	48	400	19200	0
2001	6	54	400	21600	0
2002	6	53	400	21200	0
2003	6	40	400	16000	0
2004	5	50	400	20000	0
2005	5	45	400	18000	0
2006	5	45	400	18000	0
2007	5	45	400	18000	0
2008	5	40	400	16000	0
2009	5	40	400	16000	0
2010	6	36	400	14400	0
2011	6	30	400	12000	0

Table 3: Special Tagging Summary

Year	Number of Tagging Events (No Time Record)	Total Effort (sec)	Sturgeon Encountered
1999	6	17894	0
2000	6	13196	0
2001	6	13784	0
2002	3(5)	8196	0
2003	8	20300	0
2004	0(4)		0
2005	4(15)	6300	0
2006	0(11)		0
2007	9(7)	17016	0
2008	14	19786	0
2009	24	30789	0
2010	28	35138	0
2011	20	39451	0

Table 4: Push Net Effort Summary

Year	Number of Sites Sampled	Number of Pushes	Duration (sec)	Total Effort (sec)	Flow Meter Volume (m^3)	Sturgeon Encountered
2005	6	84	600	50400	N/A	**0**
2006	6	78	600	46800	120371	**0**
2007	6	66	600	39600	79778	**0**
2008	6	66	600	39600	88248	**0**
2009	6	54	600	32400	78129	**0**
2010	6	66	600	39600	100504	**0**
2011	6	66	600	39600	99202	**0**

Table 5: Adult Eel Pot Effort Summary

Year	Number of Sites Sampled	Pots Deployed/Day	Deployment Days	Soak Time (Hrs)	Total Effort (Hrs)	Sturgeon Encountered
2008	4	40	23	48	1104	**0**
2009	4	40	21	48	1008	**0**
2010	4	40	17	48	816	**0**
2011	4	40	18	48	864	**0**

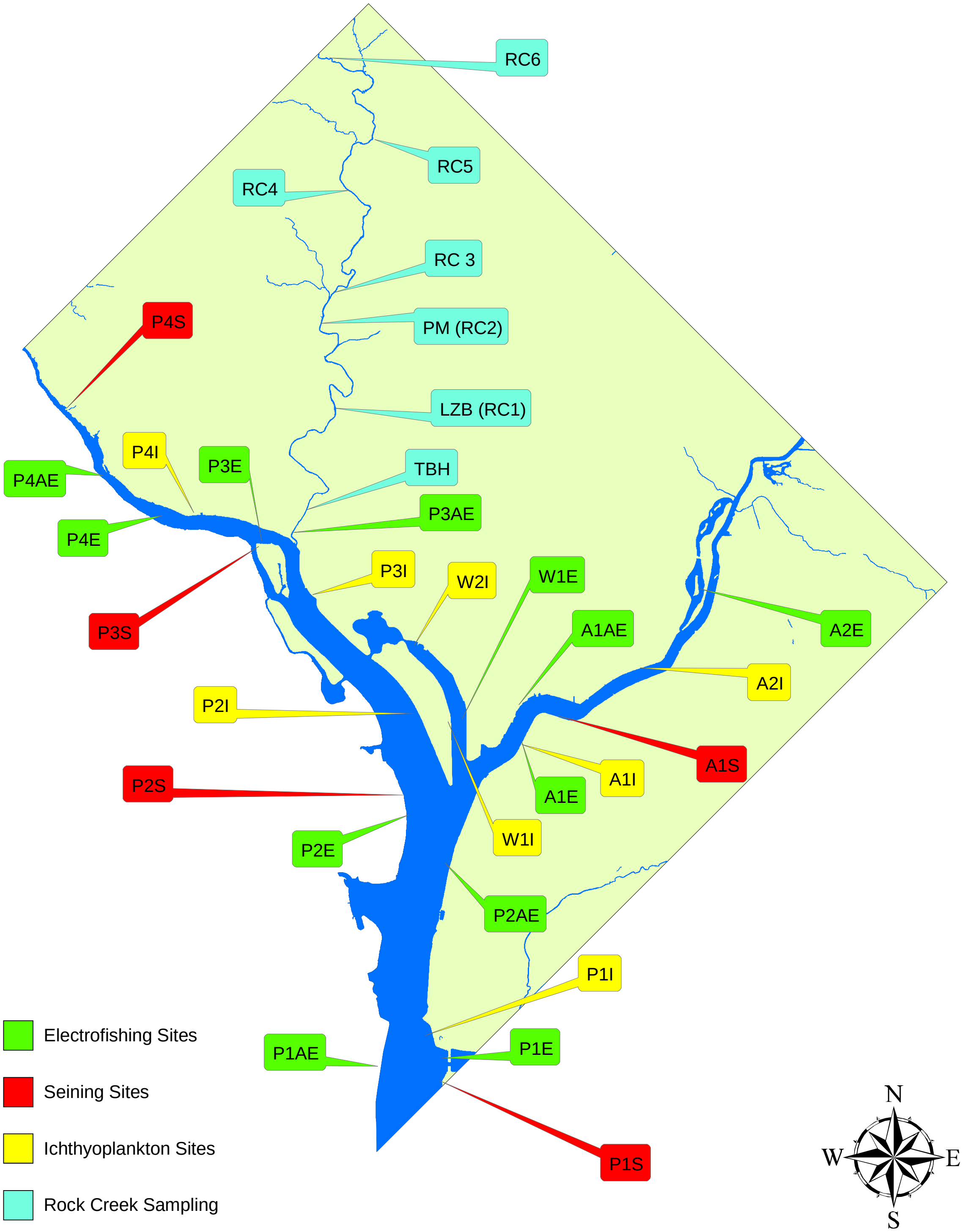
Table 6: Backpack Electrofishing Effort Summary

