NATIONAL MARINE FISHERIES SERVICE
ENDANGERED SPECIES ACT
BIOLOGICAL OPINION

Agency:	U.S. Navy (lead); U.S. Army Corps of Engineers, New England District
Activity Considered:	Maintenance Dredging of the Kennebec River FNP (2019-2029) **GARFO-2019-01719**
Conducted by:	National Marine Fisheries Service Greater Atlantic Regional Fisheries Office
Date Issued:	October 25, 2019
Approved by:	

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1.0 INTRODUCTION

This constitutes the biological opinion (Opinion) of NOAA's National Marine Fisheries Service (NMFS) issued pursuant to Section 7 of the Endangered Species Act (ESA) of 1973, as amended, on the effects of your (U.S. Navy) planned maintenance dredging of the Federal Navigation Project (FNP) in the lower Kennebec River, Maine from 2019-2029. The project will require a permit from the U.S. Army Corps of Engineers (USACE) under their Section 404 permitting process. This Opinion is based on the description of the effects of the proposed action on ESA-listed species and critical habitat that you provided in your Biological Assessment (BA) dated June 27, 2019. That analysis, along with scientific papers and other sources of information as cited in the references section also helped form the basis of this Opinion. A complete administrative record of this consultation will be kept at our NMFS Greater Atlantic Regional Fisheries Office.

Updates to the regulations governing interagency consultation (50 CFR § 402) will become effective on October 28, 2019 [84 FR 44976]. Because this consultation was pending and will be completed prior to that time, we are applying the previous regulations to the consultation. However, as the preamble to the final rule adopting the new regulations noted, "[t]his final rule does not lower or raise the bar on section 7 consultations, and it does not alter what is required or analyzed during a consultation. Instead, it improves clarity and consistency, streamlines consultations, and codifies existing practice." Thus, the updated regulations would not be expected to alter our analysis.

2.0 ESA CONSULTATION HISTORY

We have previously completed several section 7 consultations with USACE and you for the dredging of the Kennebec River FNP. In 1989 and 1991, USACE permitted dredging operations at the Doubling Point reach from September 15 to October 15 and from March 1 through April 30 and at Popham Beach from November 1 through April 30. Consultation on dredging in 1989 and 1991 was concluded informally, with us concurring with the determination that dredging was not likely to adversely affect endangered shortnose sturgeon (*Acipenser brevirostrum*). However, during dredging operations in October 1991, two shortnose sturgeon with severe lacerations were observed floating just downstream of the dredge site. It was assumed that these fish were killed during the ongoing maintenance dredging of the Doubling Point reach.

The first BO was issued on August 28, 1997, and considered the effects of maintenance dredging from November 1 through April 30, a time of year (TOY) restriction intended to protect shortnose sturgeon. On November 29, 2000, we provided an amendment to the 1997 BO in which we stated that new information from fisheries sampling in the Kennebec suggested that shortnose sturgeon we present in higher numbers than previously known during the months of November and April. Therefore, the amendment stated that as long as maintenance dredging was performed from December 1 to March 1, reinitiation of the 1997 BO was not warranted; however, any proposed dredging outside of that window would require reinitiation. On March 5, 2002, you requested that formal consultation be reinitiated in order to assess the effects of maintenance dredging outside the amended time window of December 1 to March 1 (i.e., you proposed to perform maintenance dredging between November 1 and April 30). In our BO issued on April 16, 2002, we required a TOY restriction prohibiting dredging from May 1 to October 31. Since the conclusion of this BO, we revised our Atlantic salmon (*Salmo salar*) ESA listing, designated Atlantic salmon critical habitat, listed Atlantic sturgeon (*Acipenser oxyriynchus oxyriynchus*), and designated critical habitat for Atlantic sturgeon, all of which occur in the Kennebec River. See Section 4 for a further discussion of ESA-listed species and critical habitat in the action area.

Since the completion of the BO in 2002, we have had to complete two subsequent formal ESA section 7 consultations for maintenance dredging activities in the Kennebec River FNP under either emergency or expedited processes that have taken place within the restricted TOY window. Both of the consultations were for single maintenance dredging events, and did not cover future maintenance dredging of the Kennebec River FNP. An emergency consultation was conducted in 2003 for dredging in October to remove shoaling that had reached critical levels and would have prevented the safe transit of the U.S.S. Chafee, a U.S. Navy Destroyer, from Bath Iron Works, ME, on October 10, 2003. Observers were present and recorded three dredge related shortnose sturgeon mortalities in addition to two injured shortnose sturgeon.

On July 29, 2011, we issued another BO; though this consultation was not an emergency consultation, it was conducted as an expedited consultation to allow for dredging in August, outside the established work window. Observers were present during dredging and did not witness any take of listed species.

In a March 22, 2017 letter, USACE requested an emergency consultation pursuant to Section 7 of the ESA for the proposed dredging of the Kennebec River FNP. An emergency situation existed where the United States Navy Destroyer, U.S.S. Rafael Peralta, would have been unable to depart from the Bath Iron Works (BIW), on or about April 27, 2017, due to critical shoaling in two reaches of the Federal channel in the Kennebec River. You determined that failure of U.S.S. Rafael Peralta to sail would have had critical impacts to Navy Fleet Operations and National Defense.

In a letter dated August 18, 2017, USACE described the effects of the emergency dredging action which occurred between April 21-26, 2017, including the lethal take of a single Atlantic sturgeon, and requested initiation of formal consultation. Our office has currently dedicated its resources to working with you and USACE to proactively plan for future maintenance dredging events, thus obviating the need for additional emergency consultations.

Our conversations with USACE, both in-person and on the phone in August 2018 and May 2019, respectively, led to your submission on June 27, 2019, of a BA assessing the effects of 10 years of maintenance dredging of the Kennebec River FNP (2019-2029). On July 16, 2019, we sent you a letter stating that all information required to initiate formal section 7 consultation was included in your June 27, 2019 letter and BA, or is otherwise accessible for our consideration and reference; therefore, the date of the June 27, 2019 correspondence will serve as the commencement of the formal consultation process. The ESA and the section 7 regulations (50 CFR§402.14) require that formal consultation be concluded within 90 calendar days of initiation (September 25, 2019), and that a biological opinion be completed within 45 days after the conclusion of formal consultation (November 9, 2019), unless we mutually agree on an extension.

3.0 DESCRIPTION OF THE PROPOSED ACTION

The authorized FNP in the lower Kennebec River consists of a channel 27 feet (ft) deep at Mean Lower Low Water (MLLW) and 500 ft wide extending about 13 miles (mi) upstream from the river mouth at Popham Beach to the city of Bath. About 8 mi upstream of Bath, the FNP provides for a navigation channel 17 ft deep MLLW and 150 ft wide along the east side of Swan Island for 14 mi to the city of Gardiner. An 18-foot deep MLLW and 150 ft wide channel extends through the ledge at Lovejoy Narrows opposite the upper end of Swan Island. A training wall was built along the Beef Rock Shoal opposite the lower end of Swan Island and another training wall was built opposite South Gardiner. A secondary channel 12 ft deep and 100 ft wide was provided along the west-side of Swan Island to Richmond, with the navigation channel deepening to 15 ft MLLW near the upper end of Swan Island. A 16-ft deep MLW channel was provided at Gardiner. A channel 11 ft deep MLLW and 150 ft wide extends 7 mi to the upper limit of the FNP in Augusta.

Since the FNP for the lower Kennebec River was deepened to 27 ft deep in the early 1940's, maintenance dredging has been performed at the Doubling Point and Popham Beach reaches at approximately three-year intervals. These sites have been dredged a total of approximately 20 times since 1950. Dredging has been performed using a hopper dredge and the amount of material removed has ranged from 4,707 cubic yards (cy) to 108,830 cy. Disposal sites have historically been located in the river north of Bluff Head for the material removed from the channel near Doubling Point and at a nearshore disposal site located approximately 0.4 nautical miles (nm) south of Jackknife Ledge for the material dredged from the channel at the river mouth near Popham Beach. In recent years, dredging occurred in 1991, 1997, 2000, 2002, 2003, 2011, and 2017 (see Table 1).

Table 1: Dredging of the Kennebec River FNP (1991-Present)

Location	Dates	Volume Removed (cy)	Observer Present?	Interactions with ESA-listed species
Doubling Point	October 1991	69,000	No	2 shortnose sturgeon (lethal)
Doubling Point	November 1997	21,660	Yes	0
Doubling Point	December 2000	19,900	Yes	0
Doubling Point	April 2002	21,582	Yes	0
Doubling Point	October 2003	22,310	Yes	3 shortnose sturgeon (lethal); 2 shortnose sturgeon (injured but alive upon release)
Doubling Point & Popham Beach	August 2011	58,000	Yes	0
Doubling Point & Popham Beach	April 2017	62,353	Yes	1 Atlantic sturgeon (lethal)

Dredging is necessary to provide access for naval warships to navigate from the BIW shipyard to the open ocean. The scope of the Proposed Action includes ten years of maintenance dredging. Based on previous dredging requirements, you anticipate maintenance dredging to be needed every three years; however, future Navy ship movements from the BIW shipyard to the open ocean or shoaling conditions could increase the need for dredging to possibly five times over the next ten years. When possible, dredge events will occur from December 1 to March 1, an in-water work window designed to protect diadromous fish, including sturgeon; however, given the aforementioned unpredictability of environmental conditions (e.g., sediment transport) and Navy activities, along with past instances where circumstances have required dredging outside this window, you are proposing that as many as two dredge events may occur from March 2 to November 30 between 2019 and 2029.

3.1 Location

The Kennebec River is located in Sagadahoc County approximately 25 mi north of the city of Portland, Maine. It flows southerly for approximately 150 mi from Moosehead Lake at Moosehead, Maine to its mouth between Bay Point and Popham Beach where it empties into the Atlantic Ocean. The dredging areas are in the proximity of Doubling Point near Bath and in the Popham Beach area near the mouth of the Kennebec River (Figure 1, Figure 2).

Material dredged from the Doubling Point area will be disposed of at an in-river disposal site located north of Bluff Head (Figure 1). Material dredged from the channel near Popham Beach will be disposed of in an area approximately 0.4 nm south of Jackknife Ledge (Figure 2).

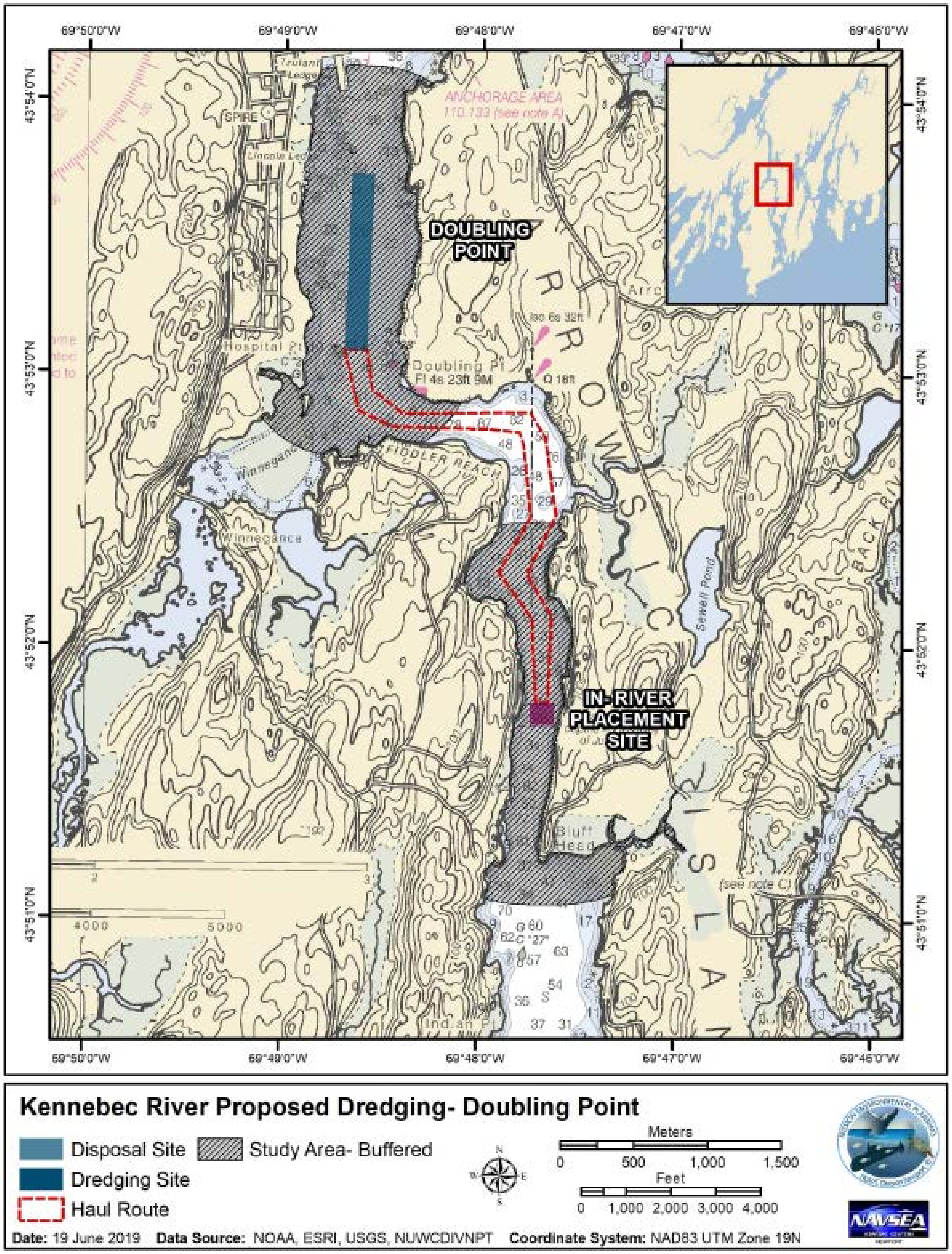

Figure 1: Historic dredging location at Doubling Point and the Bluff Head disposal site (U.S. Navy 2019)

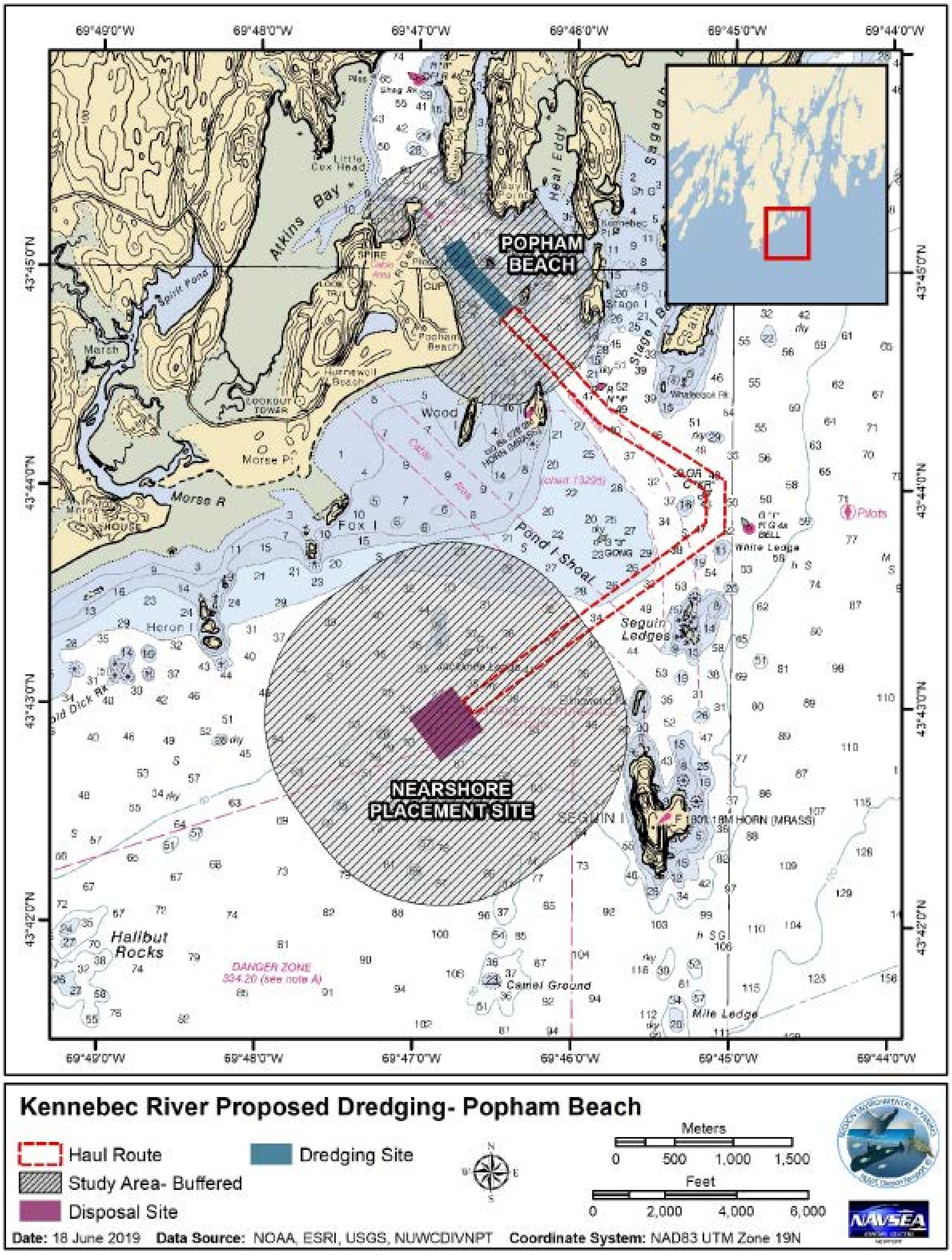

Figure 2: Historic dredging location at Popham Beach and the Jackknife Ledge disposal site (U.S. Navy 2019)

3.2 Dredging of the Kennebec River FNP

Maintenance dredging will be performed in the vicinity of Doubling Point to remove accumulated sand on the shoals to a depth of 35 ft below MLLW. Maintenance dredging in the channel near Popham Beach will be to 27 ft below MLLW plus 2 ft of allowable overdepth. Dredging may occur during the day or night. On average, dredging at Doubling Point and Popham Beach takes approximately 5–7 days to complete; however, this may be extended by inclement weather, equipment failure, or other adverse conditions.

Dredging will be performed by either a hydraulic hopper dredge or a mechanical dredge. A hopper dredge has been utilized many times to perform maintenance dredging of the FNP in the lower Kennebec River. Most recently, in 2017, a medium-class hopper dredge (265 ft long, 52 ft wide), the NEWPORT, was used at Doubling Point and Popham Beach. A hopper dredge is typically used to dredge soft materials such as sand or gravel and is most suitable for dredging long shoals in open areas such as entrance channels and ocean bars. Hopper dredges are typically, slow-moving (i.e., 2-3 mph while dredging). Much like a vacuum cleaner, a hopper dredge works in a “back and forth” motion over the dredge area using a hydraulic suction pump and drag-arms that hang down from the side of the vessel. Attached to the ends of the drag-arms are dragheads (most often 2) that ride along the bottom to loosen and remove bottom-material. The dredged material is drawn up through the drag-arms in a slurry of water and sediment and is deposited into hoppers or holds aboard the dredge vessel. As pumping continues, the sand settles to the bottom of the hopper and excess water flows overboard though troughs. When the hopper is full, the drag-arms are raised and the dredge proceeds to the disposal site and releases the material through bottom opening doors, or in some cases may pump material from the hopper to the placement site. You are not proposing to pump material anywhere as part of this action (e.g., for beach nourishment).

Mechanical bucket dredging involves the use of a stationary barge-mounted crane, backhoe, or cable-arm with an attached bucket to excavate the bottom-material. The material is lifted from the bottom and placed in a scow for transport to the disposal site by tug. For open-water or ocean disposal, a split-hull scow is generally used for ease of disposal and to minimize the discharge plume. Although a mechanical dredge is less mobile than a hopper dredge, a properly sized mechanical dredge is suitable for the Proposed Action because it is capable of remaining stationary by use of spuds on the barge to effectively work in the current and work in exposed marine environs. Because a mechanical dredge has never been used to dredge the Kennebec River FNP, the average dredge cycle time for this method is not known. The dredge cycle of a mechanical dredge most likely presents a similar scenario as the hopper dredge operation in that there will be periods of active dredging followed by a period of time when dredging would stop while the scow is taken to the disposal site.

During a typical dredging event, approximately 50,000 cubic yards (cy) of clean sand will be removed from the Doubling Point section over an area up to 45 acres, and approximately 20,000-30,000 cy of clean sand will be removed over an area up to 31 acres from the channel in the Popham Beach section. The two dredge areas account for a total of approximately 70,000–80,000 cy of material per dredge event.

3.3 Disposal

The material dredged from the Doubling Point area will be disposed of at the previously used in-river disposal site located north of Bluff Head (Figure 1). The in-river disposal site has an area of approximately 274,989 square feet (ft^2), and a water depth between 30 and 100 ft, with an average depth of 77 ft (Figure 1). This site was used in 1986, 1991, 1997, 2000, 2002, 2003, 2011, and 2017. Material dredged from the Popham Beach area will be placed in the previously used nearshore disposal site with an area of 2,250,000 ft^2 and located about 0.4 nm south of Jackknife Ledge (Figure 2). This site has a water depth of approximately 40 to 50 ft. This disposal area was used in 1989, 2000, 2002, 2003, 2011, and 2017. The disposal area at Jackknife Ledge was selected in coordination with the Maine Geological Survey based on studies that predicted that the material would be retained in the nearshore system and potentially renourish nearby beaches.

As an example of a typical dredging and disposal cycle, in 2017, 26 loads were dredged from Doubling Point and placed at the in-river disposal site. The average time between disposal events was 3 hours and 5 minutes. At Popham Beach, six loads were removed and placed at the Jackknife Ledge disposal site. The average time between disposal events was 3 hours and 16 minutes. The maximum speed of a typical dredge vessel moving to the Jackknife Ledge disposal site would be in the range of 10–15 knots.