Year	Number of Sites Sampled	Duration (sec)	Sturgeon Encountered
2008	6	29165	**0**
2009	6	25539	**0**
2010	6	28322	**0**
2011	6	27283	**0**

Table 7: American Shad Gillnetting Effort Summary

Year	Deployment Days	Soak Time (Hrs)	Total Effort (Hrs)	Total Net Fished (Sq. Ft)	Sturgeon Encountered
2006	9	1	9	130,500	**0**
2007	11	1	11	212,400	**0**
2008	12	1	12	222,000	**0**
2009	12	1	12	295,200	**0**
2010	7	1	7	127,200	**0**
2011	0	0	0	0	**0**

District of Columbia Sampling Sites



APPENDIX B.

Sea turtle and resuscitation measures as found at 50 CFR 223.206(d)(1).

(d) (1) (i) Any specimen taken incidentally during the course of fishing or scientific research activities must be handled with due care to prevent injury to live specimens, observed for activity, and returned to the water according to the following procedures.

(A) Sea turtles that are actively moving or determined to be dead as described in (d)(1)(i)(C) of this section must be released over the stern of the boat. In addition, they must be released only when fishing or scientific collection gear is not in use, when the engine gears are in neutral position, and in areas where they are unlikely to be recaptured or injured by vessels.

(B) Resuscitation must be attempted on sea turtles that are comatose, or inactive, as determined in paragraph (d)(1) of this section by:

(1) placing the turtle on its bottom shell (plastron) so that the turtle is right side up, and elevating its hindquarters at least 6 inches (15.2 cm) for a period of 4 up to 24 hours. The amount of the elevation depends on the size of the turtle; greater elevations are needed for larger turtles. Periodically, rock the turtle gently left to right and right to left by holding the outer edge of the shell (carapace) and lifting one side about 3 inches (7.6 cm) then alternate to the other side. Gently touch the eye and pinch the tail (reflex test) periodically to see if there is a response.

(2) sea turtles being resuscitated must be shaded and kept damp or moist but under no circumstance be placed into a container holding water. A water-soaked towel placed over the head, neck, and flippers is the most effective method in keeping a turtle moist.

(3) sea turtles that revive and become active must be released over the stern of the boat only when fishing or scientific collection gear is not in use, when the engine gears are in neutral position, and in areas where they are unlikely to be recaptured or injured by vessels. Sea turtles that fail to respond to the reflex test or fail to move within 4 hours (up to 24, if possible) must be returned to the water in the same manner as that for actively moving turtles.

(C) A turtle is determined to be dead if the muscles are stiff (rigor mortis) and/or the flesh has begun to rot; otherwise the turtle is determined to be comatose or inactive and resuscitation attempts are necessary.

APPENDIX C.

PIT Tagging Procedures for Shortnose and Atlantic sturgeon

(adapted from Damon-Randall *et al*. 2010)

Passive integrated transponder (PIT) tags provide long term marks. These tags are injected into the musculature below the base of the dorsal fin and above the row of lateral scutes on the left side of the Atlantic sturgeon (Eyler *et al*. 2009), where sturgeon are believed to experience the least new muscle growth. Sturgeon should not be tagged in the cranial location. Until safe dorsal PIT tagging techniques are developed for sturgeon smaller than 300 mm, only sturgeon larger than 300 mm should receive PIT tags.

It is recommended that the needles and PIT tags be disinfected in isopropyl alcohol or equivalent rapid acting disinfectant. After any alcohol sterilization, we recommend that the instruments be air dried or rinsed in a sterile saline solution, as alcohol can irritate and dehydrate tissue (Joel Van Eenennam, University of California, pers. comm.). Tags should be inserted antennae first in the injection needle after being checked for operation with a PIT tag reader.

Sturgeon should be examined on the dorsal surface posterior to the desired PIT tag site to identify a location free of dermal scutes at the injection site. The needle should be pushed through the skin and into the dorsal musculature at approximately a 60 degree angle (Figure 15). After insertion into the musculature, the needle angle should be adjusted to close to parallel and pushed through to the target PIT tag site while injecting the tag. After withdrawing the needle, the tag should be scanned to check operation again and tag number recorded.

Some researchers check tags in advance and place them in individual 1.5 ml microcentrifuge tubes with the PIT number labeled to save time in the field.

Because of the previous lack of standardization in placement of PIT tags, we recommend that the entire dorsal surface of each fish be scanned with a PIT tag reader to ensure detection of fish tagged in other studies. Because of the long life span and large size attained, Atlantic sturgeon may grow around the PIT tag, making it difficult to get close enough to read the tag in later years. For this reason, full length (highest power) PIT tags should be used.

Fuller et al. (2008) provide guidance on the quality of currently available PIT tags and readers and offer recommendations on the most flexible systems that can be integrated into existing research efforts while providing a platform for standardizing PIT tagging programs for Atlantic sturgeon on the east coast. The results of this study were consulted to assess which PIT tags/readers should be recommended for distribution. To increase compatibility across the range of these species, the authors currently recommend the Destron TX1411 SST 134.2 kHz PIT tag and the AVID PT VIII, Destron FS 2001, and Destron PR EX tag readers. These readers can read multiple tags, but software must be used to convert the tag ID number read by the Destron

PR EX. The FWS/Maryland Fishery Resources Office (MFRO) will collect data in the coastal tagging database and provide approved tags for distribution to researchers.