3.3 Action Area

The action area is defined as “all areas to be affected directly or indirectly by the Federal action and not merely the immediate area (project area) involved in the proposed action” (50 CFR 402.02). As described above, the proposed action area includes the dredging locations at Doubling Point and Popham Beach, the in-river and nearshore disposal sites, and the haul routes between dredging and disposal locations. Additionally, you have determined that increased suspended sediment may extend up to 2,400 ft (731 meters [m]) down-current from the dredging locations (for both hopper dredging and mechanical dredging) and up to 4,000 ft (1,219 m) from a disposal location. You based these estimates on examination of sediment type and literature for ranges of elevated levels during discharge of sediment (USACE 1983). Therefore, the action area is characterized by a 2,400 ft buffer from the dredge sites and a 4,000 ft buffer from the disposal locations, as well as the vessel routes between those locations (Figure 3). The upstream limit of the action area is at approximately river kilometer (rkm) 19. You have estimated the action area to be 1,314 acres (i.e., the Doubling point dredge site, the Popham beach dredge site, the in-river disposal site, and the vessel routes between them).

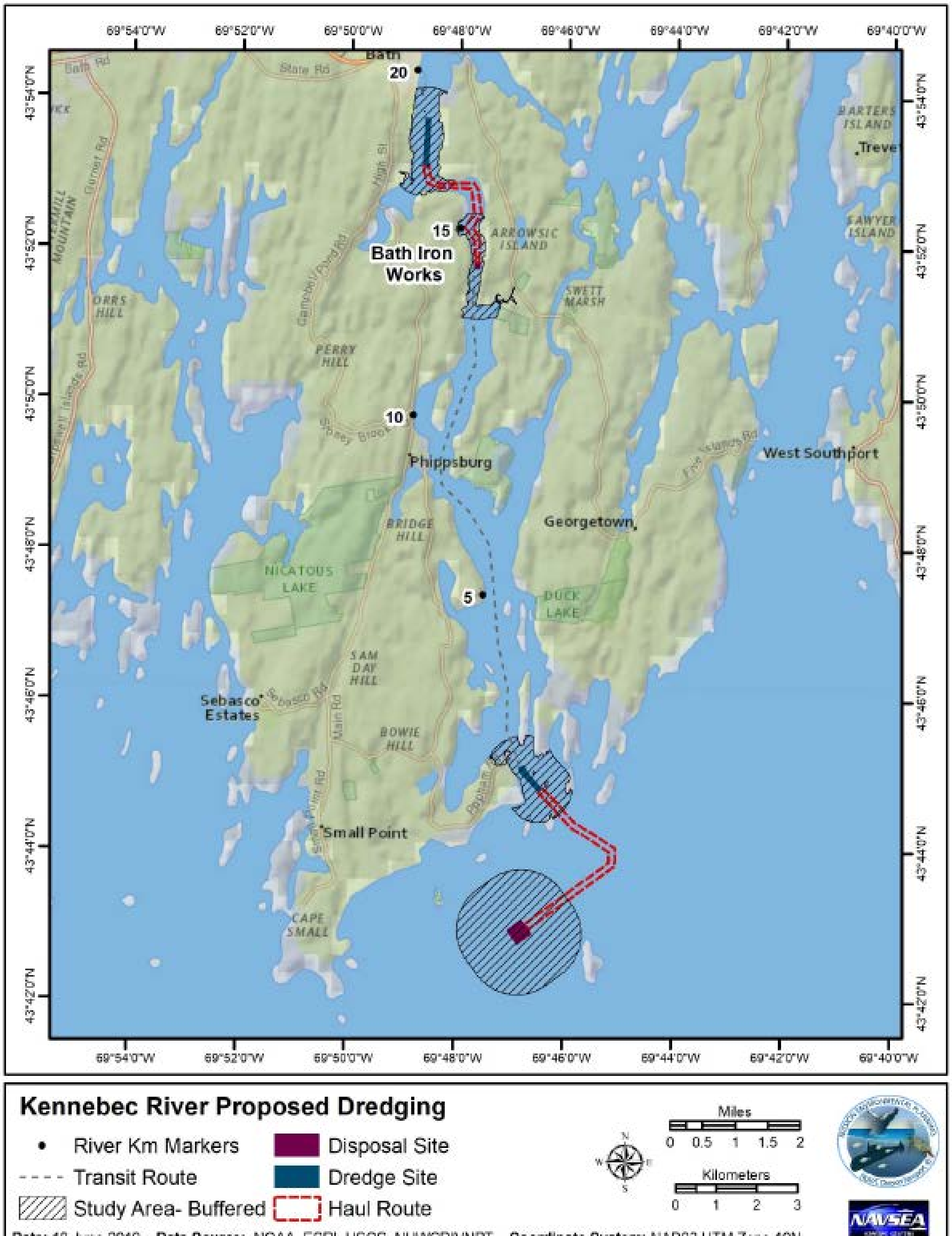

Figure 3: Approximate Action Area for Kennebec River FNP Dredging and Disposal (U.S. Navy 2019)

3.3.2 Habitat in the Action Area

From its source at Moosehead Lake in west-central Maine, to the point where it empties into the Atlantic Ocean, the Kennebec River is approximately 225 km long (Fenster and Fitzgerald 1996). Upstream from the action area in Merrymeeting Bay, the Kennebec River Estuary receives water from six different river systems, the two largest of which are the Kennebec and Androscoggin Rivers. Together, these two rivers drain roughly a third of the land area of Maine (Moore and Reblin 2010). In the lower estuary, the Kennebec is also connected to the Sheepscot River in two places by the Sasanoa River (just north of the action area, east of Bath, ME) and the Back River (within the action area, near Georgetown, ME).

The Kennebec River is a complex estuarine system draining Sagadahoc County below Merrymeeting Bay. Landward of the beaches and ebb deltas near at the estuary's mouth, lower-energy intertidal communities are represented by saltmarshes and mudflats that fringe the Kennebec channel. The area has extensive salt marshes and is abutted by sand flats with productive shellfish habitat. The habitat adjacent to the dredge and disposal sites can be characterized as undeveloped marshland with silty sand sediments, rocky intertidal areas or sandy beaches. Moving north in the estuary, as salinities decline, freshwater and brackish tidal marshes become more common at about 16 km (10 mi) from the river's mouth, supplanting saltmarshes as the dominant inter-tidal community (Moore 2010).

The U.S. Fish and Wildlife Service characterizes the Kennebec River north of Merrymeeting Bay as "tidal riverine" and the area below Merrymeeting Bay as an estuarine subsystem. Depending on the river flows and the strength of the tide, marine waters typically penetrate up the estuary between 5 and 35 km (3–22 mi) from the Kennebec's mouth (Kistner and Pettigrew 2001).

The Kennebec River estuary is an elongate, rock-bound estuary where the lower estuary (approximately 27 km from the mouth) is characterized by salt-water intrusion. Semidiurnal tides have a mean range of 8 ft and a maximum spring range of 11.5 ft. The Kennebec River estuary has a strong ebb-current dominance that is produced primarily through spring snowmelt floods (freshets) (Fenster and FitzGerald 1996; Fenster et al. 2001). The unique geology, extreme discharge seasonality, and large tidal ranges create transport of coarse-grained sediment from the lower 17 mi of the river to the nearshore and coastal region of south-central Maine (Fenster and FitzGerald 1996; Fenster et al. 2005; Fenster et al. 2001; FitzGerald et al. 2005). The Kennebec Estuary is one of the primary sources of freshwater to the Gulf of Maine with a discharge that ranges between 100 cubic meters per second (m^3/s) and 4,000 m^3/s (annual mean = 425 m^3/s) (Kistner and Pettigrew 2001). Freshwater annual discharge averages approximately 341 cy per second at the Kennebec River estuary mouth, but varies seasonally from summer and mid-winter low flows to early winter and late spring high flows (Fenster and FitzGerald 1996). Spring flood freshwater discharge can exceed average daily flows by an order of magnitude in the lower estuary (Stumpf and Goldschmidt 1992).

As noted above, the authorized FNP in the lower Kennebec River consists of a channel 8.2 m (27 ft) deep at MLLW extending about 21 km (13 mi) upstream from the river mouth to the city of Bath. However, sediment transport creates shoals and sand waves in several areas of the channel, including Doubling Point, with varying elevations at the ranging from -5.6 m (18.4 ft) to -8.1 m (26.5 ft) MLLW. Elsewhere in the lower estuary, main channel depths occur naturally from 17 m (58 ft) near the mouth to less than 10 m (33 ft) in the Kennebec River above Merrymeeting Bay (Moore and Reblin 2010). While the channel authorized by the FNP is 152 m (500 ft) wide, the natural width of the river in the action area ranges from approximately 200-1,525 m. Substrate in the lower estuary consists mainly of sand, with some outcrops of bedrock; however, portions of the river that experience lower energy flows (e.g., coves, margins along the banks) are composed of some finer materials (Fenster and Fitzgerald 1996; Moore and Reblin 2010). At Bath, the tidal range averages 2.1 m, greatly influencing the salinity throughout the action area, from approximately 5-25 parts per thousand (ppt) just downstream of Bath (Moore and Reblin 2010).

Doubling Point Dredge Site

The west side of the Kennebec River in the vicinity of Doubling Point is the developed riverbank of Bath, while the east side of the riverbank is largely underdeveloped land of Arrowsic. The current flow in the Doubling Point area of the Kennebec River has north/south orientation prior to a shift to in the east direction before reaching Bluff Head to the south. At the Doubling Point area, the Winnegance Creek marsh system is supplied by river flow southwestward from Hospital Point. The mean tidal range in this region is 6.8 ft and the diurnal range is 7.4 (NOAA 2019a). High and low water occur approximately one hour after the tide at the river mouth.

Freshwater outflow of the Kennebec River is a result of the seasonal runoff from rain and snowmelt. The influx of salt water on the incoming tide creates an approximate six-foot tidal flux. The physical properties of fresh water make it less dense than saltwater and, as the outflow of freshwater encounters the saline influx a layering effect (halocline) occurs. The intrusion of saltwater is greater along the bottom of the river and the outflow of freshwater is strongest towards the top of the water column, and the mixing and dilution along the salinity gradient creates “salt wedge” layering with seasonal salinity variations (approximately 10–28 practical salinity units [psu], 10–20 psu in mid estuary) (Mayer et al. 1996; Wong and Townsend 1999). The extent, range and concentrations for the salt wedge are dependent on lunar cycles, precipitation levels and other meteorological conditions. The salt wedge has been identified as extending seven kilometers upstream of the proposed action area. During the fall of 2007, the mean water column salinities near Bath, ME (close to the Doubling Point dredging site) was 6 ppt at or near low tide and 16 ppt at high tide, classifying the Doubling Point dredging site as mesohaline (average 5.0-18.0 ppt) (Moore 2010; Odum 1988).

Salinity data collected in the Kennebec River by Hubbard (1986) depicted a riverine/estuarine interaction. The results reflect a dominance of riverine influence at this upstream area from the proposed dredging. The biota in the vicinity of the upstream river proposed action area is estuarine. Field work conducted by the Corps in 1986 (Hubbard 1986) showed that saline intrusion does occur through and above the Doubling Point area. The water quality classification for the Doubling Point area is Class SB (See Section 4.1.3.2 for additional detail). Grain size analysis of the dredged material has been performed in 1971, 1977, 1979, 1986, 1988, 1989, 1991, and 1995, and 2010. The results of this testing has always shown the material to be sand, usually medium or medium to fine grained; sometimes with traces of silt and/or gravel. This material is a result of the current scour that prohibits settling of fine grained silts and clays.

On a daily cycle, the Kennebec River below the Chops (upstream of the City of Bath) has reversing currents driven by the rise and fall of the tides (Fenster et al. 2001). Bidirectional (flood and ebb) transport of bedload (river-bottom) sand in the Kennebec River estuary results in a "bedload convergence zone" in Doubling Point Channel. A zone of bedload convergence in tide-dominated estuaries occurs where dual-directional sediment transport converges and induces sediment deposits (Anthony 2009; Dalrymple and Choi 2007). Sand is transported downstream in the river-dominated section of the Kennebec River from Merrymeeting Bay (Fenster et al. 2005; FitzGerald et al. 2000) where it accumulates in the form of large sand waves in a bedload convergence zone, creating sand features that need to be periodically dredged. Sand may also be transported upstream to the bedload convergence zone from south of Doubling Point.

Popham Beach Dredge Site

Water movement in the vicinity of the Popham Beach dredging area reflects the riverine outwash nature of this coastal constriction. The Kennebec is classified as a mesotidal estuary (FitzGerald et al. 2000); the daily tidal range at its mouth averages 2.6 m (8.5 ft), though during spring tides the range can be as large as 2.8 m (9.2 ft)(NOAA 2019a). Maximum flood tides run 332 degrees at 2.4 knots while maximum ebb tides run 151 degrees at 2.9 knots.

Extreme shoreline change and dune erosion occurs along the beaches in this area. Grain size samples were collected from the Popham beach dredge area in 1995 and 2010. In general, the material was coarser in 1995 with a larger percentage of gravel and coarse sand than was collected in 2010. Overall the material from this area of the Kennebec is medium to fine sand with 0.8% or less fines (silt/clay). The biota in the vicinity of the Popham Beach proposed action area is characteristically more marine than the Doubling Point and Bluff Head areas, but the salinity will vary with the amount of freshwater moving downstream especially after spring storms.

Bluff Head (In-River) Disposal Site

The disposal of material dredged from the channel near Doubling Point will occur at an in-river site 2,500 ft north of Bluff Head. The disposal site is located at a deep portion of the channel, with waters up to approximately 30-100 ft deep with an average depth of 76.5 ft and is 500 ft wide by 500 ft long located within the Federal channel. The site is about two mi downriver of the proposed dredge site. The shoreline is rocky intertidal or marsh and with much of the upland areas forested.

At Bath, the tidal range averages 2.1 m (6.8 ft) (National Oceanic and Atmospheric Administration 2019a). Tidal currents between the Kennebec River entrance and Bath have average velocities at strength of 2 to 3 knots (NOAA 2019b). Ebb velocities up to 6 knots have been observed, and considerably larger velocities may be expected during freshets (National Oceanic and Atmospheric Administration 2019b). The disposal area is estuarine with salinities varying (10–20 psu) with river runoff (Mayer et al. 1996; Wong and Townsend 1999).

Sediments from the river bed in this area of the Kennebec can be carried upstream by flood currents that are stronger than ebb currents or downstream in the mouth of the river when freshwater discharge exceeds 294–425 yd3/s (FitzGerald et al. 2005). In 1981, USACE conducted several hydrographic surveys, before disposal, one-month post-disposal and 10 months post-disposal. The average depth for the disposal area and surveyed regions up to approximately 1000 ft downstream were all slightly shallower (5–10 ft) one month after disposal, but all surveyed areas even the site 300 ft upstream of the disposal area had eroded some (2–7 ft) 10 months post-disposal (Hubbard 1982). Only one grain size sample was collected from the Bluff Head disposal area in 1986 and the material consisted medium grained sand. Fenster and FitzGerald (1996) describe the particularly narrow regions of the channel (i.e., 820 ft in Fiddler Reach) as absent of all semi-consolidated and unconsolidated sediment units and the bedrock basement forming the channel bottom. The Bluff Head disposal area is an erosional area with sand moving through the area but not expected to stay in the area over the long-term.

Jackknife Ledge Disposal Site

Jackknife Ledge is located southwest of the mouth of the Kennebec River in the GOM. The proposed disposal area for material dredged from the Popham Beach area is located about 0.4 nm south of Jackknife Ledge in depths of about 40 to 50 ft. This previously used site has an area of approximately 2,250,000 square ft (51.7 acres)

In 1989 the Maine Geological Survey Unit conducted a side-scan sonar survey of Jackknife Ledge disposal area. The disposal area was mapped as sand with some gravel located 50–100 yards south of the outer edge of the site and the closest mapped rock was approximately 400 yards from the edge. In 2010, a grab sample was taken from the center of the disposal area and analyzed for grain size; the material was found to be medium to fine grained sand.

There is a clockwise, sand-circulation cell that involves the exchange of bedload among the entrance channel to the Kennebec estuary, adjacent beaches, nearshore, and offshore region (FitzGerald et al. 2000). Fitzgerald and Fink (1987) first described the cyclic nature of the sand budget for this area. Their study concludes that the glacially deposited beach is renourished by a sediment gyre. Wave action moves sediments easterly along the beachfront to be transported into the Kennebec River by flood tidal and wave energy. The rivers ebb delta brings the sand back seaward to be reworked onto the beach face. In the past, this site was previously selected as a disposal site because it is believed that sand deposited there will remain in the near shore system and may help to indirectly re-nourish the glacially deposited beach due to the prevalent sediment gyre (Goldschmidt et al. 1991) and wave action.

4.0 STATUS OF LISTED SPECIES AND CRITICAL HABITAT IN THE ACTION AREA

We have determined that the action considered in this biological opinion may affect the following endangered or threatened species and critical habitat under our jurisdiction (Table 4):

Table 2: ESA-listed species and critical habitat in the action area

ESA-Listed Species	Latin Name	Distinct Population Segment (DPS)	Federal Register (FR) Citation	Recovery Plan
Atlantic Salmon	*Salmo salar*	Gulf of Maine	74 FR 29344	NMFS & USFWS 2019

ESA-Listed Species	**Latin Name**	**Distinct Population Segment (DPS)**	**Federal Register (FR) Citation**	**Recovery Plan**
Atlantic Sturgeon	*Acipenser oxyrinchus oxyrinchus*	Gulf of Maine; New York Bight	77 FR 5880	N/A
Shortnose Sturgeon	*Acipenser brevirostrum*	Range-wide	32 FR 4001	NMFS 1998
Leatherback Sea Turtle	*Dermochelys coriacea*	Range-wide	35 FR 849	NMFS & USFWS 1992
Loggerhead sea turtle	*Caretta caretta*	Northwest Atlantic DPS	76 FR 58868	NMFS & USFWS 2008
Kemp's ridley sea turtle	*Lepidochelys kempii*	Range-wide	35 FR 18319	NMFS et al. 2011
Green sea turtle	*Chelonia mydas*	North Atlantic DPS	81 FR 20057	NMFS & USFWS 1991
Designated Critical Habitat (species)	**Latin Name**	**Distinct Population Segment (DPS)**	**Federal Register (FR) Citation**	**Recovery or River Unit**
Atlantic Salmon	*Salmo salar*	Gulf of Maine	74 FR 29300	Merrymeeting Bay Salmon Habitat Recovery Unit
Atlantic Sturgeon	*Acipenser oxyrinchus oxyrinchus*	Gulf of Maine	82 FR 39160	Kennebec River Unit

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

4.1 Species and Critical Habitat Not Likely to be Adversely Affected by the Proposed Action

4.1.1 Sea Turtles

Four species of federally listed threatened or endangered sea turtles may be seasonally found in coastal waters of New England including the action area. These species include the threatened Northwest Atlantic Ocean distinct population segment (DPS) of loggerhead and North Atlantic DPS of green, and endangered Kemp’s ridley and leatherback sea turtles. Sea turtles are generally distributed in coastal Atlantic waters from Florida to New England. As water temperatures of coastal New England rise in the spring, turtles begin to migrate north from their overwintering waters in the south. Sea turtles are expected to be found in the New England waters during the summer and fall months (May-November) when the water temperatures are at least 59° F (Shoop and Kenney 1992) with the higher concentrations of turtles from May through

October (Morreale 1999; Morreale and Standora 2005). While the presence of any of the four species in the action area is extremely rare, leatherback sea turtles are most commonly sighted (Sea Turtle Sighting Hotline 2019; Kate Sampson, Sea Turtle Disentanglement Coordinator, pers. comm. 2019). We only expect sea turtles to potentially be present in the southern portion of the action area, from the mouth of the Kennebec River along the vessel route to the nearshore placement disposal site, in ocean waters. The proposed action will account for approximately 26 vessel trips and disposal events over five to seven days approximately every three years (typically from December to March when sea turtles are not present, though the potential exists for the work to occur year-round). Given the rarity with which we expect sea turtles to be present in the action area and the short term, ephemeral nature of the action in terms of vessel movement, turbidity and total suspended sediment exposure, and impacts to foraging habitat, any adverse effects to sea turtles are extremely unlikely to occur, and are therefore, discountable.

4.1.2 Atlantic Salmon (Gulf of Maine DPS) and Critical Habitat Designated for the Gulf of Maine DPS of Atlantic Salmon

The GOM DPS of anadromous Atlantic salmon was initially listed by USFWS and us (collectively, the Services) as an endangered species on November 17, 2000 (65 FR 69459). A subsequent rule issued by the Services (74 FR 29344, June 19, 2009) expanded the geographic range for the GOM DPS of Atlantic salmon. The GOM DPS of Atlantic salmon is defined as all anadromous Atlantic salmon whose freshwater range occurs in the watersheds from the Androscoggin River northward along the Maine coast to the Dennys River, and wherever these fish occur in the estuarine and marine environment. The marine range of the GOM DPS extends from the Gulf of Maine, throughout the Northwest Atlantic Ocean, to the coast of Greenland. Included in the GOM DPS are all associated conservation hatchery populations used to supplement these natural populations; currently, such conservation hatchery populations are maintained at Green Lake National Fish Hatchery (GLNFH) and Craig Brook National Fish Hatcheries (CBNFH), both operated by the USFWS, as well as private watershed-based facilities (Downeast Salmon Federation's East Machias and Pleasant River facilities). Excluded from the GOM DPS are landlocked Atlantic salmon and those salmon raised in commercial hatcheries for the aquaculture industry (74 FR 29344, June 19, 2009).