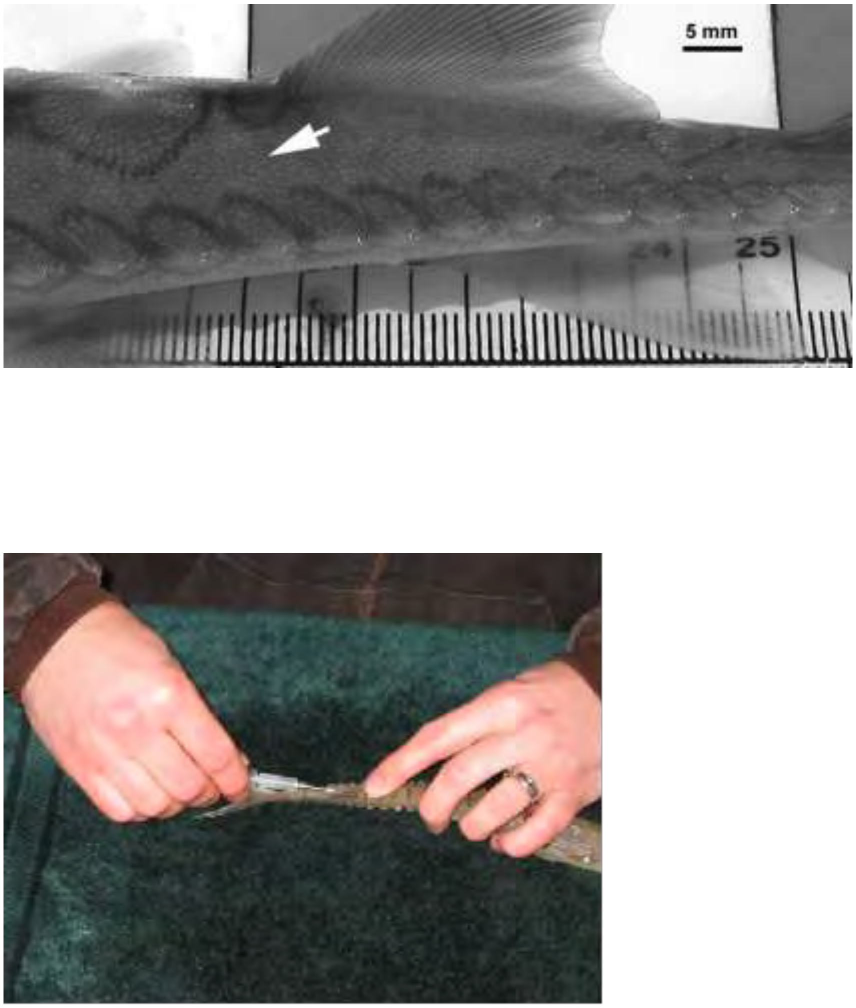


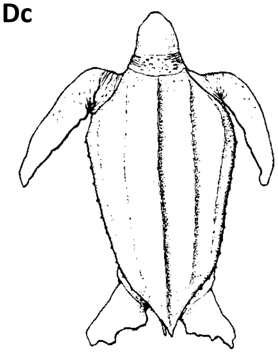
Figure 15. (from Damon-Randall *et al*. 2010). Illustration of PIT tag location (indicated by white arrow; top), and photo of a juvenile Atlantic sturgeon being injected with a PIT tag (bottom). *Photos courtesy of James Henne, US FWS.*

APPENDIX D

Identification Key for Sea Turtles and Sturgeon Found in Northeast U.S. Waters

SEA TURTLES

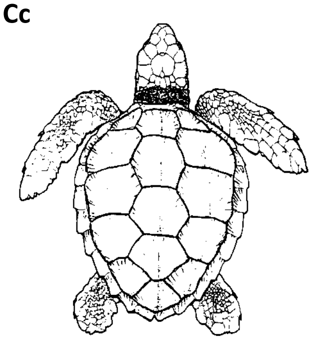
Dc



Leatherback (*Dermocheyls coriacea*)

Found in open water throughout the Northeast from spring through fall. Leathery shell with 5-7 ridges along the back. Largest sea turtle (4-6 feet). Dark green to black; may have white spots on flippers and underside.

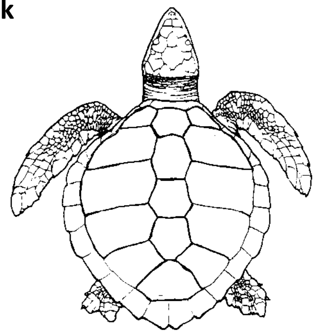
Cc



Loggerhead (*Caretta caretta*)

Bony shell, reddish-brown in color. Mid-sized sea turtle (2-4 feet). Commonly seen from Cape Cod to Hatteras from spring through fall, especially in southern portion of range. Head large in relation to body.

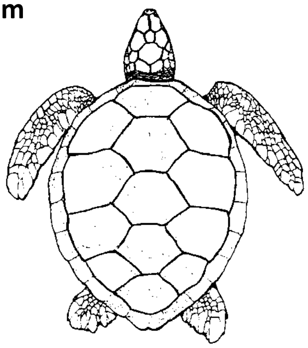
Lk



Kemp's ridley (*Lepidochelys kempi*)

Most often found in Bays and coastal waters from Cape Cod to Hatteras from summer through fall. Offshore occurrence undetermined. Bony shell, olive green to grey in color. Smallest sea turtle in Northeast (9-24 inches). Width equal to or greater than length.

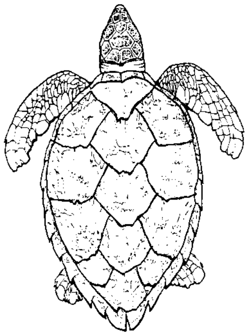
Cm



Green turtle (*Chelonia mydas*)

Uncommon in the Northeast. Occur in Bays and coastal waters from Cape Cod to Hatteras in summer. Bony shell, variably colored; usually dark brown with lighter stripes and spots. Small to mid-sized sea turtle (1-3 feet). Head small in comparison to body size.

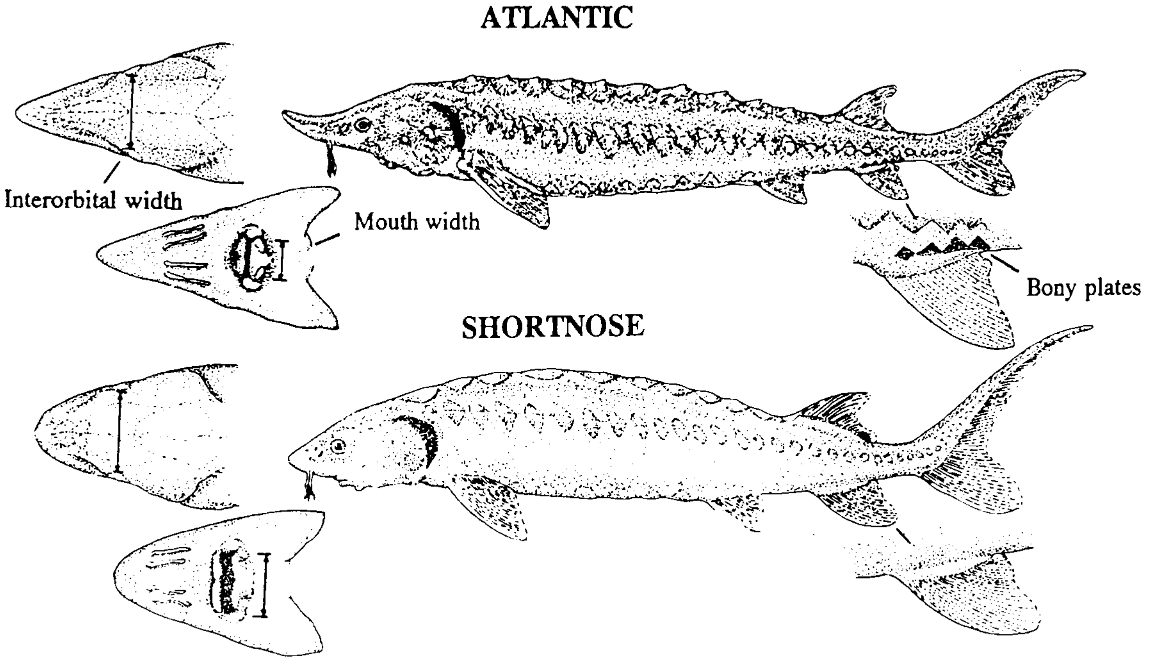
Ei



Hawksbill (*Eretmochelys imbricata*)

Rarely seen in Northeast. Elongate bony shell with overlapping scales. Color variable, usually dark brown with yellow streaks and spots (tortoise-shell). Small to mid-sized sea turtle (1-3 feet). Head relatively small, neck long.

Sturgeon Identification



Distinguishing Characteristics of Atlantic and Shortnose Sturgeon

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

* From Vecsei and Peterson, 2004

APPENDIX E

Procedure for obtaining fin clips from sturgeon for genetic analysis

Obtaining Sample

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

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

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

Storage of Sample

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

Sending of Sample

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

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

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

APPENDIX F

Incident Report: ESA Listed Species Take

Photographs should be taken and the following information should be collected from all listed fish and sea turtles (alive and dead) collected.