Atlantic salmon adult and smolt life stages move through the action area during their spawning and outmigration periods. Although spawning does not occur until late fall, the majority of Atlantic salmon in Maine enter freshwater between May and mid-July (Meister 1958; Baum 1997), but may enter at any time between early spring and late summer. Peak upstream migration movements in the Kennebec River occur in the month of June (Fay *et al.* 2006). The number of Atlantic salmon returning to the Kennebec River annually has been low; ranging between 5 and 64 between 2008 and 2017, with an average of approximately 26 salmon per year (USASAC 2018). These salmon would be migrating through the mainstem of the Kennebec River between April and November. Between 2014 and 2017, 125 pre-spawn Atlantic salmon were trapped at the Lockwood Dam fish trap, approximately 103 km upstream of the action area (Brookfield 2015, 2016, 2017, 2018).

After spawning, male and female Atlantic salmon (kelts) either return to sea immediately or remain in fresh water until the following spring before returning to the sea (Fay *et al.* 2006). No kelt outmigration data exists for the Androscoggin River; however, Baum (1997) reported that 20% of kelts outmigrated to the ocean in the fall, with the remaining 80% migrating to the ocean in the spring.

After hatching, salmon fry remain in their natal river for three years. Once smoltification occurs, smolts begin their downstream migration between April and June. In 2015, smolt trapping studies on the Sheepscot River in the Merrymeeting Bay Salmon Habitat Recovery Unit (SHRU) indicated a median migration date of May 12 with a migration duration of 33 days (USASAC 2016). While the annual abundance of smolts in the Kennebec River is presently unknown, MDMR estimates the current egg and fry stocking in the Sandy River could be producing approximately 9,000 to 14,000 smolts annually based on life-stage survival estimates. Since 2011, 2,000 fry have been released annually to the Sandy River (USASAC, 2015). Typically, over 500,000 eggs are also planted annually in the Sandy River. Redd counts and juvenile surveys confirmed that adult salmon trucked to the Sandy River successfully spawned (MDMR 2010). In addition, some amount of natural reproduction is likely occurring in the Sandy River. We do expect the seasonal presence of downstream migrating kelts and smolts in the spring of each year; while we only expect a few kelts each year, we anticipate thousands of smolts to migrate through the action area annually.

Table 3: Timing of Atlantic salmon lifestages and behaviors in the action area

Lifestage	Time of Year Present in Action Area	Behavior in Action Area
Adults	April 1-November 30	Migration of spawning adults in the spring-fall; outmigration of kelts in the fall and spring.
Smolts	April 1-June 30	Outmigration to marine waters

4.1.2.1 Effects of the Proposed Action on the Gulf of Maine DPS of Atlantic Salmon

As noted, above, when possible, dredge events will occur from December 1 to March 1, an in-water work window designed to protect diadromous fish, including sturgeon; however, as many as two dredge events may occur from March 2 to November 30 between 2019 and 2029.

Dredge Entrainment and Capture

There are no known incidences of Atlantic salmon being captured in a hopper or mechanical dredge. As Atlantic salmon are highly mobile and not likely to be concentrated in the action area there is little risk of individuals being entrained or captured. The risk of entrainment and capture is further reduced by the distribution of Atlantic salmon in the upper water column, not near the bottom where the drag heads and mechanical buckets are actively dredging. Though a dredge bucket may be open (depending on the type of bucket used) as it travels through the water column, the low number and sparse spatial concentration of Atlantic salmon in the action area make effects of dredge bucket capture extremely unlikely. Furthermore, you are proposing to dredge from December 1 to March 1 whenever possible. We do not expect any salmon life stages to be present in the action area during that time of year. As such, it is extremely unlikely that any Atlantic salmon will be captured or entrained during dredging operations. Therefore, the effects of dredge entrainment or capture on Atlantic salmon are discountable.

Turbidity and Suspended Sediments

Suspended sediments can have lethal and sub-lethal effects on Atlantic salmon. Sub-lethal effects of suspended sediments can include impairment of swimming activity, respiration, and predator avoidance.

Turbidity and TSS effects to Atlantic salmon worsen with increased levels of turbidity (Newcomb 1994). Juvenile and adult salmonids show minor physiological stress and sub-lethal effects at suspended sediment concentrations of 7 mg/L for a six-day exposure and at 55 mg/L for a seven-hour exposure (Newcomb and Jensen 1996). MaineDOT's Programmatic Biological Assessment (ATS PBA 2016) outlined biological responses for Atlantic salmon and classified them into three major categories. The three categories are behavioral responses, sub-lethal effects, and potential mortality, as defined below.

Behavioral response - The range of turbidity releases expected to result in behavioral reactions ranging from a startle response to avoidance. These responses are anticipated after exposure to turbidity/suspended sediment levels of:

- 1-20 mg/L for one hour; or,
- 1 mg/L for 24 hours

Sub-lethal effects – The ranges of turbidity releases expected to result in sub-lethal effects including stress, reduction in feeding rates, and increased respiration rates. These responses are anticipated after exposure to turbidity/suspended sediment levels of:

- 20-22,026 mg/L for one hour; or,
- 1 mg/L for six days

Potential mortality - A higher range of releases has the potential to result in fish mortality. These responses are anticipated after exposure to turbidity/suspended sediment levels of:

- >22,026 mg/L for one hour; or,
- 7 mg/L for 30 months.

We expect that migrating adults, outmigrating kelts, and smolts will be present in the action area for less than one day as movement through the estuary is direct and rapid. During this migration, salmon may encounter increased levels of turbidity and suspended sediments from hopper dredging activities and disposal of dredged material.

As discussed the Effects of the Action section below, we expect that near-bottom plumes caused by hopper and mechanical dredges may extend approximately 2,400 ft (731 m) downcurrent from the dredge with TSS concentrations ranging from 80.0-475.0 mg/L ((USACE 1983; Anchor Environmental 2003). During the discharge of sediment at offshore disposal sites, we expect TSS levels as high as 500.0 mg/L within 250 ft (76 m) of the disposal vessel and decreasing to background levels (i.e., 15.0-100.0 mg/L depending on location and sea conditions) within 4,000 ft (1219 m) (ACOE 1983). As the substrate in the action area is predominantly sand with little fine material (i.e., silt), which generates very little turbidity when disturbed and settles through the water column quickly (likely in a matter of minutes), these are likely very conservative estimates (both the distance of the turbidity plume and the TSS levels). We expect disposal events to last for approximately 5 minutes, and occur approximately 8-10 times a day, with at least an hour between disposal events and conditions returning to background levels between disposal events. Based on past events, dredging will occur for approximately 10 non-continuous hours per day, with breaks for disposal and to move from one area requiring dredging to another.

Consistent with the categories above, salmon may have encountered TSS levels reaching approximately 500 mg/L in the action area. While this TSS level falls within a range that can result in sub-lethal effects, the highest TSS levels were measured very close to the draghead (i.e., at the riverbed) and in close proximity to the point of disposal. Because we expect salmon adults, kelts, and smolts to quickly move through the estuary using the upper portion of the water column, we do not expect that the action will have any effects on salmon beyond a brief avoidance response, as they may avoid quickly settling sand. Therefore, given the short period of time we expect salmon to spend in action area, along with the ephemeral nature of the stressor, we expect any effects to salmon migration (i.e., migratory delay due to avoidance of the portion of the river with elevated TSS) to be so small that they cannot be meaningfully measured, detected or evaluated, and therefore, insignificant.

Habitat Modification

The action may create temporary disturbances within Atlantic salmon migratory habitat from the presence of an active hopper or mechanical dredge, hopper or scow movement to disposal areas, and increases in turbidity from dredging and disposal activities. Given the short period of time that in-water work is anticipated to occur in an event (approximately 5-7 days), if salmon adults, kelts, or smolts enter the action area while in-water work is occurring (or indirect effects were still present), we expect they will be able to continue their migration through the habitat without delay by making minor evasive movements. Any effects to water quality from increasing the depth of the channel and increases in TSS and turbidity (i.e., water temperature, salinity, dissolved oxygen) are also either temporary or too small to be meaningfully measured or detected (i.e., dredging will only occur in a small portion of the channel, which is itself only a small portion of the lower Kennebec estuary).

Therefore, any modifications to salmon habitat in the action area are minor and temporary, and their effects on salmon use of the habitat are too small to be meaningfully measured or detected, and are insignificant.

4.1.2.2 Physical and Biological Features of Atlantic Salmon Critical Habitat in the Action Area

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

As part of the 2009 GOM DPS listing and designation of critical habitat, we defined three Salmon Habitat Recovery Units (SHRU): the Merrymeeting Bay SHRU, the Penobscot Bay SHRU, and the Downeast Coastal SHRU (Figure 4). As defined in the Endangered Species Consultation Handbook, a Recovery Unit is a “management subset of the listed species that is created to establish recovery goals or carry out management actions.” The NMFS Interim Recovery Plan Guidance goes on to state that recovery units are frequently managed as management units, though makes the distinction that recovery units are deemed necessary to both the survival and recovery of the species, whereas management units are defined as not always being "necessary" to both the survival and recovery[1].

The action area occurs within the Merrymeeting Bay SHRU. Outside of marine survival, dams are the greatest impediment to the recovery of salmon in the Penobscot, Kennebec, and Androscoggin river basins (Fay et al. 2006). Hydropower dams in the Merrymeeting Bay SHRU significantly impede the migration of Atlantic salmon and other diadromous fish and either reduce or eliminate access to roughly 352,000 units of historically accessible spawning and rearing habitat. In addition to hydropower dams, agriculture and urban development largely affect the lower third of the Merrymeeting Bay SHRU by reducing substrate and cover, reducing water quality, and elevating water temperatures. Additionally, smallmouth bass and brown trout introductions, along with other non-indigenous species, significantly degrade habitat quality throughout the Merrymeeting Bay SHRU by altering natural predator/prey relationships.

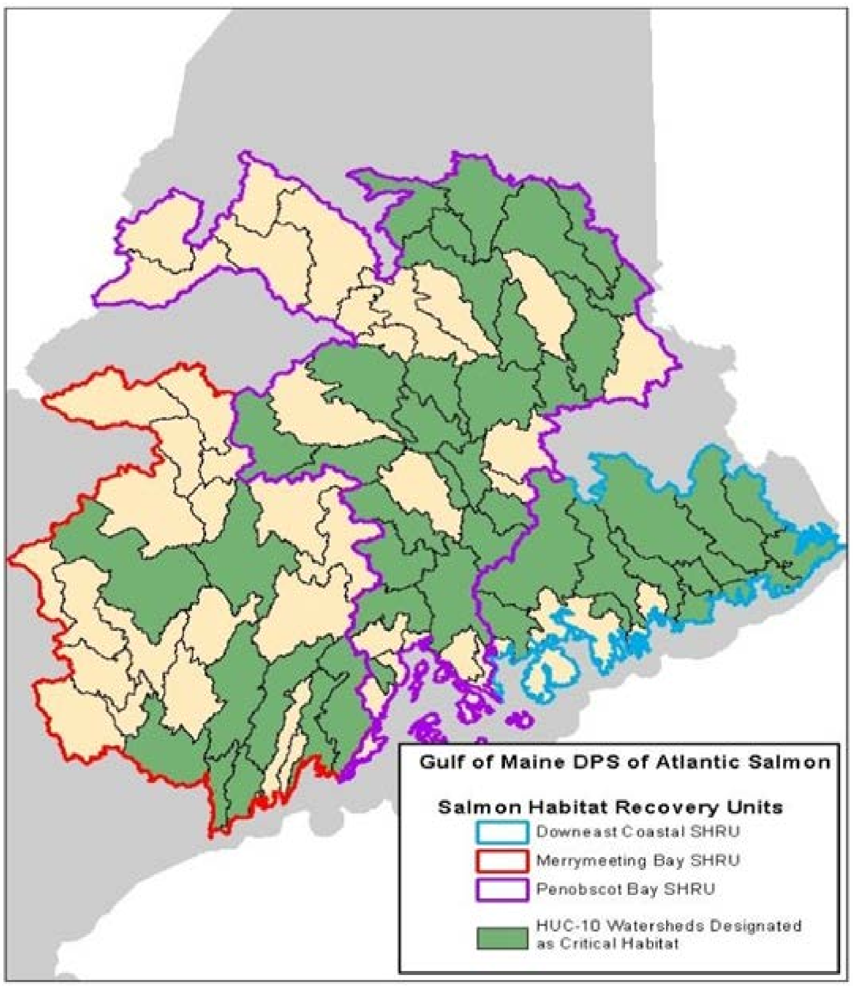

Figure 4: HUC-10 Watersheds Designated as Atlantic Salmon Critical Habitat and Salmon Habitat Recovery Units within the GOM DPS

[1] https://www.fisheries.noaa.gov/national/endangered-species-conservation/endangered-species-act-guidance-policies-and-regulations

Designation of critical habitat is based on the known physical and biological features within the occupied areas of a listed species that are deemed essential to the conservation of the species. For the GOM DPS, the physical and biological features (PBFs) essential for the conservation of Atlantic salmon are: 1) sites for spawning and rearing, and, 2) sites for migration (excluding marine migration[2]). We chose not to separate spawning and rearing habitat into distinct PBFs, although each habitat does have distinct features, because of the GIS-based habitat prediction model approach that was used to designate critical habitat (74 FR 29300; June 19, 2009). This model cannot consistently distinguish between spawning and rearing habitat across the entire range of the GOM DPS.

The physical and biological features for Atlantic salmon critical habitat are as follows:

Physical and Biological Features of Spawning and Rearing Habitat

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

Physical and Biological Features of Migratory Habitat

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

[2] Although successful marine migration is essential to Atlantic salmon, we were not able to identify the essential features of marine migration and feeding habitat or their specific locations at the time critical habitat was designated.

5. Freshwater and estuary migration sites with sufficiently cool water temperatures and water flows that coincide with diurnal cues to stimulate smolt migration.
6. Freshwater migration sites with water chemistry needed to support sea water adaptation of smolts.

Habitat areas designated as critical habitat must contain one or more physical and biological features within the acceptable range of values required to support the biological processes for which the species uses that habitat. Critical habitat includes all perennial rivers, streams, and estuaries and lakes connected to the marine environment within the range of the GOM DPS, except for those areas that have been specifically excluded as critical habitat. Critical habitat has only been designated in areas (HUC-10 watersheds) considered currently occupied by the species. Critical habitat includes the stream channels within the designated stream reach and includes a lateral extent as defined by the ordinary high-water line or the bankfull elevation in the absence of a defined high-water line. In estuaries, critical habitat is defined by the perimeter of the water body as displayed on standard 1:24,000 scale topographic maps or the elevation of extreme high water, whichever is greater.

To facilitate and standardize determinations of effect for section 7 consultations involving Atlantic salmon critical habitat, we developed the “Matrix of Essential Features for Designated Atlantic Salmon Critical Habitat in the GOM DPS” (Table 4). The matrix lists the physical and biological features (essential features) of Atlantic salmon habitat, and the potential conservation status of critical habitat within an action area. Two essential features in the matrix (spawning and rearing, and migration) are described in regards to five distinct Atlantic salmon life stages: 1) adult spawning; 2) embryo and fry development; 3) parr development; 4) adult migration; and, 5) smolt migration. The conservation status of the essential features may exist in varying degrees of functional capacity within the action area. The three degrees of functional capacity used in the matrix are described in ascending order: 1) fully functioning; 2) limited function; and 3) not properly functioning.

Table 4: Matrix of essential features for assessing the functioning of critical habitat in the action area

	Conservation Status Baseline		
Essential Features	Fully Functioning	Limited Function	Not Properly Functioning
A) Adult Spawning (October 1st - December 14th)			
Substrate	highly permeable course gravel and cobble between 1.2 to 10 cm in diameter	40- 60% cobble (22.5-256 mm dia.) 40-50% gravel (2.2 – 22.2 mm dia.); 10-15% course sand (0.5 -2.2 mm dia.), and <3% fine sand (0.06-0.05mm dia.)	more than 20% sand (particle size 0.06 to 2.2 mm), no gravel or cobble
Depth	17-30 cm	30 - 76 cm	< 17 cm or > 76 cm
Velocity	31 to 46 cm/sec.	8 to 31cm/sec. or 46 to 83 cm/sec.	< 5-8 cm/sec. or > 83cm/sec.
Temperature	7º to 10ºC	often between 7º to 10ºC	always < 7º or > 10ºC

Essential Features	Fully Functioning	Limited Function	Not Properly Functioning
pH	> 5.5	between 5.0 and 5.5	< 5.0

Conservation Status Baseline

Essential Features	Fully Functioning	Limited Function	Not Properly Functioning
Cover	Abundance of pools 1.8-3.6 meters deep (McLaughlin and Knight 1987). Large boulders or rocks, over hanging trees, logs, woody debris, submerged vegetation or undercut banks	Limited availability of pools 1.8-3.6 meters deep (McLaughlin and Knight 1987). Large boulders or rocks, over hanging trees, logs, woody debris, submerged vegetation or undercut banks	Absence of pools 1.8-3.6 meters deep (McLaughlin and Knight 1987). Large boulders or rocks, over hanging trees, logs, woody debris, submerged vegetation or undercut banks
Fisheries Interactions	Abundant diverse populations of indigenous fish species	Abundant diverse populations of indigenous fish species, low quantities of non-native species present	Limited abundance and diversity of indigenous fish species, abundant populations of non-native species
B) Embryo and Fry Development: (October 1st - April 14th)			
Temperature	0.5ºC and 7.2ºC, averages nearly 6oC from fertilization to eye pigmentation	averages < 4 ºC, or 8 to 10ºC from fertilization to eye pigmentation	>10ºC from fertilization to eye pigmentation
D.O.	at saturation	7-8 mg/L	< 7 mg/L
pH	> 6.0	6 - 4.5	< 4.5
Depth	5.3-15cm	NA	<5.3 or >15cm
Velocity	4 – 15cm/sec.	NA	<4 or > 15cm/sec.
Fisheries Interactions	Abundant diverse populations of indigenous fish species	Abundant diverse populations of indigenous fish species, low quantities of non-native species present	Limited abundance and diversity of indigenous fish species, abundant populations of non-native species
C) Parr Development: (All year)			
Substrate	gravel between 1.6 and 6.4 cm in diameter and boulders between 30 and 51.2 cm in diameter. May contain rooted aquatic macrophytes	gravel < 1.2cm and/or boulders > 51.2. May contain rooted aquatic macrophytes	no gravel, boulders, or rooted aquatic macrophytes present

Essential Features	Fully Functioning	Limited Function	Not Properly Functioning
Depth	10cm to 30cm	NA	<10cm or >30cm
Velocity	7 to 20 cm/sec.	< 7cm/sec. or > 20 cm/sec.	velocity exceeds 120 cm/sec.
Temperature	15° to 19°C	generally between 7- 22.5 °C, but does not exceed °C at any time	stream temperatures are continuously < °C or known to exceed 29 °C

Conservation Status Baseline

Essential Features	Fully Functioning	Limited Function	Not Properly Functioning
D.O.	> 6 mg/L	2.9 - 6 mg/L	< 2.9 mg/L
Food	Abundance of larvae of mayflies, stoneflies, chironomids, caddisflies, blackflies, aquatic annelids, and mollusks as well as numerous terrestrial invertebrates and small fish such as alewives, dace or minnows	Presence of larvae of mayflies, stoneflies, chironomids, caddisflies, blackflies, aquatic annelids, and mollusks as well as numerous terrestrial invertebrates and small fish such as alewives, dace or minnows	Absence of larvae of mayflies, stoneflies, chironomids, caddisflies, blackflies, aquatic annelids, and mollusks as well as numerous terrestrial invertebrates and small fish such as alewives, dace or minnows
Passage	No anthropogenic causes that inhibit or delay movement	Presence of anthropogenic causes that result in limited inhibition of movement	barriers to migration known to cause direct inhibition of movement
Fisheries Interactions	Abundant diverse populations of indigenous fish species	Abundant diverse populations of indigenous fish species, low quantities of non-native species present	Limited abundance and diversity of indigenous fish species, abundant populations of non-native species

D) Adult migration (April 15th- December 14th)

Velocity	30 cm/sec to 125 cm/sec	In areas where water velocity exceeds 125 cm/sec adult salmon require resting areas with a velocity of < 61 cm/s	sustained speeds > 61 cm/sec and maximum speed > 667 cm/sec
D.O.	> 5mg/L	4.5-5.0 mg/L	< 4.5mg/L
Temperature	14 – 20°C	temperatures sometimes exceed 20 °C but remain below 23°C.	> 23°C
Passage	No anthropogenic causes that delay migration	Presence of anthropogenic causes that result in limited delays in migration	Presence of anthropogenic barriers to migration known to cause significant delay, injury, or mortality of adults

Essential Features	Fully Functioning	Limited Function	Not Properly Functioning
Fisheries Interactions	Abundant diverse populations of indigenous fish species	Abundant diverse populations of indigenous fish species, low quantities of non-native species present	Limited abundance and diversity of indigenous fish species, abundant populations of non-native species
E) Juvenile Migration: (April 15th - June 14th)			
Temperature	8 - 11oC	5 - 11ºC.	< 5 ºC or > 11 ºC
pH	> 6	5.5 - 6.0	< 5.5
	Conservation Status Baseline		
Essential Features	Fully Functioning	Limited Function	Not Properly Functioning
Passage	No anthropogenic causes that delay migration	Presence of anthropogenic causes that result in limited delays in migration	barriers to migration known to cause direct or indirect mortality of smolts

Within the action area, several PBFs for Atlantic salmon migration for the juvenile (smolt) and adult life stages are present. These PBFs are:

***Migration PBF M1**. 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.*
***Migration PBF M3**. Freshwater and estuary migration sites with abundant, diverse native fish communities to serve as a protective buffer against predation.*
***Migration PBF M4**. Freshwater and estuary migration sites free from physical and biological barriers that delay or prevent emigration of smolts to the marine environment.*

There is no freshwater within the action area, so none of the seven PBFs of spawning and rearing habitat are present. The action area primarily consists of the main river channel and a nearshore disposal area with a swift current and mostly sandy bottom. As such, we have determined that Migration PBF M2 (i.e., freshwater and estuary migration sites with pool, lake, and in-stream habitat that provide cool, oxygenated water and cover items (e.g., boulders, woody debris, and vegetation) to serve as temporary holding and resting areas during upstream migration of adult salmon) does not occur in the action area. Any smolts entering the action area have already experienced the water temperature, flows, and diurnal cues to stimulate their migration, because once in the action area, their downstream migration to the lower estuary and ocean is nearly complete. Therefore, we do not expect any further smolt migration stimulation to occur or be needed, and Migration PBF 5 does not occur in the action area (i.e., freshwater and estuary migration sites with sufficiently cool water temperatures and water flows that coincide with diurnal cues to stimulate smolt migration). Similarly, we expect freshwater migration sites with the water chemistry to support sea water adaption of smolts (PBF 6) to occur upstream of the action area, because once they enter the action area they will have been in a mostly saline environment for approximately 10 rkm (where Merrymeeting Bay meets the lower Kennebec estuary). Therefore, we do not expect Migration PBF 6 to occur in the action area.