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

Species Identification:____

Type of Gear and Length of deployment:
____
____

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

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

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

--

Sturgeon Information:
Species __________________________________

Fork length (or total length) _____________________ Weight ______________________

Condition of specimen/description of animal
____
____
____
____

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

Photograph taken: YES / NO
(please label *species, date, geographic site* and *vessel name* when transmitting photo)

Genetics Sample taken: YES / NO
Genetics sample transmitted to: ____________________ on ____/_____/20__

Sea Turtle Species Information: *(please designate cm/m or inches.)*
Species ______________________________ Weight (kg or lbs)____________________________

Sex (circle): Male Female Unknown How was sex determined? ___________________

Straight carapace length ________________ Straight carapace width _____________________

Curved carapace length ________________ Curved carapace width ______________________

Plastron length _______________________ Plastron width ______________________________

Tail length ____________________________ Head width ________________________________

Condition of specimen/description of animal____
____

Existing Flipper Tag Information
Left _______________________________ Right ___________________________________
PIT Tag # __________________________________

Miscellaneous:
Genetic biopsy taken: YES NO
Photos Taken: YES NO Is this a Recapture: YES NO

Turtle Release Information:
Date ____________________________ Time _______________________________
Lat _____________________________ Long _______________________________
State ___________________________ County ______________________________

Remarks: (note if turtle was involved with tar or oil, gear or debris entanglement, wounds or mutilations, propeller damage, papillomas, old tag locations, etc.)
____
____

APPENDIX G

STURGEON SALVAGE FORM

For use in documenting dead sturgeon in the wild under ESA permit no. 1614 (version 05-16-2012)

INVESTIGATORS'S CONTACT INFORMATION

Name: First ________________ Last ______________________

Agency Affiliation ________________ Email______________________

Address ____

____

Area code/Phone number ______________________________

UNIQUE IDENTIFIER (Assigned by NMFS)

DATE REPORTED:

Month ☐☐ Day☐☐ Year 20☐☐

DATE EXAMINED:

Month ☐☐ Day☐☐ Year 20☐☐

SPECIES: (check one)

☐ shortnose sturgeon

☐ Atlantic sturgeon

☐ Unidentified *Acipenser* species

Check "Unidentified" if uncertain . See reverse side of this form for aid in identification.

LOCATION FOUND: ☐Offshore (Atlantic or Gulf beach) ☐Inshore (bay, river, sound, inlet, etc)

River/Body of Water________________ City________________________ State ____

Descriptive location (be specific)______________________________________

____

____

Latitude ______________N (Dec. Degrees) Longitude ______________ W (Dec. Degrees)

CARCASS CONDITION at time examined: (check one)

☐ 1 = Fresh dead

☐ 2 = Moderately decomposed

☐ 3 = Severely decomposed

☐ 4 = Dried carcass

☐ 5 = Skeletal, scutes & cartilage

SEX:

☐ Undetermined

☐ Female ☐ Male

How was sex determined?

☐ Necropsy

☐ Eggs/milt present when pressed

☐ Borescope

MEASUREMENTS: Circle unit

Fork length _________ cm / in

Total length _________ cm / in

Length ☐ actual ☐ estimate

Mouth width (inside lips, see reverse side) _________ cm / in

Interorbital width (see reverse side) _________ cm / in

Weight ☐ actual ☐ estimate _________ kg / lb

TAGS PRESENT? Examined for external tags including fin clips? ☐ Yes ☐ No Scanned for PIT tags? ☐ Yes ☐ No

Tag #	Tag Type	Location of tag on carcass

CARCASS DISPOSITION: (check one or more)

☐1 = Left where found

☐2 = Buried

☐3 = Collected for necropsy/salvage

☐4 = Frozen for later examination

☐5 = Other (describe) ________________________

Carcass Necropsied?