4.1.2.3 Effects of the Proposed Action on Critical Habitat Designated for the Gulf of Maine DPS of Atlantic Salmon

As detailed in section 4.1.2, the action area occurs within the Merrymeeting Bay SHRU, and we have determined that several critical habitat Migration PBFs are present (PBFs M1, M3, and M4). In this analysis, we consider the direct and indirect effects of the action on the identified PBFs. For each feature that may be affected by the action, we then determine whether any effects to the feature are insignificant, discountable, or entirely beneficial. In making this determination, we consider the action's potential to affect how each PBF supports the conservation needs of Atlantic salmon in the action area. Part of this analysis is consideration of whether the action will have effects on the ability of Atlantic sturgeon to access the feature, temporarily or permanently, and consideration of the effect of the action on the action area's ability to develop the feature over time.

<u>Migratory PBF 1:</u>
Freshwater and estuary migratory sites free from physical and biological barriers that delay or prevent access of adult salmon seeking spawning grounds needed to support recovered populations.

The proposed action may have temporary negative effects on PBF M1 by creating in water stressors from dredging and disposal activities; however, as described above, none of the proposed activities will be barriers to the movement of adult Atlantic salmon. Based on our assessment, these impediments to movement are extremely unlikely to affect the function of PBF M1 to the conservation of the species in the action area; that is, it is extremely unlikely that the habitat alterations in the action area will impede the movement of adults to and from spawning sites; therefore, the effects are discountable.

<u>Migratory PBF 3:</u>
Freshwater and estuary migration sites with abundant, diverse native fish communities to serve as a protective buffer against predation.

Several diadromous species, including adult alewives, blueback herring and American shad (three unlisted anadromous clupeid species), move through the project area during their upstream migration period. Alewives generally move upstream in the Kennebec River during May. American shad and blueback herring tend to run during the latter part of the spring (i.e., late May and June).

When possible, dredging will occur from December 1 to March 1, avoiding the spawning migration of the most important native fish communities that serve as a protective buffer against Atlantic salmon predation (i.e., alewife, blueback herring, and American shad). Up to two events may occur from March 2 to November 30; however, we do not expect the temporary effects from dredging or disposal activities to impede or delay the upstream or downstream passage of these species. Therefore, we do not expect the proposed project to affect diverse native fish communities' ability to serve as a protective buffer against salmon predation.

Migratory PBF 4:
Freshwater and estuary migration sites free from physical and biological barriers that delay or prevent emigration of smolts to the marine environment.

When possible, dredging will occur from December 1 to March 1, avoiding the time of year when outmigrating smolts are expected to be in the action area (April 1 – June 30). Up to two events may occur from March 2 to November 30. Therefore, the proposed action may have temporary negative effects on PBF M3 by creating in water stressors from dredging and disposal activities; however, as described above, none of the proposed activities will be barriers to the movement of Atlantic salmon smolts. Based on our assessment, these impediments to movement are extremely unlikely to affect the function of PBF M3 to the conservation of the species in the action area; that is, it is extremely unlikely that the habitat alterations in the action area will impede the movement of adults to and from spawning sites; therefore, the effects are discountable.

Summary of Effects of Proposed Activities on Atlantic Salmon Critical Habitat
We have determined that all of the effects of the proposed maintenance dredging and disposal on critical habitat designated for the GOM DPS of Atlantic salmon, including PBFs M1, M3, and M4, are insignificant or discountable.

4.1.3 Critical Habitat Designated for the Gulf of Maine DPS of Atlantic Sturgeon

4.1.3.1 Physical and Biological Features of Atlantic Sturgeon Critical Habitat in the Action Area
On August 17, 2017, we issued a final rule to designate critical habitat for the threatened Gulf of Maine DPS of Atlantic sturgeon, the endangered New York Bight DPS of Atlantic sturgeon, the endangered Chesapeake Bay DPS of Atlantic sturgeon, the endangered Carolina DPS of Atlantic sturgeon, and the endangered South Atlantic DPS of Atlantic sturgeon (82 FR 39160). The rule was effective on September 18, 2017. The action area overlaps with the Kennebec River critical habitat unit designated for the Gulf of Maine DPS.

The conservation objective identified in the final rule is to increase the abundance of each DPS by facilitating increased successful reproduction and recruitment to the marine environment. We designated five critical habitat units to achieve this objective for the Gulf of Maine DPS: (1) Penobscot River main stem from the Milford Dam downstream for 53 river kilometers (rkm) to where the main stem river discharges at its mouth into Penobscot Bay; (2) Kennebec River main stem from the Ticonic Falls/Lockwood Dam downstream for 103 rkm to where the main stem river discharges at its mouth into the Atlantic Ocean; (3) Androscoggin River main stem from the Brunswick Dam downstream for 10 rkm to where the main stem river discharges at its mouth into Merrymeeting Bay; (4) Piscataqua River from its confluence with the Salmon Falls and Cocheco rivers downstream for 19 rkm to where the main stem river discharges at its mouth into the Atlantic Ocean as well as the waters of the Cocheco River from its confluence with the Piscataqua River and upstream 5 rkm to the Cocheco Falls Dam, and waters of the Salmon Falls River from its confluence with the Piscataqua River and upstream 6 rkm to the Route 4 Dam;

and, (5) Merrimack River from the Essex Dam (also known as the Lawrence Dam) downstream for 48 rkm to where the main stem river discharges at its mouth into the Atlantic Ocean. In total, these designations encompass approximately 244 kilometers (152 mi) of aquatic habitat.

As identified in the final rule, the physical features that are essential to the conservation of the species and that may require special management considerations or protection are:

1) Hard bottom substrate (*e.g.*, rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (*i.e.*, 0.0 to 0.5 parts per thousand (ppt) range) for settlement of fertilized eggs, refuge, growth, and development of early life stages;
2) Aquatic habitat with a gradual downstream salinity gradient of 0.5 up to as high as 30 ppt and soft substrate (*e.g.*, sand, mud) between the river mouth and spawning sites for juvenile foraging and physiological development;
3) Water of appropriate depth and absent physical barriers to passage (*e.g.*, locks, dams, thermal plumes, turbidity, sound, reservoirs, gear, etc.) between the river mouth and spawning sites necessary to support:
   (i) Unimpeded movement of adults to and from spawning sites;
   (ii) Seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary; and
   (iii) Staging, resting, or holding of subadults or spawning condition adults.

   Water depths in main river channels must also be deep enough (*e.g.*, at least 1.2 m) to ensure continuous flow in the main channel at all times when any sturgeon life stage would be in the river.
4) Water, between the river mouth and spawning sites, especially in the bottom meter of the water column, with the temperature, salinity, and oxygen values that, combined, support:
   (i) Spawning;
   (ii) Annual and interannual adult, subadult, larval, and juvenile survival; and
   (iii) Larval, juvenile, and subadult growth, development, and recruitment (*e.g.*,13 °C to 26 °C for spawning habitat and no more than 30 °C for juvenile rearing habitat, and 6 milligrams per liter (mg/L) dissolved oxygen (DO) or greater for juvenile rearing habitat).

The action area for the proposed work considered in this Opinion covers approximately 1,057 acres of the Kennebec River critical habitat unit. The critical habitat designation is bank-to-bank within the Kennebec River. The action area is approximately a 19 rkm stretch in the saline reaches of the Kennebec. It contains three of the four PBFs; it does not contain PBF 1, hard bottom substrate (*e.g.*, rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (*i.e.*, 0.0 to 0.5 parts per thousand (ppt) range) for settlement of fertilized eggs, refuge, growth, and development of early life stages. Information on the PBFs within the action area is contained in the section below.

4.1.3.2 Status of Atlantic Sturgeon Critical Habitat in the Action Area

As noted above in the description of the proposed action, the action area considered in this Opinion extends from rkm 0 to rkm 19 (Figure 3). The Kennebec River critical habitat unit extends from Ticonic Falls/Lockwood Dam (approximately rkm 103) downstream to where the main stem river discharges at its mouth into the Atlantic Ocean.

PBF 2

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

Salinities in the action area (approximately 5-25 ppt), from rkm 0-19, meet the salinity range as defined in PBF 2. Substrate in the lower Kennebec estuary consists mainly of sand, with some outcrops of bedrock; however, portions of the river that experience lower energy flows (e.g., coves, margins along the banks) are composed of some finer materials (Fenster and Fitzgerald 1996; Moore and Reblin 2010). As noted above, sediment sampling results from the Doubling Point dredge area show the material to be primarily sand (medium or medium to fine grained; sometimes with traces of silt and/or gravel). Moving downstream approximately 3 rkm, the Bluff Head disposal site is located at a deep portion of the channel, with waters up to approximately 30-100 ft deep with an average depth of 76.5 ft and is 500 ft wide by 500 ft long located within the Federal channel. The only sediment sampling done at the site in 1986 returned medium grained sand. Given the flow dynamics in this narrow region of the channel which create the scour and depths of this habitat, semi-consolidated and unconsolidated sediment units are expected to be widely absent, with transitional sand moving through the area over a bedrock basement (channel bottom). Lastly, past sampling at the Popham Breach dredge area indicates that benthic habitat in this reach is medium to fine sand with 0.8% or less fines (silt/clay).

While some bedrock outcrops may exist, based on the best available information on the benthic habitat in the action area, we believe the vast majority of the critical habitat within the action area meets the defined criteria of PBF 2. You have estimated that the area of critical habitat within the action area (including the footprint of the two dredge sites and the disposal sites, the vessel transit routes, and the areas experiencing increased levels of turbidity from dredging and disposal) to be 1,057 acres.

As defined, PBF 2 focuses on soft substrates for juvenile foraging and physiological development. Based on extensive sampling, tagging, tracking, over the past several decades (see Section 5.6.1), we are confident that the action area is heavily utilized by juvenile Atlantic sturgeon from the GOM DPS. Juvenile foraging in the lower Kennebec estuary occurs primarily from April through November, with juveniles moving upstream into Merrymeeting Bay in the late fall and winter months; however, we expect that on rare occasions individuals may pass through the action area from December through March.

Activities that have impacted and will continue to impact PBF 2 include those that impact salinity and those that result in the loss or disturbance of soft sediment within the transitional salinity zone. These include activities that result in sediment disturbance and subsequent sediment deposition that buries prey species (e.g., disturbance of soft substrate by deep draft vessels such as Naval ships traveling to or from BIW), direct removal or displacement of soft bottom substrate (e.g., dredging, construction), activities that result in the contamination or degradation of habitat reducing or eliminating populations of benthic invertebrates, and activities that influence the salinity gradient (e.g., climate change, deepening of the river channel). Very few deep draft vessels with the capacity to disturb benthic sediments pass through the Kennebec River FNP to and from BIW. Beyond minor projects at marinas and piers, dredging in the action area is limited to the proposed dredging that is the subject of this Opinion (occurring approximately once every three years), as well as the dredging at the piers and sinking basin at BIW (occurring approximately once every two years).

As described in Section 5.5, water pollution and contamination have historically been, and continue to be, an issue in the Kennebec River, despite significant progress in limiting pollution and improving water quality in the past few decades. Point source discharges (e.g.., municipal wastewater, industrial cooling water or waste water) and compounds associated with discharges (e.g., metals, dioxins, dissolved solids, phenols, and hydrocarbons) contribute to poor water quality and may also impact the health benthic fauna consumed by foraging juvenile sturgeon in the transitional salinity zone. We consider the impacts of climate change in Section 6.0.

<u>PBF 3</u>

Water of appropriate depth and absent physical barriers to passage (e.g., locks, dams, thermal plumes, turbidity, sound, reservoirs, gear, etc.) between the river mouth and spawning sites necessary to support:

- *(i) Unimpeded movement of adults to and from spawning sites;*
- *(ii) Seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary; and*
- *(iii) Staging, resting, or holding of subadults or spawning condition adults.*

Water depths in main river channels must also be deep enough (e.g., at least 1.2 m) to ensure continuous flow in the main channel at all times when any sturgeon life stage would be in the river.

Following these criteria, PBF 3 is present throughout the portion of the action area that overlaps with critical habitat (i.e., rkm 0-19).

Both historically and today, the location of the Lockwood Dam (Ticonic Falls) is the upstream limit for Atlantic sturgeon in the Kennebec River. Within the action area, aside from some bankside developments (piers) and potentially some exposed boulders, there are no physical obstructions preventing passage of sturgeon. In addition to navigating around existing structures, sturgeon movements can also be impacted by gear set in the river, vessel traffic, and in-water stressors from ongoing construction projects (e.g., turbidity from dredging, sound pressure waves from pile driving, etc.). We are not aware of any ongoing construction projects in the action area.

The Kennebec River estuary experiences semidiurnal tides with mean range of 8 ft and a maximum spring range of 11.5 ft. While the channel authorized by the FNP is 152 m (500 ft) wide, the natural width of the river in the action area ranges from approximately 200-1,525 m. Depths within the action area vary. The authorized FNP in the lower Kennebec River consists of a channel 8.2 m (27 ft) deep at MLLW. Shoaling at Doubling Point creates varying elevations ranging from -5.6 m (18.4 ft) to -8.1 m (26.5 ft) MLLW. Elsewhere in the lower estuary, main channel depths occur naturally from 17 m (58 ft) near the mouth to less than 10 m (33 ft) upstream of the action area (Moore and Reblin 2010). The Bluff Head disposal site is one of the deepest natural points, reaching depths of approximately 32m (100 ft).

The action area currently supports the unimpeded movement of juvenile, subadult, and adult Atlantic sturgeon, and in addition to forage habitat, may also support staging, resting, or holding of subadults or spawning condition adults.

<u>PBF 4</u>

Water, between the river mouth and spawning sites, especially in the bottom meter of the water column, with the temperature, salinity, and oxygen values that, combined, support:

- *(i) Spawning;*
- *(ii) Annual and interannual adult, subadult, larval, and juvenile survival; and*
- *(iii) Larval, juvenile, and subadult growth, development, and recruitment (e.g.,13 °C to 26 °C for spawning habitat and no more than 30 °C for juvenile rearing habitat, and 6 milligrams per liter (mg/L) dissolved oxygen (DO) or greater for juvenile rearing habitat).*

Adhering to these criteria, PBF 4 is present throughout the action area (rkm 0-19); however, based on an exceedance of salinity tolerance, we do not expect spawning or the development of early life stages to occur the action area.

Water quality factors of temperature, salinity and dissolved oxygen are interrelated environmental variables, and are constantly changing from influences of the tide, weather, season, etc. Dissolved oxygen concentrations in water can fluctuate given a number of factors including water temperature (e.g., cold water holds more oxygen than warm water) and salinity (e.g., the amount of oxygen that can dissolve in water decreases as salinity increases). This means that, for example, the dissolved oxygen levels that support growth and development will be different at different combinations of water temperature and salinity. Similarly, the dissolved oxygen levels that we would expect Atlantic sturgeon to avoid would also vary depending on the particular water temperature, salinity, and life stage. As dissolved oxygen tolerance changes with age, the conditions that support growth and development and likewise, the dissolved oxygen levels that would be avoided, change (82 FR 39160; NMFS 2017).

Before the Clean Water Act of 1972, textile, pulp and paper, and municipalities discharged directly into the Kennebec River causing it to be one of the most heavily polluted rivers in the United States. Pollution caused reductions in fish and other aquatic organisms due to anoxic conditions during the summer months. However, even with this pollution, dissolved oxygen levels in the Androscoggin River just above the Brunswick Dam were measured at ~6 mg/L in the 1930s (Brennan et al. 1931 in Moore and Reblin 2010). With the implementation of legal mandates on pollution discharge, dissolved oxygen levels have continued to improve in the Kennebec and Androscoggin Rivers (Moore and Reblin 2010). Surveys conducted in 2004 in the Kennebec estuary from approximately Popham Beach to Merrymeeting Bay returned surface and bottom DO levels ranging from 7.2-9.1 mg/L (Souther 2005 in Moore and Reblin 2010).

In the lower Kennebec River water quality can be negatively affected by both point and non-point pollution sources in the watersheds of the Kennebec and Androscoggin rivers, located north and/or upstream of Merrymeeting Bay. These pollution sources include 8 municipal waste water treatment plants (with 6 containing combined sewer overflows), multiple agricultural farms, and multiple acres of impervious surfaces located in urban and suburban areas of the watersheds. Following rain events, pollution from these sources can be transported into the Kennebec and Androscoggin rivers as either overland runoff, or discharged directly into the river via combined sewer overflows and wastewater treatment plant bypasses. These pollutants (from both rivers) could eventually transported downstream to the lower Kennebec River, and can negatively affect the water quality and its designated uses (such as shellfish harvesting).

The State of Maine classifies all estuarine and marine waters lying within the boundaries of Sagadahoc County (county encompassing the action area), that are not otherwise classified, as Class SB waters; Phippsburg and Georgetown, which are the town adjacent to the most downstream portion of the action area near the river mouth, are Class SA waters.

Per the states regulations (§465-B)(Maine Legislature 2019):

1) Class SA waters. Class SA shall be the highest classification and shall be applied to waters which are outstanding natural resources and which should be preserved because of their ecological, social, scenic, economic or recreational importance.
    A. Class SA waters must be of such quality that they are suitable for the designated uses of recreation in and on the water, fishing, aquaculture, propagation and harvesting of shellfish, navigation and as habitat for fish and other estuarine and marine life. The habitat must be characterized as free-flowing and natural.
2) Class SB waters. Class SB waters shall be the 2nd highest classification.
    A. Class SB waters must be of such quality that they are suitable for the designated uses of recreation in and on the water, fishing, aquaculture, propagation and harvesting of shellfish, industrial process and cooling water supply, hydroelectric power generation, navigation and as habitat for fish and other estuarine and marine life. The habitat must be characterized as unimpaired.

Based on known water quality parameters of the action area, as well as past sampling, tagging, and tracking of Atlantic sturgeon in the action area, water quality in the action area is adequate to support Atlantic sturgeon annual and interannual adult, subadult, and juvenile survival; and juvenile and subadult growth, development, and recruitment.

4.1.3.3 Effects of the Proposed Action on Critical Habitat

In this analysis, we consider the direct and indirect effects of the action on the critical habitat PBFs we determined to be in the action area (section 4.1.3.1). For each PBF, we identify those activities that may affect the PBF. For each feature that may be affected by the action, we then determine whether any negative effects to the feature are insignificant, discountable, or entirely beneficial and if not, consider the consequences of those adverse effects. In making this determination, we consider the action's potential to affect how each PBF supports Atlantic sturgeon's conservation needs in the action area. Part of this analysis is consideration of the conservation value of the habitat and whether the action will have effects on the ability of

Atlantic sturgeon to use the feature, temporarily or permanently, and consideration of the effect of the action on the action area's ability to develop the feature over time.

As described above, the action area extends from rkm 0 to rkm 19 (Figure 3). The Kennebec River critical habitat unit extends from Ticonic Falls/Lockwood Dam (approximately rkm 103) downstream to where the main stem river discharges at its mouth into the Atlantic Ocean. As salinities in the action area range from approximately 5-25 ppt, the action area does not support Atlantic sturgeon spawning habitat and early life stages are not expected to be present. Therefore, PBF 1 is not present in the action area, and will not be analyzed below.

PBF 2

In considering effects to PBF 2, we consider whether the proposed action will have any effect on areas of soft substrate within transitional salinity zones between the river mouth and spawning sites for juvenile foraging and physiological development; therefore, we consider effects of the action on soft substrate and salinity and any change in the value of this feature in the action area. We also consider whether the action will have effects on access to this feature, temporarily or permanently. We also consider the effect of the action on the action area's ability to develop the feature over time.

In order to successfully complete their physiological development, Atlantic sturgeon must have access to a gradual gradient of salinity from freshwater to saltwater. Atlantic sturgeon move along this gradient as their tolerance to increased salinity increases with age. Within the action area PBF 2 occurs from approximately rkm 0 (where the final rule describes the mouth of the river entering the ocean) to approximately rkm 19, the upstream limit of direct and indirect effects of dredging. Using the best available information, we estimate the area of PBF 2 critical habitat within the action area (including the footprint of the two dredge sites and the disposal sites, the vessel transit routes, and the areas experiencing increased levels of turbidity from dredging and disposal) to be 1,057 acres. Based on extensive sampling, tagging, tracking, over the past several decades (see Section 5.8.1), we are confident that the action area is heavily utilized by juvenile Atlantic sturgeon from the GOM DPS.

The proposed action has the potential to affect (e.g., remove or bury) the substrate that supports juvenile foraging, and result in temporary reduction in the availability of benthic habitat. However, the small portion of this habitat that may be affected by the proposed action would be very small relative to the total amount of aquatic juvenile habitat available for juvenile foraging and physiological development within the action area. Specifically, the estimated area of PBF 2 to be removed or buried (45 acres for the Doubling Point dredge site, 31 acres for the Popham Beach dredge site, and 5.7 acres for the Bluff Head disposal site) is compared to the 1,057 acres of PBF 2 habitat within the action area. In total, this 81.7 acres of non-contiguous PBF 2 habitat that may be affected equates to 7.7% of the PBF 2 within the action area.

As described in Section 7.4, we expect dredged areas and the disposal site to regain their full conservation function in one to two years. Dredging and disposal in the action area may occur once every two years (5 events in 10 years). Bluff Head disposal site is a dynamic areas where we expect dredged material to be transported downstream relatively quickly, potentially lessening the effects of prey item burial. Therefore, we expect juvenile Atlantic sturgeon to have access to fully reestablished forage grounds for at least one year prior to subsequent dredging events.

Dredging 76 acres and disposing of dredged material over 5.7 acres will negatively affect PBF 2, and will contribute to the feature's inability to improve in value in the future. The repeated removal of substrates to maintain the channel depth will interrupt the establishment and succession of benthic invertebrates in these areas on which juvenile Atlantic sturgeon would otherwise feed. However, the areas to be dredged represent a small (approximately 7.7% of the area potentially supporting PBF 2 in the action area) and non-contiguous amount of the available soft bottom substrate within the action area By comparison, 92.3% (975.3 acres) of the unaffected, contiguous habitat in the action area supporting PBF 2 remains available to support juvenile foraging and development. Considering these factors, the effects of dredging this small amount of habitat (5 events in 10 years) on juvenile foraging or physiological development will be so small that they cannot be meaningfully measured, evaluated, or detected. Therefore, any effects to the value of PBF 2 to the conservation of the species are insignificant.

PBF 3

In considering effects to PBF 3, we consider whether the proposed action will have any effect on water of appropriate depth and absent physical barriers to passage (e.g., locks, dams, thermal plumes, turbidity, sound, reservoirs, gear, etc.) between the river mouth and spawning sites necessary to support: unimpeded movements of adults to and from spawning sites; seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary, and; staging, resting, or holding of subadults or spawning condition adults. We also consider whether the proposed action will affect water depth or water flow, as if water is too shallow it can be a barrier to sturgeon movements, and an alteration in water flow could similarly impact the movements of sturgeon in the river, particularly early life stages that are dependent on downstream drift. Therefore, we consider effects of the action on water depth and water flow and whether the action results in barriers to passage that impede the movements of Atlantic sturgeon. We also consider whether the action will have effects on access to this feature, temporarily or permanently and consider the effect of the action on the action area's ability to develop the feature over time.

By definition, PBF 3 is present throughout the portion of the action area that overlaps with critical habitat (i.e., rkm 0-19). Areas subject to dredging and disposal will experience localized and temporary effects (i.e., turbidity plumes, presence of vessels) that do not extend across the entire width of the river at any time. These activities overlap with juvenile, subadult, and adult Atlantic sturgeon life stages where PBF 3 occurs in the action area. However, Atlantic sturgeon (less those injured or killed by entrainment or capture in the dredges) will still have room to maneuver within the river while avoiding adverse effects from potential barrier-causing stressors related to project activities. Proposed activities will not prevent adults from migrating to and from spawning sites, nor will they prevent juvenile sturgeon from reaching appropriate salinity zones necessary for foraging and development.

In sum, the proposed action may have temporary negative effects on PBF 3 by creating in water stressors from dredging and disposal activities; however, none of the effects of proposed activities serve as long-term barriers to the movement of juvenile, subadult, or adult Atlantic sturgeon. Based on our assessment, these impediments to movement are extremely unlikely to affect the value of PBF 3 to the conservation of the species in the action area; that is, it is extremely unlikely that the habitat alterations that will affect the movement of Atlantic sturgeon in the action area will impede the movement of adults to and from spawning sites or the seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary or impede the staging, resting, or holding of subadults or spawning condition adults; therefore, the effects are discountable.

PBF 4

In considering effects to PBF 4, we consider whether the proposed action will have any effect on water quality, between the river mouth and spawning sites, especially in the bottom meter of the water column, with the temperature, salinity, and oxygen values that, combined, support: spawning; annual and interannual adult, subadult, larval, and juvenile survival; and larval, juvenile, and subadult growth, development, and recruitment. Therefore, we consider effects of the action on temperature, salinity and dissolved oxygen needs for Atlantic sturgeon spawning and recruitment. These water quality conditions are interactive and both temperature and salinity influence the dissolved oxygen saturation for a particular area. We also consider whether the action will have effects to access to this feature, temporarily or permanently and consider the effect of the action on the action area's ability to develop the feature over time.

By definition, PBF 4 is present throughout the action area (rkm 0-19); however, based on an exceedance of salinity tolerance, we do not expect spawning or the development of early life stages to occur the action area.

Proposed dredging and disposal can affect DO through increases in suspended sediments and turbidity. Additionally, dredging can potentially affect DO levels. Depending on the scale of the dredging effort, effects can be either short-term or long-term, and involve physical changes to river morphology and hydrology because of alterations to water depth and circulation (Kaur et al. 2007; May 1973). Increased water depth can result in decreased water temperatures, thereby increasing the capacity for DO saturation, particularly during summer months when aquatic animals require more oxygen to support higher metabolisms and DO levels are generally at the lowest. Conversely, these changes can also decrease DO concentrations when a deeper depth results in slowing of river velocities and reduced vertical mixing, leading to thermal stratification and potential changes of flow that introduce oxygen rich waters into the system (Kaur et al. 2007; May 1973). However, long-term changes are not anticipated from the proposed action, as the river naturally fluctuates in depth, with some areas significantly deeper than the proposed dredge depths. In some years, spring runoff events flush enough sediment out of the action area to obviate the need for dredging entirely (depending on the timing of ship movements).

Short-term changes in DO that may occur during dredging are a function of the amount of resuspended sediment in the water column, the oxygen demand of the sediment, and the duration of resuspension (Pithakpol 2007; LaSalle et al. 1991). Studies have indicated wide variations in DO levels associated with dredging from minimal (Lunz et al. 1988), or no measurable reduction, to large reductions in DO levels. Some literature suggests that the effects are negligible (Herbich 2000; Lewis et al. 2001; Ohimain et al. 2008; Pithakpol 2007).

We expect that any elevated suspended solids concentrations, and subsequent impacts on DO levels, from the Proposed Action would be confined to the immediate proximity of the dredge or disposal areas and dissipate rapidly at the completion of the operation. We do not expect any minor changes in temperature to alter how juvenile, subadult, or adult Atlantic sturgeon use those respective portions of the action area for migration, rearing, or development.

The proposed action will not cause any permanent effects to temperature, salinity, and oxygen values in the action area. Therefore, the effects of the action on the value of PBF 4 to the conservation of the species (i.e., the current and future development of this feature to provide the temperature, salinity, and oxygen values that, combined, support: annual and interannual adult, subadult, and juvenile survival; and juvenile, and subadult growth, development, and recruitment) to be too small to be meaningfully measured or detected, and are therefore, insignificant.

7.5.2.4 Summary of Effects of Proposed Activities on Atlantic sturgeon Critical Habitat
We have determined that effects of the proposed action on PBF 2 and 4 will be so small that they are not able to be meaningfully measured, detected or evaluated and are therefore insignificant. We have determined that effects to PBF 3 are extremely unlikely to occur and are therefore, discountable.

4.2 Species Likely to be Adversely Affected by the Action

4.2.1 Shortnose Sturgeon
Shortnose sturgeon are fish that occur in rivers and estuaries along the East Coast of the U.S. and Canada (SSSRT 2010). They have a head covered in bony plates, as well as protective armor called scutes extending from the base of the skull to the caudal peduncle. Other distinctive features include a subterminal, protractile tube-like mouth, and chemosensory barbels for benthic foraging (SSSRT 2010). Sturgeon have been present in North America since the Upper Cretaceous period, more than 66 million years ago. The information below is a summary of available information on the species. More thorough discussions can be found in the cited references as well as the SSSRT's Biological Assessment (2010). Information on the populations that occur in the action area is provided in section 4.3.3, while details on activities that impact individual shortnose sturgeon in the action area can be found in the Environmental Baseline (section 5.0).

4.2.1.1 Life History and General Habitat Use
There are differences in life history, behavior, and habitat use across the range of the species. Current research indicates that these differences are adaptations to unique features of the rivers where these populations occur. For example, there are differences in larval dispersal patterns in the Connecticut River (MA) and Savannah River (GA) (Parker 2007). There are also morphological and behavioral differences. Growth and maturation occurs more quickly in southern rivers but fish in northern rivers grow larger and live longer. We provide general life history attributes in Table 5.

Table 5: Shortnose sturgeon general life history for the species throughout its range

Stage	Size (mm)	Duration	Behaviors/Habitat Used
Egg	3-4	13 days post spawn	stationary on bottom; Cobble and rock, fresh, fast flowing water
Yolk Sac Larvae	7-15	8-12 days post hatch	Photonegative; swim up and drift behavior; form aggregations with other YSL; Cobble and rock, stay at bottom near spawning site
Post Yolk Sac Larvae	15 - 57	12-40 days post hatch	Free swimming; feeding; Silt bottom, deep channel; fresh water
Young of Year	57 – 140 (north); 57-300 (south)	From 40 days post-hatch to one year	Deep, muddy areas upstream of the saltwedge
Juvenile	140 to 450-550 (north); 300 to 450-550 (south)	1 year to maturation	Increasing salinity tolerance with age; same habitat patterns as adults
Adult	450-1100 average; (max recorded 1400)	Post-maturation	Freshwater to estuary with some individuals making nearshore coastal migrations

Shortnose sturgeon live on average for 30-40 years (Dadswell *et al.* 1984). Males mature at approximately 5-10 years and females mature between age 7 and 13, with later maturation occurring in more northern populations (Dadswell *et al.* 1984). Females typically spawn for the first time 5 years post-maturation (age 12-18; Dadswell 1979; Dadswell *et al.* 1984) and then spawn every 3-5 years (Dadswell 1979; Dadswell *et al.* 1984;). Males spawn for the first time approximately 1-2 years after maturity with spawning typically occurring every 1-2 years (Kieffer and Kynard 1996; NMFS 1998; Dadswell *et al.* 1984). Shortnose sturgeon are iteroparous (spawning more than once during their life) and females release eggs in multiple "batches" during a 24 to 36-hour period (total of 30,000-200,000 eggs). Multiple males are likely to fertilize the eggs of a single female.

Cues for spawning are thought to include water temperature, day length and river flow (Kynard 2012). Shortnose sturgeon spawn in freshwater reaches of their natal rivers when water temperatures reach 9–15°C in the spring (Dadswell 1979; Taubert 1980a and b; Kynard 1997). Spawning occurs over gravel, rubble, and/or cobble substrate (Dadswell 1979, Taubert 1980a and b; Buckley and Kynard 1985b; Kynard 1997) in areas with average bottom velocities between 0.4 and 0.8 m/s. Depths at spawning sites are variable, ranging from 1.2 - 27 m (multiple references in SSSRT 2010). Eggs are small and demersal and stick to the rocky substrate where spawning occurs.

Shortnose sturgeon occur in waters between 0-34°C (Dadswell *et al.* 1984; Heidt and Gilbert 1978); with temperatures above 28°C considered to be stressful. Depths used are highly variable, ranging from shallow mudflats while foraging to deep channels up to 30 m (Dadswell *et al.* 1984; Dadswell 1979). Salinity tolerance increases with age; while young of the year must remain in freshwater, adults have been documented in the ocean with salinities of up to 30 parts-per-thousand (ppt) (Holland and Yeverton 1973; Saunders and Smith 1978). Dissolved oxygen affects distribution, with preference for DO levels at or above 5mg/L and adverse effects anticipated for prolonged exposure to DO less than 3.2 mg/L.

Shortnose sturgeon feed on benthic insects, crustaceans, mollusks, and polychaetes (Dadswell *et al.* 1984). Both juvenile and adult shortnose sturgeon primarily forage over sandy-mud bottoms, which support benthic invertebrates (Carlson and Simpson 1987; Kynard 1997). Shortnose sturgeon have also been observed feeding off plant surfaces (Dadswell *et al.* 1984).

Following spawning, adult shortnose sturgeon disperse quickly down river to summer foraging grounds areas and remain in areas downstream of their spawning grounds throughout the remainder of the year (Buckley and Kynard 1985, Dadswell *et al.* 1984; Buckley and Kynard 1985; O'Herron *et al.* 1993).

In northern rivers, shortnose aggregate during the winter months in discrete, deep (3-10m) freshwater areas with minimal movement and foraging (Kynard *et al.* 2012; Buckley and Kynard 1985a; Dadswell 1979, Li *et al.* 2007; Dovel *et al.* 1992; Bain *et al.* 1998a and b). In the winter, adults in southern rivers spend much of their time in the slower moving waters downstream near the salt-wedge and forage widely throughout the estuary (Collins and Smith 1993, Weber *et al.* 1998). Pre-spawning sturgeon in some northern and southern systems migrate into an area in the upper tidal portion of the river in the fall and complete their migration in the spring (Rogers and Weber 1995). Older juveniles typically occur in the same overwintering areas as adults while young of the year remain in freshwater (Jenkins *et al.* 1993, Jarvis *et al.* 2001).

4.2.1.2 Listing History

Shortnose sturgeon were listed as endangered in 1967 (32 FR 4001), and the species remained on the endangered species list with the enactment of the ESA in 1973. Shortnose sturgeon are thought to have been abundant in nearly every large East Coast river prior to the 1880s (see Catesby 1734; McDonald 1887; Smith and Clugston 1997). Pollution and overfishing, including bycatch in the shad fishery, were listed as principal reasons for the species' decline. The species remains listed as endangered throughout its range. While the 1998 Recovery Plan refers to Distinct Population Segments (DPS), the process to designate DPSs for this species has not been undertaken. The SSSRT published a Biological Assessment for shortnose sturgeon in 2010. The report summarized the status of shortnose sturgeon within each river and identified stressors that continue to affect the abundance and stability of these populations.

4.2.1.3 Current Status

There is no current total population estimate for shortnose sturgeon rangewide. Information on populations and metapopulations is presented below. In general, populations in the Northeast are larger and more stable than those in the Southeast (SSSRT 2010). Population size throughout the species' range is considered to be stable; however, most riverine populations are below the historic population sizes and most likely are below the carrying capacity of the river (Kynard 1996).

<u>Population Structure</u>

There are 19 documented populations of shortnose sturgeon ranging from the St. Johns River, Florida (possibly extirpated from this system) to the Minas Basin in Nova Scotia, Canada. There is a large gap in the middle of the species range with individuals present in the Chesapeake Bay separated from populations in the Carolinas by a distance of more than 400 km. Currently, there are significantly more shortnose sturgeon in the northern portion of the range.

Developments in genetic research as well as differences in life history support the grouping of shortnose sturgeon into five genetically distinct groups, all of which have unique geographic adaptations (see Grunwald *et al.* 2008; Grunwald *et al.* 2002; King *et al.* 2001; Waldman *et al.* 2002b; Walsh *et al.* 2001; Wirgin *et al.* 2009; Wirgin *et al.* 2002; SSSRT 2010). These groups are: 1) Gulf of Maine; 2) Connecticut and Housatonic Rivers; 3) Hudson River; 4) Delaware River and Chesapeake Bay; and 5) Southeast. The Gulf of Maine, Delaware/Chesapeake Bay and Southeast groups function as metapopulations.[3] The other two groups (Connecticut/Housatonic and the Hudson River) function as independent populations.

While there is migration within each metapopulation (i.e., between rivers in the Gulf of Maine and between rivers in the Southeast) and occasional migration between populations (e.g., Connecticut and Hudson), interbreeding between river populations is limited to very few individuals per generation; this results in morphological and genetic variation between most river populations (see Walsh *et al.* 2001; Grunwald *et al.* 2002; Waldman *et al.* 2002; Wirgin *et al.* 2005). Indirect gene flow estimates from mtDNA indicate an effective migration rate of less than two individuals per generation. This means that while individual shortnose sturgeon may move between rivers, very few sturgeon are spawning outside their natal river; it is important to remember that the result of physical movement of individuals is rarely genetic exchange.

Summary of Status of Northeast Rivers

In our Greater Atlantic Region, shortnose sturgeon are known to spawn in the Kennebec, Androscoggin, Merrimack, Connecticut, Hudson and Delaware Rivers. Shortnose sturgeon are also known to occur in the Penobscot and Potomac Rivers; although it is unclear if spawning is currently occurring in those systems.

Gulf of Maine Metapopulation

Tagging and telemetry studies indicate that shortnose sturgeon are present in the Penobscot, Kennebec, Androscoggin, Sheepscot and Saco Rivers. Individuals have also been documented in smaller coastal rivers; however, the duration of presence has been limited to hours or days and the smaller coastal rivers are thought to be only used occasionally (Zydlewski *et al.* 2011).

Since the removal of the Veazie and Great Works Dams (2013 and 2012, respectively), in the Penobscot River, shortnose sturgeon range from the Bay to the Milford Dam. Shortnose sturgeon now have access to their full historical range. Adult and large juvenile sturgeon have

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[3] A metapopulation is a group of populations in which distinct populations occupy separate patches of habitat separated by unoccupied areas (Levins 1969). Low rates of connectivity through dispersal, with little to no effective movement, allow individual populations to remain distinct as the rate of migration between local populations is low enough not to have an impact on local dynamics or evolutionary lineages (Hastings and Harrison 1994). This interbreeding between populations, while limited, is consistent, and distinguishes metapopulations from other patchy populations.

been documented to use the river. While potential spawning sites have been identified, no spawning has been documented. Foraging and overwintering are known to occur in the river. Nearly all pre-spawn females and males have been documented to return to the Kennebec or Androscoggin Rivers. Robust design analysis with closed periods in the summer and late fall estimated seasonal adult abundance ranging from 636-1285 (weighted mean), with a low estimate of 602 (95%CI: 409.6-910.8) and a high of 1306 (95% CI: 795.6-2176.4) (Fernandes 2008; Fernandes *et al.* 2010; Dionne 2010 in Maine DMR 2010).

Kennebec/Androscoggin/Sheepscot

The estimated size of the adult population (>50cm TL) in this system, based on a tagging and recapture study conducted between 1977-1981, was 7,200 (95% CI = 5,000 - 10,800; Squiers *et al.* 1982). A population study conducted 1998-2000 estimated population size at 9,488 (95% CI = 6,942 -13,358; Squiers 2003) suggesting that the population exhibited significant growth between the late 1970s and late 1990s. Spawning is known to occur in the Androscoggin and Kennebec Rivers. In both rivers, there are hydroelectric facilities located at the base of natural falls thought to be the natural upstream limit of the species. The Sheepscot River is used for foraging during the summer months.

Merrimack River

The historic range in the Merrimack extended to Amoskeag Falls (Manchester, NH, rkm 116; Piotrowski 2002); currently shortnose sturgeon cannot move past the Essex Dam in Lawrence, MA (rkm 46). A current population estimate for the Merrimack River is not available. Based on a study conducted 1987-1991, the adult population was estimated at 32 adults (20–79; 95% confidence interval; B. Kynard and M. Kieffer unpublished information). However, recent gill-net sampling efforts conducted by Kieffer indicate a dramatic increase in the number of adults in the Merrimack River. Sampling conducted in the winter of 2009 resulted in the capture of 170 adults. Preliminary estimates suggest that there may be approximately 2,000 adults using the Merrimack River annually. Spawning, foraging and overwintering all occur in the Merrimack River.

Tagging and tracking studies demonstrate movement of shortnose sturgeon between rivers within the Gulf of Maine, with the longest distance traveled between the Penobscot and Merrimack rivers. Genetic studies indicate that a small, but statistically insignificant amount of genetic exchange likely occurs between the Merrimack River and these rivers in Maine (King *et al.* 2013). The Merrimack River population is genetically distinct from the Kennebec-Androscoggin-Penobscot population (SSSRT 2010). In the Fall of 2014, a shortnose sturgeon tagged in the Connecticut River in 2001 was captured in the Merrimack River. To date, genetic analysis has not been completed and we do not yet know the river of origin of this fish.

Connecticut River Population

The Holyoke Dam divides the Connecticut River shortnose population; there is currently limited successful passage downstream of the Dam. No shortnose sturgeon have passed upstream of the dam since 1999 and passage between 1975-1999 was an average of four fish per year. The number of sturgeon passing downstream of the Dam is unknown. Despite this separation, the populations are not genetically distinct (Kynard 1997, Wirgin *et al.* 2005, Kynard *et al.*2012). The most recent estimate of the number of shortnose sturgeon upstream of the dam, based on captures and tagging from 1990-2005 is approximately 328 adults (CI = 188–1,264 adults; B. Kynard, USGS, unpubl. Data in SSSRT 2010); this compares to a previous Peterson mark-recapture estimate of 370–714 adults (Taubert 1980a). Using four mark-recapture methodologies, the longterm population estimate (1989-2002) for the lower Connecticut River ranges from 1,042-1,580 (Savoy 2004). Comparing 1989-1994 to 1996-2002, the population exhibits growth on the order of 65-138%. The population in the Connecticut River is thought to be stable, but at a small size.

The Turners Falls Dam is thought to represent the natural upstream limit of the species; however, in 2017, a shortnose sturgeon was confirmed above the Turners Falls Dam, and future research will investigate whether there is a larger population in that location. While limited spawning is thought to occur below the Holyoke Dam, successful spawning has only been documented upstream of the Holyoke Dam. Abundance of pre-spawning adults was estimated each spring between 1994–2001 at a mean of 142.5 spawning adults (CI =14–360 spawning adults) (Kynard *et al.* 2012). Overwintering and foraging occur in both the upper and lower portions of the river. Occasionally, sturgeon have been captured in tributaries to the Connecticut River including the Deerfield River and Westfield River. Additionally, a sturgeon tagged in the CT river was recaptured in the Housatonic River (T. Savoy, CT DEP, pers. comm.). Three individuals tagged in the Hudson were captured in the CT, with one remaining in the river for at least one year (Savoy 2004).