☐Yes ☐No

Date Necropsied:____________

Necropsy Lead:

____

PHOTODOCUMENTATION:

Photos/vide taken? ☐ Yes ☐ No

Disposition of Photos/Video:__________

____

____

SAMPLES COLLECTED? ☐ Yes ☐ No

Sample	How preserved	Disposition (person, affiliation, use)

Comments:

____

____

____

Distinguishing Characteristics of Atlantic and Shortnose Sturgeon (version 07-20-2009)

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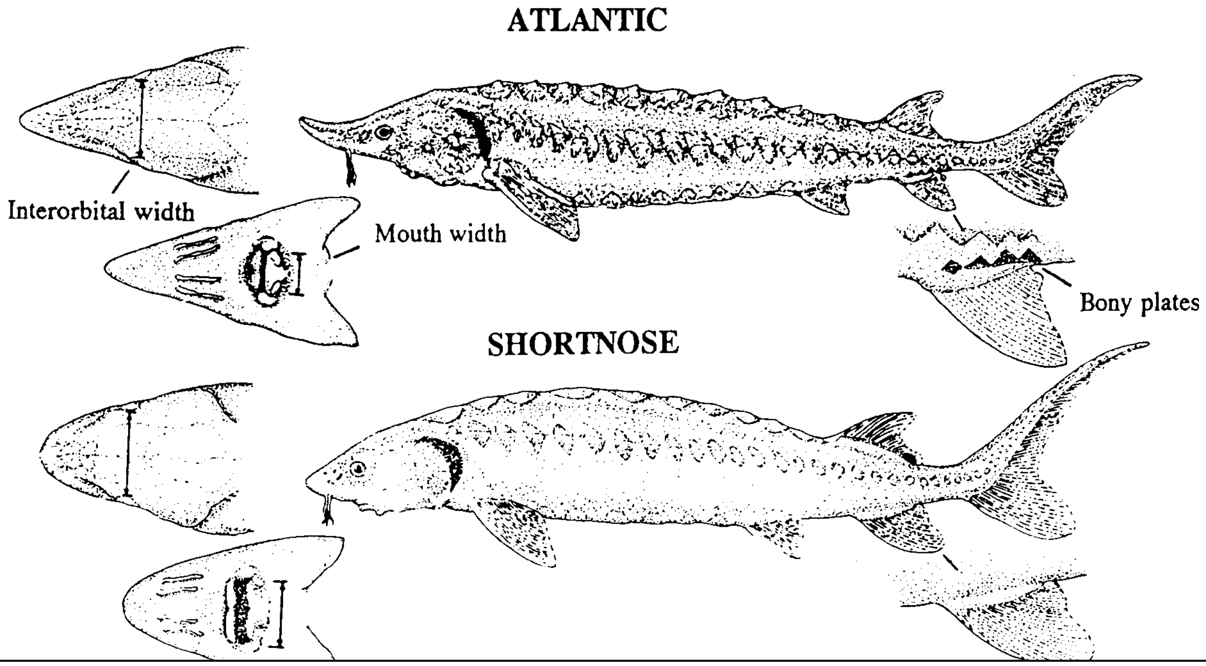

Describe any wounds / abnormalities (note tar or oil, gear or debris entanglement, propeller damage, etc.). **Please note if no wounds / abnormalities are found.**

Data Access Policy: Upon written request, information submitted to National Marine Fisheries Service (NOAA Fisheries) on this form will be released to the requestor provided that the requestor credit the collector of the information and NOAA Fisheries. NOAA Fisheries will notify the collector that these data have been requested and the intent of their use.

Submit completed forms (within 30 days of date of investigation) to: **Northeast Region Contacts** – Shortnose Sturgeon Recovery Coordinator (Jessica Pruden, Jessica.Pruden@noaa.gov, 978-282-8482) or Atlantic Sturgeon Recovery Coordinator (Lynn Lankshear, Lynn.Lankshear@noaa.gov, 978-282-8473); **Southeast Region Contacts**- Shortnose Sturgeon Recovery Coordinator (Stephania Bolden, Stephania.Bolden@noaa.gov, 727-824-5312) or Atlantic Sturgeon Recovery Coordinator (Kelly Shotts, Kelly.Shotts@noaa.gov, 727-551-5603).