<u>Hudson River Population</u>

The Hudson River population of shortnose sturgeon is the largest in the United States. Studies indicated an extensive increase in abundance from the late 1970s (13,844 adults (Dovel *et al.* 1992), to the late 1990s (56,708 adults (95% CI 50,862 to 64,072; Bain *et al.* 1998). This increase is thought to be the result of high recruitment (31,000 – 52,000 yearlings) from 1986-1992 (Woodland and Secor 2007). Woodland and Secor examined environmental conditions throughout this 20-year period and determined that years when water temperatures drop quickly and flow increases rapidly in the fall (particularly October) are followed by high levels of recruitment in the spring. This suggests that these environmental factors may index a suite of environmental cues that initiate the final stages of gonadal development in spawning adults. The population in the Hudson River exhibits substantial recruitment and is considered to be stable at high levels.

<u>Delaware River-Chesapeake Bay Metapopulation</u>

Shortnose sturgeon range from Delaware Bay up to at least Scudders Falls (rkm 223); there are no dams within the species' range on this river. The population is considered stable (comparing 1981-1984 to 1999-2003) at around 12,000 adults (Hastings *et al.* 1987 and ERC 2006b). Spawning occurs primarily between Scudders Falls and the Trenton rapids. Overwintering and foraging also occur in the river. Shortnose sturgeon have been documented to use the Chesapeake-Delaware Canal to move from the Chesapeake Bay to the Delaware River.

In Chesapeake Bay, shortnose sturgeon have most often been found in Maryland waters of the mainstem bay and tidal tributaries such as the Susquehanna, Potomac, and Rappahannock Rivers (Spells 1998; Litwiler 2001; Kynard et al. 2007, 2009; SSSRT 2010). Spells (1998), Skjeveland et al. (2000), and Welsh et al. (2002) all reported one capture each of adult shortnose sturgeon in the Rappahannock River. Recent documented use of Virginia waters of Chesapeake Bay is currently limited to two individual shortnose sturgeon: one captured in 2016 (Balazik 2017) and a second sturgeon (a confirmed gravid female) caught in 2018 in the James River (Balazik, pers. comm. 2018).

Spawning has not been documented in any tributary to the Bay although suitable spawning habitat and two pre-spawning females with late stage eggs have been documented in the Potomac River. Current information indicates that shortnose sturgeon are present year round in the Potomac River with foraging and overwintering taking place there. Shortnose sturgeon captured in the Chesapeake Bay are not genetically distinct from the Delaware River population.

<u>Southeast Metapopulation</u>
There are no shortnose sturgeon between the Chesapeake Bay and the Carolinas. Shortnose sturgeon are only thought to occur in the Cape Fear River and Yadkin-Pee Dee River in North Carolina and are thought to be present in very small numbers.

The Altamaha River supports the largest known population in the Southeast with successful self-sustaining recruitment. The most recent population estimate for this river was 6,320 individuals (95% CI = 4,387-9,249; DeVries 2006). The population contains more juveniles than expected. Comparisons to previous population estimates suggest that the population is increasing; however, there is high mortality between the juvenile and adult stages in this river. This mortality is thought to result from incidental capture in the shad fishery, which occurs at the same time as the spawning period (DeVries 2006).

The only available estimate for the Cooper River is of 300 spawning adults at the Pinoplis Dam spawning site (based on 1996-1998 sampling; Cooke *et al.* 2004). This is likely an underestimate of the total number of adults as it would not include non-spawning adults. Estimates for the Ogeechee River were 266 (95%CI=236-300) in 1993 (Weber 1996, Weber *et al.* 1998); a more recent estimate (sampling from 1999-2004; Fleming *et al.* 2003) indicates a population size of 147 (95% CI = 104-249). While the more recent estimate is lower, it is not significantly different than the previous estimate. Available information indicates the Ogeechee River population may be experiencing juvenile mortality rates greater than other southeastern rivers.

Spawning is also occurring in the Savannah River, the Congaree River, and the Yadkin-Pee Dee River. There are no population estimates available for these rivers. Occurrence in other southern rivers is limited, with capture in most other rivers limited to fewer than five individuals. They are thought to be extremely rare or possibly extirpated from the St. Johns River in Florida as only a single specimen was found by the Florida Fish and Wildlife Conservation Commission during extensive sampling of the river in 2002/2003. In these river systems, shortnose sturgeon occur in nearshore marine, estuarine, and riverine habitat.

4.2.1.4 Threats
Because sturgeon are long-lived and slow growing, their stock productivity is relatively low, making the species vulnerable to rapid decline and slow recovery (Musick 1999). In well studied rivers (e.g., Hudson, upper Connecticut), researchers have documented significant year to year

recruitment variability (up to 10 fold over 20 years in the Hudson and years with no recruitment in the CT). However, this pattern is not unexpected given the life history characteristics of the species and natural variability in hydrogeologic cues relied on for spawning.

The small amount of effective movement between populations means recolonization of currently extirpated river populations is expected to be very slow and any future recolonization of any rivers that experience significant losses of individuals would also be expected to be very slow. Despite the significant decline in population sizes over the last century, gene diversity in shortnose sturgeon is moderately high in both mtDNA (Quattro *et al.* 2002; Wirgin *et al.* 2005; Wirgin *et al.* 2000) and nDNA (King *et al.* 2001) genomes.

A population of sturgeon can go extinct as a consequence of demographic stochasticity (fluctuations in population size due to random demographic events); the smaller the metapopulation (or population); the more prone it is to extinction. Anthropogenic impacts acting on top of demographic stochasticity further increase the risk of extinction.

All shortnose sturgeon populations are highly sensitive to increases in juvenile mortality that would result in reductions in the number of adult spawners (Anders *et al.* 2002; Gross *et al.* 2002; Secor 2002). Populations of shortnose sturgeon that do not have reliable natural recruitment are at increased risk of experiencing population decline leading to extinction (Secor *et al.* 2002). Elasticity studies of shortnose sturgeon indicate that the highest potential for increased population size and stability comes from YOY and juveniles as compared to adults (Gross *et al.* 2002); that is, increasing the number of YOY and juveniles has a more significant long term impact to the population than does increasing the number of adults or the fecundity of adults.

The Shortnose Sturgeon Recovery Plan (NMFS 1998) and the Shortnose Sturgeon Status Review Team's Biological Assessment of shortnose sturgeon (2010) identify habitat degradation or loss and direct mortality as principal threats to the species' survival. Natural and anthropogenic factors continue to threaten the recovery of shortnose sturgeon and include: poaching, bycatch in riverine fisheries, habitat alteration resulting from the presence of dams, in-water and shoreline construction, including dredging; degraded water quality which can impact habitat suitability and result in physiological effects to individuals including impacts on reproductive success; direct mortality resulting from dredging as well as impingement and entrainment at water intakes; and, loss of historical range due to the presence of dams. Shortnose sturgeon are also occasionally killed as a result of research activities. The total number of sturgeon affected by these various threats is not known. Climate change, particularly shifts in seasonal temperature regimes and changes in the location of the salt wedge, may impact shortnose sturgeon in the future (more information on Climate Change is presented in Section 6.0). More information on threats experienced in the action area is presented in the Environmental Baseline section of this Opinion.

4.2.1.5 Survival and Recovery

The 1998 Recovery Plan outlines the steps necessary for recovery and indicates that each population may be a candidate for downlisting (i.e., to threatened) when it reaches a minimum population size that is large enough to prevent extinction and will make the loss of genetic diversity unlikely; the minimum population size for each population has not yet been determined.

The Recovery Outline contains three major tasks: (1) establish delisting criteria; (2) protect shortnose sturgeon populations and habitats; and, (3) rehabilitate habitats and population segments. We know that in general, to recover, a listed species must have a sustained positive trend of increasing population over time. To allow that to happen for sturgeon, individuals must have access to enough habitat in suitable condition for foraging, resting and spawning. In many rivers, particularly in the Southeast, habitat is compromised and continues to impact the ability of sturgeon populations to recover. Conditions must be suitable for the successful development of early life stages. Mortality rates must be low enough to allow for recruitment to all age classes so that successful spawning can continue over time and over generations. There must be enough suitable habitat for spawning, foraging, resting and migrations of all individuals. Habitat connectivity must also be maintained so that individuals can migrate between important habitats without delays that impact their fitness. The loss of any population or metapopulation would result in the loss of biodiversity and would create (or widen) a gap in the species' range.

4.2.1.6 Summary of Status

Shortnose sturgeon remain listed as endangered throughout their range, with populations in the Northeast being larger and generally more stable than populations in the Southeast. All populations are affected by mortality incidental to other activities, including dredging, power plant intakes and shad fisheries where those still occur, and impacts to habitat and water quality that affect the ability of sturgeon to use habitats and impacts individuals that are present in those habitats. While the species is overall considered to be stable (i.e., its trend has not changed recently, and we are not aware of any new or emerging threats that would change the trend in the future), we lack information on abundance and population dynamics in many rivers. We also do not fully understand the extent of coastal movements and the importance of habitat in non-natal rivers to migrant fish. While the species has high levels of genetic diversity, the lack of effective movement between populations increases the vulnerability of the species should there be a significant reduction in the number of individuals in any one population or metapopulation as recolonization is expected to be very slow. All populations, regardless of size, are faced with threats that result in the mortality of individuals and/or affect the suitability of habitat and may restrict the further growth of the population. Additionally, there are several factors that combine to make the species particularly sensitive to existing and future threats; these factors include: the small size of many populations, existing gaps in the range, late maturation, the sensitivity of adults to very specific spawning cues which can result in years with no recruitment, and the impact of losses of young of the year and juveniles to population persistence and stability.

4.2.2 Atlantic sturgeon

The section below describes the Atlantic sturgeon listing, provides life history information that is relevant to all DPSs of Atlantic sturgeon and then provides information specific to the status of each DPS of Atlantic sturgeon we expect to be present in the action area. Below, we also provide information on the use of the action area by Atlantic sturgeon (see Environmental Baseline).

Species description

Atlantic sturgeon occupy ocean waters and associated bays, estuaries, and coastal river systems from Hamilton Inlet, Labrador, Canada, to Cape Canaveral, Florida (Stein *et al.* 2004a) (Figure 5). Atlantic sturgeon are listed as five DPSs under the ESA.

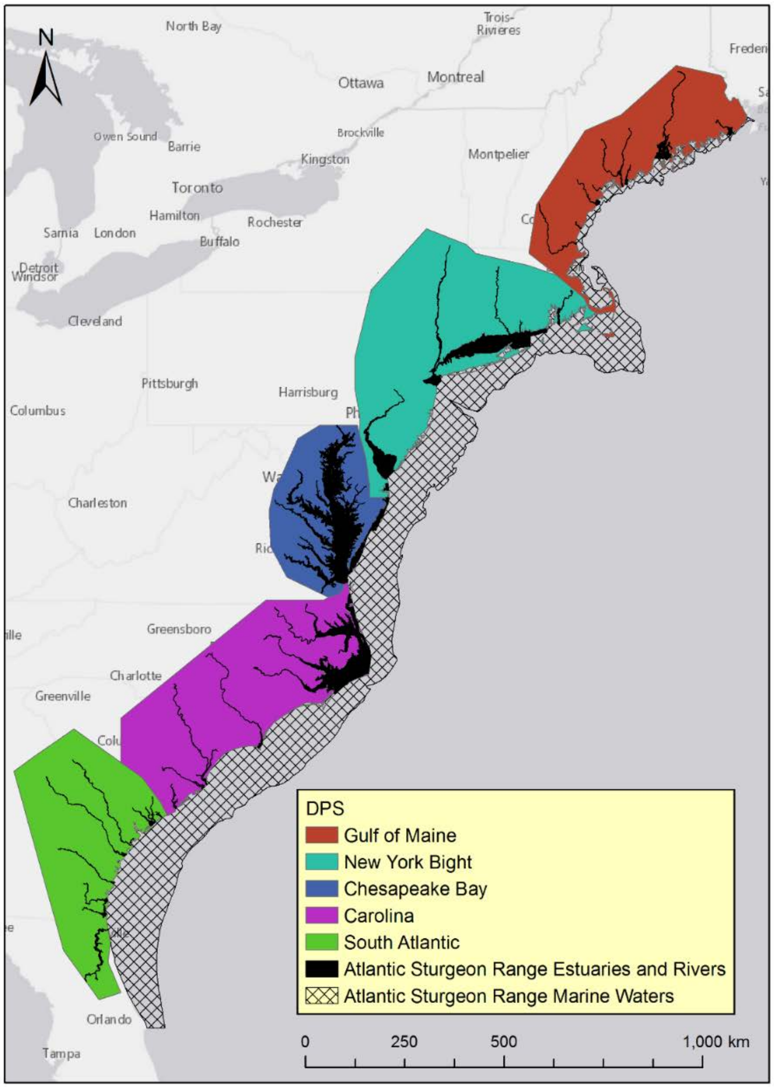

Figure 5. Map Depicting the 5 Atlantic Sturgeon DPSs

The Atlantic sturgeon is a long-lived, late maturing, anadromous species. Atlantic sturgeon attain lengths of up to approximately 14 ft, and weights of more than 800 pounds (Figure 10). They are bluish black or olive brown dorsally with paler sides and a white ventral surface and have five major rows of dermal scutes (Colette and Klein-MacPhee 2002). Five DPSs were listed under the ESA on February 6, 2012. The Gulf of Maine DPS was listed as threatened, and the New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs were listed as endangered (Table 6).

Table 6. Atlantic sturgeon information bar provides species' Latin name, common name and current Federal Register notice of listing status, designated critical habitat, Distinct Population Segment, recent status review, and recovery plan.

Species	Common Name	Distinct Population Segment	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Acipenser oxyrinchus oxyrinchus	Atlantic Sturgeon	Gulf of Maine (GOM)	Threatened	2007	77 FR 5880	No	82 FR 39160
Acipenser oxyrinchus oxyrinchus	Atlantic Sturgeon	New York Bight (NYB)	Endangered	2007	77 FR 5880	No	82 FR 39160
Acipenser oxyrinchus oxyrinchus	Atlantic Sturgeon	Chesapeake Bay (CB)	Endangered	2007	77 FR 5880	No	82 FR 39160
Acipenser oxyrinchus oxyrinchus	Atlantic Sturgeon	Carolina	Endangered	2007	77 FR 5914	No	82 FR 39160
Acipenser oxyrinchus oxyrinchus	Atlantic Sturgeon	South Atlantic (SA)	Endangered	2007	77 FR 5914	No	82 FR 39160

Life history

Atlantic sturgeon size at sexual maturity varies with latitude with individuals reaching maturity in the Saint Lawrence River at 22 to 34 years (Scott and Crossman 1973). Atlantic sturgeon spawn in freshwater, but spend most of their adult life in the marine environment. Spawning adults generally migrate upriver in May through July in Canadian systems (Murawski and Pacheco 1977; Smith 1985; Bain 1997; Smith and Clugston 1997; Caron *et al.* 2002). Atlantic sturgeon spawning is believed to occur in flowing water between the salt front and fall line of large rivers at depths of three to 27 m (Borodin 1925; Leland 1968; Scott and Crossman 1973; Crance 1987; Bain *et al.* 2000). Atlantic sturgeon likely do not spawn every year; spawning intervals range from one to five years for males (Smith 1985; Collins *et al.* 2000; Caron *et al.* 2002) and two to five years for females (Vladykov and Greeley 1963; Van Eenennaam *et al.* 1996; Stevenson and Secor 2000).

Sturgeon eggs are highly adhesive and are deposited on the bottom substrate, usually on hard surfaces (Gilbert 1989; Smith and Clugston 1997) between the salt front and fall line of large rivers (Borodin 1925; Scott and Crossman 1973; Crance 1987; Bain *et al.* 2000). Following spawning in northern rivers, males may remain in the river or lower estuary until the fall; females typically exit the rivers within four to six weeks (Savoy and Pacileo 2003). Hatching occurs approximately 94 to 140 hours after egg deposition at temperatures of 20 and 18 degrees Celsius, respectively (Theodore *et al.* 1980). The yolk sac larval stage is completed in about eight to 12 days, during which time larvae move downstream to rearing grounds over a six to 12 day period (Kynard and Horgan 2002). Juvenile sturgeon continue to move further downstream into waters ranging from zero to up to ten parts per thousand salinity. Older juveniles are more tolerant of higher salinities as juveniles typically spend two to five years in freshwater before eventually becoming coastal residents as sub-adults (Smith 1985; Boreman 1997; Schueller and Peterson 2010).

Upon reaching the subadult phase, individuals may move to coastal and estuarine habitats (Murawski and Pacheco 1977; Dovel and Berggren 1983; Smith 1985; Stevenson 1997). Tagging and genetic data indicate that subadult and adult Atlantic sturgeon may travel widely once they emigrate from rivers. Despite extensive mixing in coastal waters, Atlantic sturgeon exhibit high fidelity to their natal rivers (King *et al.* 2001; Waldman *et al.* 2002; Grunwald *et al.* 2008). Because of high natal river fidelity, it appears that most rivers support independent populations (Waldman and Wirgin 1998; Wirgin *et al.* 2000, 2002; King *et al.* 2001; Grunwald *et al.* 2008). Atlantic sturgeon feed primarily on polychaetes, isopods, American sand lances and amphipods in the marine environment, while in fresh water they feed on oligochaetes, gammarids, mollusks, insects, and chironomids (Moser and Ross 1995; Johnson *et al.* 1997; Guilbard *et al.* 2007; Savoy 2007; Novak *et al.* 2017).

Population dynamics

The following is a discussion of the species' population and its variance over time. This section includes: abundance, population growth rate, genetic diversity, and distribution as it relates to Atlantic sturgeon.

Abundance

Historically, the Gulf of Maine DPS likely supported more than 10,000 spawning adults. The current abundance is estimated to be one to two orders of magnitude smaller than historical levels (Secor *et al.* 2002; ASSRT 2007).

The New York Bight, ranging from the Delmarva Peninsula to Cape Cod, historically supported four or more spawning populations. Currently, this DPS only supports two spawning populations, the Delaware and Hudson River, although new information demonstrates that the Connecticut River may support spawning as well. Numbers of Atlantic sturgeon in the New York Bight DPS are extremely low compared to historical levels and have remained so for the past 100 years. The spawning populations of this DPS are thought to be one to two orders of magnitude below historical levels.

Historically the Delaware River is believed to have supported around 180,000 individuals (Secor 2002). In 2007, NMFS status review estimated that the population had declined to fewer than 300 individuals. In 2014, Hale *et al.* (2016) estimated that 3,656 (95% CI = 1,935-33,041) early juveniles (age zero to one) utilized the Delaware River estuary as a nursery. Based on commercial fishery landings from the mid-1980s to the mid-1990s, the total abundance of adult Hudson River Atlantic sturgeon was estimated to be 870 individuals (Kahnle *et al.* 2007). Based on the juvenile assessments from (Peterson 2000), the Hudson River suffered a series of recruitment failures, which triggered the ASMFC fishing moratorium in 1998 to allow the populations to recover.

There are no current abundance estimates for the Chesapeake Bay DPS. Historically, Atlantic sturgeon were common throughout the Chesapeake Bay and its tributaries (Kahnle *et al.* 1998; Bushnoe *et al.* 2005). At the time of listing, the James River was the only known spawning river for the Chesapeake Bay DPS (ASSRT 2007; Balazik *et al.* 2012a). Since the listing, spawning has been confirmed to occur in the Pamunkey River, a tributary of the York River (Hager *et al.*

2014; Kahn *et al.* 2014) and is suspected to be occurring in Marshyhope Creek, a tributary of the Nanticoke River. The historical and contemporary accounts of Atlantic sturgeon in the York, Rappahannock, Susquehanna, and Potomac Rivers (ASSRT 2007), as well as the presence of the features necessary to support reproduction and recruitment in this river indicate that there is the potential for spawning to occur.

The Carolina DPS spawning populations are estimated to be at less than 3% of their historic levels. Prior to 1890, there were estimated to be 7,000 to 10,500 adult female Atlantic sturgeon in North Carolina and approximately 8,000 adult females in South Carolina. Currently, the existing spawning populations in each of the rivers in the Carolina DPS are thought to have less than 300 adults spawning each year.

The South Atlantic DPS historically supported eight spawning populations ranging from the St. Johns River, Florida to the Ashepoo, Combahee, and Edisto Rivers Basin in South Carolina. Currently, this DPS supports five extant spawning populations. Of these populations, the Altamaha is believed to support the largest number of spawning adults. The current abundance of the Altamaha population is suspected to be less than 6% of historical abundance, extrapolated from the 1890s commercial landings (Secor 2002). Few captures have been documented in other populations within this DPS and are suspected to be less than 1% of their historic abundance (less than 300 spawning adults).

Stock Assessments

The ASMFC released a new benchmark stock assessment for Atlantic sturgeon in October 2017 (ASMFC 2017a). The assessment used both fishery-dependent and fishery-independent data, as well as biological and life history information. Fishery-dependent data came from commercial fisheries that formerly targeted Atlantic sturgeon (before the moratorium), as well as fisheries that catch sturgeon incidentally. Fishery-independent data were collected from scientific research and survey programs.

At the coastwide and DPS levels, the stock assessment concluded that Atlantic sturgeon are depleted relative to historical levels. The low abundance of Atlantic sturgeon is not due solely to effects of historic commercial fishing, so the ‘depleted’ status was used instead of ‘overfished.’ This status reflects the array of variables preventing Atlantic sturgeon recovery (e.g., bycatch, habitat loss, and ship strikes).

As described in the Assessment Overview, Table 7 shows “the stock status determination for the coastwide stock and DPSs based on mortality estimates and biomass/abundance status relative to historic levels, and the terminal year (i.e., the last year of available data) of indices relative to the start of the moratorium as determined by the ARIMA[4] analysis.”

[4] “The ARIMA (Auto-Regressive Integrated Moving Average) model uses fishery-independent indices of abundance to estimate how likely an index value is above or below a reference value” (ASMFC 2017a).

Table 7: Stock status determination for the coastwide stock and DPSs (from the ASMFC's Atlantic Sturgeon Stock Assessment Overview, October 2017)

	Mortality Status	**Biomass/Abundance Status**	
Population	**Probability that $Z>Z_{50\%EPR}$ 80%**	**Relative to Historic Levels**	**Average Probability of Terminal Year of Indices > 1998* Value**
Coastwide	7%	Depleted	95%
Gulf of Maine	74%	Depleted	51%
New York Bight	31%	Depleted	75%
Chesapeake Bay	30%	Depleted	36%
Carolina	75%	Depleted	67%
South Atlantic	40%	Depleted	Unknown (no suitable indices)

* *For indices that started after 1998, the first year of the index was used as the reference value. EPR= Eggs Per Recruit.*

Despite the depleted status, the assessment did include signs that the coastwide index is above the 1998 value (95% chance). The Gulf of Maine, New York Bight, and Carolina DPS indices also all had a greater than 50% chance of being above their 1998 value; however, the index from the Chesapeake Bay DPS (highlighted red) only had a 36% chance of being above the 1998 value. There were no representative indices for the South Atlantic DPS. Total mortality from the tagging model was very low at the coastwide level. Small sample sizes made mortality estimates at the DPS level more difficult. The New York Bight, Chesapeake Bay, and South Atlantic DPSs all had a less than 50% chance of having a mortality rate higher than the threshold. The Gulf of Maine and Carolina DPSs (highlighted red) had 74%-75% probability of being above the mortality threshold (ASMFC 2017a).

Distribution

The Gulf of Maine DPS includes 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, Massachusetts (Figure 5). The geomorphology of most small coastal rivers in Maine is not sufficient to support Atlantic sturgeon spawning populations, except for the Penobscot and the estuarial complex of the Kennebec, Androscoggin, and Sheepscot rivers. Spawning still occurs in the Kennebec and Androscoggin Rivers, and may occur in the Penobscot River. Atlantic sturgeon have more recently been observed in the Saco, Presumpscot, and Charles rivers.

The natal river systems of the New York Bight DPS span from the Connecticut River south to the Delaware River (Figure 5). The Connecticut River has long been known as a seasonal aggregation area for subadult Atlantic sturgeon, and both historical and contemporary records document presence of Atlantic sturgeon in the river as far upstream as Hadley, Massachusetts (Savoy and Shake 1992; Savoy and Pacileo 2003). The upstream limit for Atlantic sturgeon on the Hudson River is the Federal Dam at the fall line, approximately rkm 246 (Dovel and Berggren 1983; Kahnle *et al.* 1998). In the Delaware River, there is evidence of Atlantic sturgeon presence from the mouth of the Delaware Bay to the head-of-tide at the fall line near Trenton on the New Jersey side and Morrisville on the Pennsylvania side of the River, a distance of 220 rkm (Breece *et al.* 2013).

The natal river systems of the Chesapeake Bay DPS span from the Susquehanna River south to the James River (Figure 5).

The natal river systems of the Carolina DPS span from the Roanoke River, North Carolina south to the Santee-Cooper system in South Carolina (Figure 5). The Carolina DPS ranges from the Santee-Cooper River to the Albemarle Sound and consists of seven extant populations; one population (the Sampit River) is believed to be extirpated.

The natal river systems of the South Atlantic DPS span from Edisto south to the St. Mary's River (Figure 5). Seventy-six Atlantic sturgeon were tagged in the Edisto River during a 2011 to 2014 telemetry study (Post *et al.* 2014). Fish entered the river between April and June and were detected in the saltwater tidal zone until water temperature decreased below 25 degrees Celcius. They then moved into the freshwater tidal area, and some fish made presumed spawning migrations in the fall around September to October. Atlantic sturgeon in the Savannah River were documented displaying similar behavior three years in a row—migrating upstream during the fall and then being absent from the system during spring and summer. Forty three Atlantic sturgeon larvae were collected in upstream locations (rkm 113 to 283) near presumed spawning locations (Collins and Smith 1997).

Status

Atlantic sturgeon were once present in 38 river systems and, of these, spawned in 35 of them. Individuals are currently present in 36 rivers, and spawning occurs in at least 20 of these (ASSRT 2007). The decline in abundance of Atlantic sturgeon has been attributed primarily to the large U.S. commercial fishery which existed for the Atlantic sturgeon from the 1870s through the mid 1990s. The fishery collapsed in 1901 and landings remained at between 1%-5% of the pre-collapse peak until ASMFC placed a two generation moratorium on the fishery in 1998 (ASMFC 1998a, 1998b). The majority of the populations show no signs of recovery, and new information suggests that stressors such as bycatch, ship strikes, and low DO can and do have substantial impacts on populations (ASSRT 2007). Additional threats to Atlantic sturgeon include habitat degradation from dredging, damming, and poor water quality (ASSRT 2007). Climate change related impacts on water quality (e.g., temperature, salinity, dissolved oxygen, contaminants) have the potential to impact Atlantic sturgeon populations using impacted river systems. These effects are expected to be more severe for southern portions of the U.S. range of Atlantic sturgeon (Carolina and South Atlantic DPSs). None of the spawning populations are currently large or stable enough to provide any level of certainty for continued existence of any of the DPSs.

Recovery Goals

Recovery Plans have not yet been drafted for any of the Atlantic sturgeon DPSs.

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

There is currently no mixed stock analysis for the Androscoggin River or Kennebec Rivers. Mixed stock analysis is available for the Bay of Fundy. Given the geographic proximity of the Bay of Fundy to the action area, it is reasonable to anticipate similar distribution in these two areas (93% Gulf of Maine DPS (60% St. John, 40% Kennebec) and 7% New York Bight DPS). However, in the action area we would expect a higher frequency of Androscoggin and Kennebec River origin individuals than St. John River individuals. As such, in the Kennebec River System (including the Androscoggin River) we expect Atlantic sturgeon to occur at the following frequencies: Gulf of Maine 93% (60-100% Androscoggin and Kennebec and up to 40% St. John (Canada)) and 7% New York Bight. These occurrences are supported by preliminary genetic analyses of fish caught in the Gulf of Maine (see Damon-Randall *et al.* 2013). The genetic assignments have a plus/minus 5% confidence interval; however, for purposes of section 7 consultation we have selected the reported values above, which approximate the mid-point of the range, as a reasonable indication of the likely genetic makeup of Atlantic sturgeon in the action area. These assignments and the data from which they are derived are described in detail by Damon-Randall *et al.* (2013).

4.2.2.2 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 at least the Androscoggin, Kennebec, Merrimack, Penobscot, and Sheepscot Rivers (ASSRT, 2007). Spawning habitat is available and accessible in the Penobscot, Androscoggin, Kennebec, Merrimack, and Piscataqua (inclusive of the Cocheco and Salmon Falls rivers) rivers. Spawning has been documented in the Kennebec River. In the Androscoggin River, captures of adult Atlantic sturgeon, including a ripe male, over suitable spawning grounds during the spawning season confirm likely spawning; however Atlantic sturgeon eggs and larvae have not yet been recovered in the Androscoggin (Wippelhauser pers. comm. 2018). Despite the availability of suitable habitat and the presence of Atlantic sturgeon in the remaining rivers, there is currently no evidence spawning activity in these rivers.

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 1880s, 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 DPS have navigation channels that are maintained by dredging. Dredging outside of Federal channels and in-water construction occurs throughout the Gulf of Maine DPS. While some dredging projects operate with observers present to document fish mortalities, many do not. To date we have not received any reports of Atlantic sturgeon killed during dredging projects in the Gulf of Maine region; however, as noted above, not all projects are monitored for interactions with fish. At this time, we do not have any information to quantify the number of Atlantic sturgeon killed or disturbed during dredging or in-water construction projects. We 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 tracking of spawning condition Atlantic sturgeon downstream of the Brunswick Dam in the Androscoggin River suggests however, that Atlantic sturgeon spawning may be occurring in the vicinity of at least that project and therefore, may be affected by project operations. Until it was breached in July 2013, the range of Atlantic sturgeon in the Penobscot River was limited by the presence of the Veazie Dam. Since the removal of the Veazie Dam and the Great Works Dam, sturgeon can now travel as far upstream as the Milford Dam. While Atlantic sturgeon are known to occur in the Penobscot River, there is no evidence of spawning currently occurring. 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.

<u>Summary of the Gulf of Maine DPS</u>

Spawning for the Gulf of Maine DPS is known to occur in two rivers (Kennebec and Androscoggin). Spawning may be occurring in other rivers, such as the 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). We have 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.

4.2.2.3 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 Taunton River (ASSRT, 2007). However, there is recent evidence that spawning may be occurring in the Connecticut River. 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. A decline in the abundance of young Atlantic sturgeon appeared to occur in the mid to late 1970s followed by a secondary drop in the late 1980s (Kahnle *et al.*, 1998; Sweka *et al.*, 2007; ASMFC, 2010). At the time of listing, catch-per-unit-effort (CPUE) data suggested that recruitment remained depressed relative to catches of juvenile Atlantic sturgeon in the estuary during the mid-late 1980s (Sweka *et al.*, 2007; ASMFC, 2010). In examining the CPUE data from 1985-2007, there are significant fluctuations during this time. There appears to be a decline in the number of juveniles between the late 1980s and early 1990s while the CPUE is generally higher in the 2000s as compared to the 1990s. Given the significant annual fluctuation, it is difficult to discern any trend. Despite the CPUEs from 2000-2007 being generally higher than those from 1990-1999, they are low compared to the late 1980s. Standardized mean catch per net set from the NYSDEC juvenile Atlantic sturgeon survey have had a general increasing trend from 2006 – 2015, with the exception of a dip in 2013.

In addition to capture in fisheries operating in Federal waters, bycatch and mortality also occur in state fisheries; however, the primary fishery that impacted juvenile sturgeon (shad) in the Hudson River, has now been closed and there is no indication that it will reopen soon. In the Hudson River, sources of potential mortality include vessel strikes and entrainment in dredges. Individuals are also exposed to effects of bridge construction (including the replacement of the Tappan Zee Bridge). Impingement at water intakes, including the Danskammer, Roseton and Indian Point power plants also occurs. Recent information from surveys of juveniles (see above) indicates that the number of young Atlantic sturgeon in the Hudson River is increasing compared to recent years, but is still low compared to the 1970s. There is currently not enough information regarding any life stage to establish a trend for the entire Hudson River population.

There is no abundance estimate for the Delaware River population of Atlantic sturgeon. Harvest records from the 1800s 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 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, and four fish were entrained in the Delaware River during maintenance and deepening activities in 2017 and 2018. At this time, we do not have any additional 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.

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. Additionally, 138 sturgeon carcasses were observed on the Hudson River and reported to the NYSDEC between 2007 and 2015. Of these, 69 are suspected of having been killed by vessel strike. Genetic analysis has not been completed on any of these individuals to date, given that the majority of Atlantic sturgeon in the Hudson River belong to the New York Bight DPS, we assume that the majority of the dead sturgeon reported to NYSDEC belonged to the New York Bight DPS. Given the time of year in which the fish were observed (predominantly May through July), it is likely that many of the adults were migrating through the river to the spawning grounds.

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. We 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.

5.0 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. The activities that shape the environmental baseline in the action area of this consultation generally include: dredging operations (including those outlined in Table 1), actions that impact water quality, scientific research, shipping and other vessel traffic, and fisheries.

5.1 Upstream Dams in the Kennebec River System

On July 19, 2013, we issued an Opinion to FERC on the impacts to listed species from operations of the Lockwood, Shawmut, and Weston Projects on the Kennebec River; as well as the Brunswick, and Lewiston Falls Projects on the Androscoggin River; in order to incorporate the provisions of an interim Species Protection Plan (ISPP). In our July 19, 2013 biological opinion, we concluded that the proposed action was likely to adversely affect, but not likely to jeopardize the continued existence of the Gulf of Maine distinct population segment (DPS) of Atlantic salmon, shortnose sturgeon, or any of the five DPSs of Atlantic sturgeon. We also concluded that the action was not likely to destroy or adversely modify critical habitat designated for Atlantic salmon. The purpose of the ISPP is to collect information on passage efficiency and survival of Atlantic salmon adults and smolts attempting to migrate past the Projects. Lewiston Falls does not have fishways, so passage efficiency studies were not proposed at that project. The ITS of the Opinion authorized take for the proposed studies, as well as for the effects of ongoing operations at the Project. The ISPP, and the Opinion, have a seven-year term (2013-2019), after which the Opinion and ITS will no longer be valid. At that point (2019), FPL Energy will put together a final SPP that contains additional protection measures for listed fish, and FERC will reinitiate formal consultation in order to obtain take authorization for the remainder of the projects' license terms.

The ITS accompanying the Opinion exempted incidental take for upstream and downstream fish passage studies, as well as for the operation of the Project over the term of the ISPP. The ITS also exempted incidental take of four trapped shortnose sturgeon and Atlantic sturgeon (four in the fishway and four stranded) at the Lockwood Project (license expires in 2036), and another four trapped of each species (four in the fishway and four stranded) at the Brunswick Project (license expires in 2029). Neither mortality nor major injuries of any sturgeon is anticipated or exempted.

On March 31, 2017, Brookfield filed their ISPP Annual Report. In that report, Brookfield indicated that the average mortality of Atlantic salmon smolts is below what was anticipated at the Lockwood and Weston Projects but is in excess of what was expected at the Brunswick and Shawmut Projects. The amount of take at the Brunswick and Shawmut Projects exceeded the annual amount of take exempted for those two projects. However, in a 2017 letter to FERC, we concluded that the take exceedance was minor and of short duration, and measures will be implemented to reduce take levels below or in compliance with the amount of exempted take (i.e., the proposed measures are expected to improve smolt survival for the remainder of the ISPP), the information does not alter the conclusions in the 2013 Opinion.

5.2 Bath Iron Works

On November 4, 2009, we issued a Biological Opinion considering the effects of ten years (2009-2019) of maintenance dredging on shortnose sturgeon, the Gulf of Maine Distinct Population Segment (GOM DPS) of Atlantic salmon and critical habitat designated for Atlantic salmon. In the Opinion, we concluded that the proposed action is likely to adversely affect but is not likely to jeopardize the continued existence of shortnose sturgeon. Additionally, we concluded that the proposed action is not likely to adversely affect the GOM DPS of Atlantic salmon or critical habitat designated for Atlantic salmon. During the spring of 2012, USACE determined that reinitiation of the 2009 Opinion was necessary due to the listing of five DPSs of Atlantic sturgeon. As a result, we issued a new Opinion on November 7, 2012 accounting for effects of the proposed action on Atlantic sturgeon. We concluded that the proposed action may adversely affect but is not likely to jeopardize the continued existence of shortnose sturgeon, or the GOM or NYB DPS of Atlantic sturgeon. We also determined that the proposed actions are not likely to adversely affect the GOM DPS of Atlantic salmon. Similarly, we determined that the action is not likely to adversely affect critical habitat designated for the GOM DPS of Atlantic salmon and therefore will not result in the destruction or adverse modification of this habitat.

For the remainder of the action (2012-2019), the Incidental Take Statement (ITS) for the 2012 Opinion anticipates the take of five shortnose sturgeon and two Atlantic sturgeon (from the New York Bight or Gulf of Maine DPS) and the mortality of no more than three of the captured shortnose sturgeon and no more than one of the captured Atlantic sturgeon. Since the issuance of this Opinion, there have not been any takes of ESA-listed species.

5.3 EPA Fish Assemblage Study

On January 12, 2015, we issued a Biological Opinion on the effects of the U.S. Environmental Protection Agency's (EPA) continued funding of a multi-year bio-assessment study on the Kennebec and Sebasticook Rivers (2014-2019). The purpose of the survey is to document changes to fish assemblages in the rivers following the removal of the Edwards Dam in 2001 and the Ft. Halifax dam in 2009. The ITS in the 2015 Opinion allows for the annual non-lethal take (through 2019) of up to four shortnose sturgeon, four Atlantic sturgeon (GOM or NYB DPS), and four Atlantic salmon (GOM DPS). Since the 2015 Opinion was issued, the following non-lethal harassment has been observed during electrofishing:

Table 8: EPA Fish Assemblage Study Recorded Take (2015-2019)

Year	Atlantic salmon (GOM DPS)	Atlantic sturgeon (GOM or NYB DPS)	Shortnose Sturgeon
2015	1	0	0
2016	0	0	2
2017	0	0	2
2018	0	1	1
2019	2	1	5

5.4 Scientific Studies

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

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

The University of Maine holds a scientific research permit (No. 20347) to capture, tag, and sample genetic material from shortnose sturgeon and Atlantic sturgeon from 2017-2027. The University proposes to:

1. Combine acoustic telemetry, blood analysis, genetics and scute spine analysis to determine spawning periodicity for each sex and species and river of origin;
2. Compare aging of fin spines/rays and scute spines to determine if scute spines are an alternate means of ageing fish ; and
3. Use mark-recapture and acoustic telemetry to identify critical habitat for juveniles, estimate annual juvenile recruitment, and movement within and between river systems.

Across Gulf of Maine rivers and coastal marine habitat, their objectives for Atlantic sturgeon include capturing a maximum of 845 adults/subadults, 138 juveniles, and 200 early life stages (ELS; eggs and larvae). All adults, subadults, and juveniles will be weighed, measured, examined for tags, examined with a borescope when appropriate, marked with PIT tags and T-bar or Floy tags, photographed, and sampled for genetic material (i.e. a fin clip) and blood prior to being released. Their objectives for shortnose sturgeon include capturing a maximum of 1,535 adults, 189 juveniles, and 210 ELS. All adults, sub-adults, and juveniles will be weighed, measured, examined for tags, examined with a borescope when appropriate, marked with PIT tags and T-bar or Floy tags, photographed, and sampled for genetic material (i.e. a fin clip) and blood prior to being released (hereafter "basic processing").

Specific to the Kennebec River System (including the Androscoggin River and the action area), they propose to capture and handle as many as 200 Atlantic sturgeon (all DPSs) and 400 shortnose sturgeon. They also propose to capture 100 Atlantic sturgeon eggs/larvae from the GOM DPS and 50 shortnose sturgeon eggs/larvae, resulting in mortality. Over the lifetime of the permit, they also expect the unintentional mortality of one Atlantic sturgeon adult/subadult (all DPSs), one Atlantic sturgeon juvenile (all DPSs), two shortnose sturgeon adults, and two shortnose sturgeon juveniles.

5.5 Contaminants and Water Quality

Contaminants including heavy metals, polychlorinated aromatic hydrocarbons (PAHs), pesticides, and polychlorinated biphenyls (PCBs), can have serious, deleterious effects on aquatic life and are associated with the production of acute lesions, growth retardation, and reproductive impairment (Ruelle and Keenlyne 1993). Contaminants introduced into the water column or through the food chain, eventually become associated with the benthos where bottom dwelling species like sturgeon are particularly vulnerable.

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

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

Contaminant analysis conducted in 2003 of tissues from a shortnose sturgeon from the Kennebec River revealed the presence of fourteen metals, one semivolatile compound, one PCB Aroclor, Polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) in one or more of the tissue samples. Of these chemicals, cadmium and zinc were detected at concentrations above an adverse effect concentration reported for fish in the literature (ERC 2003).

Point source discharges (i.e., municipal wastewater, paper mill effluent, industrial or power plant cooling water or waste water) and compounds associated with discharges (i.e., metals, dioxins, dissolved solids, phenols, and hydrocarbons) contribute to poor water quality and may also impact the health of sturgeon and salmon populations. The compounds associated with discharges can alter the pH or receiving waters, which may lead to mortality, changes in fish behavior, deformations, and reduced egg production and survival.

5.6 State or Private Activities in the Action Area

5.6.1 Private Recreational Boating

The action area, encompassing a portion of the lower Kennebec River estuary, contains numerous private and public boat launches, as well as private and public piers and marinas. Recreational vessel traffic is common throughout the action area from the spring (especially during diadromous fish runs), through the summer and into the fall. We do not expect recreational vessels in the action area during the winter months. Recreational vessels include small inboard and outboard motorized vessels, as well as non-motorized vessels (e.g., canoes, kayaks, etc.).

Although smaller motorized vessels have a shallower draft and entrain less water, they often operate at higher speeds. There is evidence to suggest that small fast vessels with shallow draft are a source of vessel strike mortality on Atlantic and shortnose sturgeon. On November 5, 2008, in the Kennebec River, Maine, Maine Department of Marine Resources (Maine DMR) staff observed a small (<20 foot) boat transiting a known shortnose sturgeon overwintering area at high speeds. When Maine DMR approached the area after the vessel had passed, a fresh dead shortnose sturgeon was discovered. The fish was collected for necropsy, which later confirmed that the mortality was the result of a propeller wound to the right side of the mouth and gills.

5.6.2 State Authorized Fisheries

Shortnose and Atlantic sturgeon are taken incidentally in anadromous fisheries along the East Coast and may be targeted by poachers (NMFS 1998, ASSRT 2007). The Kennebec River is an important corridor for migratory movements of various species including alewife (*Alosa pseudohernegus*), American eel (*Anguilla rostrata*), blueback herring (*Alosa aestivalis*), American shad (*Alosa sapidissima*), rainbow smelt (*Osmerus mordax*), striped bass (*Morone saxatilis*) and lobster (*Homarus americanus*). Historically, the river and its tributaries supported the largest commercial fishery for shad in the State of Maine. However, pollution and the construction of dams decimated the shad runs in the late 1920s and early 1930s. Shortnose sturgeon in the Kennebec River may have been taken as bycatch in the shad fishery or other fisheries active in the action area. It has been estimated that approximately 20 shortnose sturgeon are killed each year in the commercial shad fishery and an additional number are also likely taken in recreational fisheries (T. Savoy pers. comm. in NMFS 1998). However, the incidental take of shortnose sturgeon in the river has not been well documented due to confusion over distinguishing between Atlantic sturgeon and shortnose sturgeon. Due to a lack of reporting, no information on the number of shortnose or Atlantic sturgeon caught and released or killed in commercial or recreational fisheries on the Kennebec River is available.

5.7 Status of Shortnose Sturgeon in the Action Area

5.7.1 Shortnose Sturgeon in the Kennebec River System

The Kennebec system includes the Kennebec, Androscoggin and Sheepscot Rivers. Shortnose sturgeon occur in the estuarine complex formed by the Sheepscot, Kennebec, and Androscoggin rivers. Atkins (1887) documented the presence of sturgeon in Maine rivers, though they were identified as common sturgeon (*Acipenser sturio*). Fried and McCleave (1973) discovered shortnose sturgeon within Montsweag Bay in the Sheepscot River in 1971 and 1972. This was the first reported occurrence of shortnose sturgeon in Maine. Shortnose were subsequently found in the Kennebec River by Maine DMR in 1977 and 1978 (Squiers and Smith 1979). Historically, the upstream extent of shortnose sturgeon in the Kennebec is thought to have been Ticonic Falls (rkm 103)(NMFS & USFWS 1998).

Sturgeon were tagged with Carlin tags from 1977 to 1981, with recaptures in each of the following years. A Schnabel estimate of 7,222 (95% CI, 5,046 to 10,765) adults for the combined estuarine complex was computed from the tagging and recapture data from 1977 through 1981 (Squiers *et al.* 1982). A Schnabel estimate using tagging and recapture data from 1998 - 2000 indicates a population estimate of 9,488 (95% CI, 6,942 to 13,358) for the estuarine complex (Squiers 2003). The average density of adult shortnose sturgeon/hectare of habitat in the estuarine complex of the Kennebec River was the second highest of any population studied through 1983 (Dadswell *et al.*, 1984). The Schnabel estimate from 1998-2000 is the most recent population estimate for the Kennebec River System shortnose sturgeon population; however, does not include an estimate of the size of the juvenile population. A comparison of the population estimate for the estuarine complex from 1982 (Squiers *et al.* 1982) to 2000 (Maine DMR 2003) suggests that the adult population has grown by approximately 30% in that twenty year period. Assuming that this trend continued past 2000, we would expect the shortnose sturgeon population in the Kennebec River system to be increasing; however, without more information on the status of more recent year classes it is not possible to determine if this trend has been sustained.

5.7.1.1 Spawning in the Kennebec

In 1999, the Edward's Dam (rkm 74), which represented the first significant impediment to the northward migration of shortnose sturgeon in the Kennebec River, was removed. The Lockwood Dam continues to operate, though it is not thought to impede shortnose access to historic habitat given its location at Ticonic Falls (rkm 103), the presumed historic upstream extent of shortnose in the Kennebec River. Thus, with the removal of the Edwards dam almost 100% of historic habitat is now accessible. Since the removal of the Edwards Dam, shortnose sturgeon have been documented just downstream of the Lockwood Dam (rkm 103) indicating this habitat is being utilized (Wippelhauser *et al.* 2015).

Wippelhauser and Squiers (2015) summarized field studies on shortnose and Atlantic sturgeon from 1977-2001 in the Kennebec River system that sought to produce population estimates and documentation of spawning, overwintering, and foraging habitat. Based on the capture of 172 adult shortnose sturgeon between May 1-31 over a period of 22 years (including two ripe males releasing sperm during handling) from rkm 47.5-74 in the Kennebec River, they identified spawning run timing and potential spawning habitat. Maine DMR conducted ichthyoplankton surveys from 1996 through 2001. Sampling sites were located both above and below the dam and were surveyed using surface tows with plankton nets and stationary sets with D-shaped plankton nets. Through these efforts, researchers captured 54 eggs and 10 larvae at two sampling locations (rkm 65 and 72.7), confirming that spawning occurs in that 9 rkm stretch below the former Edwards Dam (Wippelhauser and Squiers 2015).

Between 2007 and 2013, Wippelhauser *et al.* 2015 tagged 134 adult shortnose sturgeon throughout the Gulf of Maine (Penobscot, Kennebec, Saco, Merrimack). Twenty-one (20%) of 104 shortnose sturgeon tagged in the Penobscot River, two (50%) of four tagged in the Kennebec system, one (50%) of two tagged in the Saco River, and 16 (37%) of 43 tagged in the Merrimack River moved into the Kennebec system and made suspected spawning runs. These adults displayed two distinct pre-spawning behaviors. Some (~35%) emigrated to the Kennebec system in the summer or fall and overwintered one to two seasons before participating in a spring spawning run, while the majority (~65%) migrated to the Kennebec system in the early spring and participated in a spawning run that same year. Tagged shortnose were detected in spawning areas from April 7 through June 6 as water temperatures increased and discharge decreased. During this time, bottom temperatures in the Kennebec River ranged from 5.8-17.6°C and fish spent an average of 9.9-12.5 days in the spawning sites (varied by Kennebec location). Discharge when shortnose sturgeon were at the spawning areas was typically ≤558 m^3/s; however, flows reached as high as 1,487 m^3/s in some years. Spawning was documented for the first time in the restored portion of the Kennebec (above the former Edwards Dam (rkm 74)) between May 17-19, 2010, as two larvae were captured below the Lockwood Dam at rkm 102 using D-nets. Spawning was again confirmed below the former Edwards Dam with the capture of 23 larvae between rkm 64-72 in a sampling period from May 19-June 15, 2009, as well as the capture of seven larvae between rkm 67-73 in a sampling period from May 3-June 6, 2011 (Wippelhauser *et al.* 2015).

5.7.1.2 Spawning in the Androscoggin River
In the Androscoggin River, shortnose sturgeon migration, and thus spawning location, was likely limited historically by the natural falls located at the Brunswick Dam (rkm 8.4). From 1979-1982, MDMR conducted gillnet studies to identify spawning areas. During this period large numbers of shortnose sturgeon were captured between Brunswick and Topsham. Water temperatures during this time ranged between 8.5 and 14.5°C (late April until the end of May), many of the males captured were freely expressing milt and several females were ripe (Squiers *et al.* 1982). Tracking studies to delineate spawning habitat were performed on the Androscoggin River during 1993 (Squiers *et al.* 1993). Gill nets were used to capture study animals and catch rates were recorded. Gill net catch-per-unit-effort during this study was the highest recorded in this area, suggesting that the population in the Androscoggin has increased since last surveyed. Using cement blocks fitted with plastic mesh, this study also confirmed spawning by collecting eggs at two different discrete spawning areas (May 13 and 19) at approximately rkm 7.7. One larval shortnose sturgeon was also captured in the same general area (May 28) using a plankton net. This study indicated that spawning was concentrated in the reach of river between approximately rkm 7.7 and 8.4 (the Brunswick Dam).

Adding to this research, Wippelhauser *et al.* 2015 (discussed above) used telemetry data to record 14 spawning events (presence of late-stage females in known spawning grounds during the spawning season) from early April to early June. In data provided to MaineDOT for their BA, Wippelhauser (2016) stated that shortnose spawning below the Brunswick Dam (rkm 7.7-8.4) occurs from April 7 – June 11. During spawning, bottom temperatures in the spawning area ranged from 8.8-16.4^{0}C, and spawning adults spent an average of 4 days at the spawning site (range 0.1-7.8 days)(Wippelhauser *et al.* 2015).

5.7.1.3 Foraging
Foraging areas have been identified in the Sasanoa River entrance[5] and in the mainstem of the Kennebec River below Bath, from mid-April through November or early December (Squiers 1982, Normandeau 1999). Between June and September, shortnose sturgeon forage in shallow waters on mud flats that are covered with rooted aquatic plants. In the summer months, concentrations of shortnose sturgeon have also been known to move up into the freshwater reaches of the Kennebec River and foraging shortnose sturgeon have also been seen in Montsweag and Hockomock Bays in the Sheepscot River, which is located near the eastern end of the Sasanoa River (NMFS 1996). McCleave *et al.* (1977) examined several stomachs from shortnose sturgeon captured in Montsweag Bay and found crangon shrimp (*Crangon septemspinosous*); clams (*Mya arenaria*); and small winter flounder (*Pseudopleuronectes*

[5] The Sasanoa River entrance is located directly across the Kennebec River from the Bath Iron Works facility. The river is less than ½ mile wide at this point.

americanus) were common prey items.

In the late summer (August 10 to September 2, 1993), Squiers *et al.* 1993 looked between rkm 7.0 and 8.4 for foraging young of the year and juvenile shortnose sturgeon. No young of the year or juvenile shortnose sturgeon were captured in sampling with an otter trawl. The authors concluded that it was likely that the larval shortnose sturgeon would have emigrated further downstream prior to August and that the juveniles would be associated with deep channel areas with rugged substrate and not in the area surveyed (including the action area).

5.7.1.4 Overwintering

Studies indicate that at least a portion of the shortnose sturgeon population in the Kennebec River overwinters in Merrymeeting Bay (Squiers and Robillard 1997). The seasonal migrations of shortnose sturgeon are believed to be correlated with changes in water temperature. In 1999, when a tracking study was performed by Normandeau Associates, the water temperature near Bath Iron Works (BIW) reached the 8-9ºC threshold (believed to be the trigger prompting spawning fish to migrate to the spawning area) in mid-April. Also during the tracking study, several fish presumed to be non-spawning sturgeon, were documented in the Chops Point and Swan Island areas (north of Doubling Point) in late March and then were found to have migrated south to the BIW region (e.g., north and south of the BIW Pier and Museum Point) early in April.

Until a study aimed at specifically determining overwintering locations was conducted by the MDMR in 1996 for the MaineDOT, the sites thought to be the most likely overwintering sites were deep pools below Bluff Head, and possibly in adjacent estuaries such as the Sheepscot (Squiers and Robillard 1997). The 1996 study of overwintering activity suggests that at least one overwintering site is located above Bath. This is based on tracking 15 shortnose sturgeon collected and released in the vicinity of the Sasanoa River (Pleasant Cove), Winnegance Cove (near the Doubling Point reach), and Merrymeeting Bay (north of Bath and the Sasanoa River entrance). Tracking was done from October through January. Eleven of these fish were relocated in Merrymeeting Bay. Two of the fish from Pleasant Cove were never found in Merrymeeting Bay; one Pleasant Cove fish moved to Winnegance Cove and back to Pleasant Cove and another moved to Days Ferry (half way between Bath and Merrymeeting Bay). All of the fish that continued to transmit after November were only found in upper Merrymeeting Bay on the east-side of Swan Island (~rkm 40-42). Fish departed the wintering site between April 7-25, with most moving downstream toward the lower Kennebec estuary (Wippelhauser and Squiers 2015). This is consistent with the trends for movement of shortnose sturgeon in the Delaware River (O'Herron *et al.* 1993). Overwintering sturgeon in the Delaware River are found in the area of Newbold Island, in the Trenton to Kinkora river reach, in an area geographically similar to the area around Swan Island.

5.7.1.5 Expected Seasonal Distribution of Shortnose Sturgeon in the Action Area

The discussion below summarizes the expected seasonal distribution of shortnose sturgeon in the action area.

Wippelhauser (unpublished data, used with permission) described shortnose sturgeon migration (from 2007–2017) in the lower Kennebec River, at rkm 4.5 (from April to November), rkm 16 (from March to November), and rkm 18 (in September of 2011 only) for shortnose sturgeon tagged in the Kennebec, Penobscot, Saco, and Merrimack Rivers (Table 9). The receiver was, on average, deployed for the full month for each month from May to October. Receivers were not deployed from January to February (only in March on one occasion), therefore no data was collected during this period.

Table 9: Average number of days per month individual shortnose sturgeon were detected by acoustic tagging study (Wippelhauser (2019) unpublished data, used with permission)

Species	***Receiver Location (at rkm)***	***Mar***	***Apr***	***May***	***Jun***	***Jul***	***Aug***	***Sep***	***Oct***	***Nov***	***Dec[1]***
Shortnose sturgeon	4.5		2.2	5.4	6.2	3.8	4.7	4.2	1.8	1.4	
Shortnose sturgeon	16	2.7[2]	2.1	3.6	4.3	3.3	2.1	1.6	2.0	2.0	
Shortnose sturgeon	18							2.0[3]			

[1] Zero shortnose sturgeon were detected in December at rkm 4.5, rkm 16, and rkm 18.
[2] Only 3 shortnose sturgeon were detected in March at rkm 16 for the 8 days data was collected.
[3] One shortnose sturgeon was detected in September at rkm 18 for the 2 days; 5 at rkm 4.5 for the 21 days; and 9 at rkm 16 for the 14 days data was collected.

Wippelhauser's unpublished data (2019) was further summarized to describe monthly individual detections (2007–2017) in the lower Kennebec River, at rkm 4.5, rkm 16, and rkm 18 (Table 9, Figure 6). The number of shortnose sturgeon that were acoustically tagged in the Kennebec River include 4 in 2011, 17 in 2012, and 5 in 2013. Other detections came from fish tagged in the Penobscot, Saco, and Merrimack Rivers. Across all years and all river mile markers, the first detection of a shortnose sturgeon occurred in March at rkm 16 and was intermittent through November with detections at rkm 4.5 and rkm 16. Receiver stations were not deployed past the second day of December for any year. According to Wippelhauser (pers. comm. (2019)), shortnose sturgeon primarily migrate through the lower Kennebec River and exclusively spawn and overwinter in the upper Kennebec River. Based on the trend in these data (Figure 6), shortnose sturgeon are only rarely expected to be in the proposed action area in the late winter months as they would be likely be in overwintering habitat further upriver.

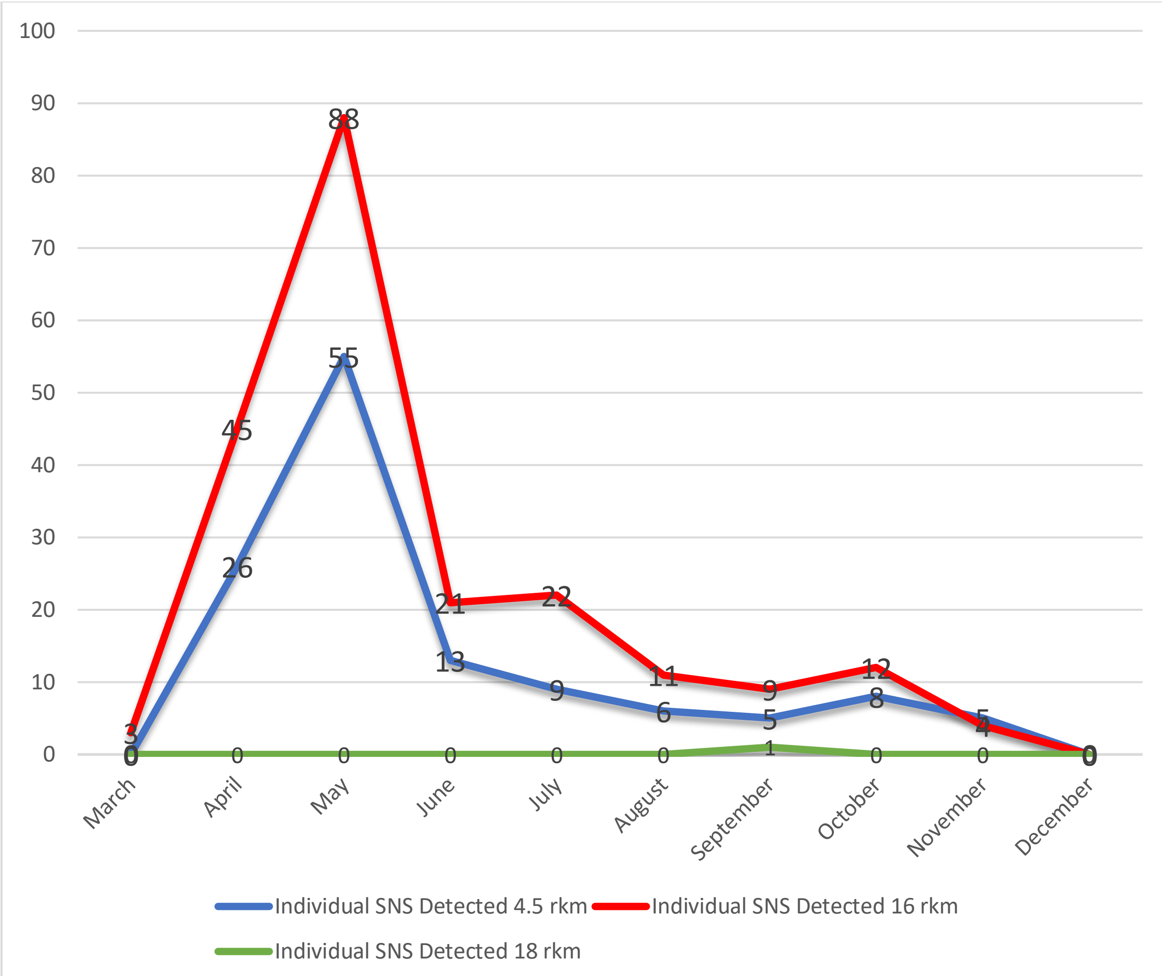

Figure 6: Number of individual shortnose sturgeon detected in the Kennebec River from 2007–2017 at rkm 4.5, 16, and 18 (Wippelhauser (2019) unpublished data, used with permission)

Additional data from a trawl survey in the Kennebec River in the late 1990s near the BIW shipyard shows captures of juvenile shortnose sturgeon from April 17 through November 17 (Atlantic Sturgeon Status Review Team 2007). Juvenile shortnose sturgeon were not captured from December 1997 through February 1998. However, the researchers were able to track tagged fish around BIW until ice impeded the researchers' navigation, providing evidence that shortnose sturgeon are potentially present year-round.

Table 10: Timing of shortnose sturgeon lifestages and behaviors in the action area

Lifestage	Time of Year Present in Action Area	Behavior in Action Area
Adults	Year-round	Adults are expected to be present and actively foraging from April through November. Shortnose sturgeon from other river systems (e.g., Merrimack, Penobscot), are likely to migrate through the action area in the early spring, and those that overwinter

Lifestage	Time of Year Present in Action Area	Behavior in Action Area
		outside of the Kennebec River system, will emigrate in the fall. Presence in the action area from December through March is expected to be rare and limited to a few individuals.
Juveniles	Year-round	Juveniles are expected to be present and actively foraging from April through November. Presence in the action area from December through March is expected to be rare and limited to a few individuals.

5.8 Status of Atlantic Sturgeon in the Action Area

5.8.1 Atlantic Sturgeon in the Kennebec River System

As noted above, 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). Following the 1880s, the sturgeon fishery was almost non-existent due to a collapse of the sturgeon stocks. While directed fishing and retention as by-catch has been prohibited since 1998, the GOM DPS of Atlantic sturgeon remains threatened. Based on the NEAMAP survey data, we estimate an ocean population of 7,455 adult and subadult GOM DPS Atlantic sturgeon. In the marine range, GOM DPS Atlantic sturgeon are still incidentally captured in federal and state managed fisheries, reducing survivorship of subadult and adult Atlantic sturgeon (Stein *et al.*, 2004; ASMFC 2007). Habitat disturbance and direct mortality from anthropogenic sources are primary concerns. Due to the lack of recaptures, to date, we do not have a population estimate for adult Atlantic sturgeon in the Kennebec River system (Wippelhauser and Squiers 2015). For a summary of threats faced by the GOM DPS of Atlantic sturgeon, see section 4.2.2.

5.8.1.1 Coastal Movements

As part of a study to assess coastal movements of Atlantic sturgeon in the Gulf of Maine, Wippelhauser *et al.* 2017 captured 681 sub-adult and adult Atlantic sturgeon within four study rivers (Merrimack, Saco, Kennebec, Penobscot). Approximately 25% (169) were tagged with acoustic transmitters for tracking using a series of acoustic receiver arrays in each of the rivers, as well as compatible arrays in the marine coastal environment. Of the 169 tagged sturgeon, 20 were captured and tagged in the Merrimack, 51 in the Saco, 55 in the Kennebec, and 43 in the Penobscot. Fifty-nine (59) individuals tagged elsewhere were detected in the Kennebec system. Nonspawning Atlantic sturgeon entered the Kennebec system in late May (median date of May 30) and departed early in the late summer or early fall (median date of August 25).

5.8.1.2 Foraging

While in the Kennebec system, adult and subadult Atlantic sturgeon that did not enter spawning grounds spent the majority of their time between rkm 0 and 45, likely foraging (Wippelhauser *et al.* 2017). From 1977-2001, between May and the end of November, Wippelhauser and Squiers (2015) also captured 304 juvenile Atlantic sturgeon (described as “early, intermediate, and late stage”) in the upper Kennebec estuary, Merrymeeting Bay, lower Kennebec estuary, and the

Sasanoa River. Over half of the juveniles (146) were caught in October and September (67), and the majority were captured in the lower Kennebec estuary (212) and Merrymeeting Bay (67), indicating the likely presence of foraging grounds.

5.8.1.3 Spawning in the Kennebec River System

To date, despite captures of sturgeon in the Merrimack, Penobscot and Piscataqua/Salmon Falls/Cocheco rivers, as well as the necessary physical and biological features to support spawning in each of those rivers, the only confirmed spawning locations for the GOM DPS of Atlantic sturgeon are in the Kennebec River system (upper Kennebec River estuary and the Androscoggin River).

As reported in Wippelhauser *et al.* 2017, between 2010 and 2014, most tagged Atlantic sturgeon entered the Kennebec system during April and May (May 6 on average, with a range of April 11-June 17). They then moved to the spawning grounds mostly in June (average of June 14, range May 8-July 20), and remained at the spawning grounds through July (average of July 13, range of June 12-August 20). Water temperatures were typically over 16°C when Atlantic sturgeon occupied spawning areas, and freshwater discharge was usually less than 399 m^3/s. After spawning, some tagged individuals from the 2009-2011 study remained in Merrymeeting Bay or the lower Kennebec estuary for approximately 60 days before departing the system in October (Wippelhauser *et al.* 2017).

5.8.1.4 Spawning in the Kennebec River

As described above in section 4.7, from 1977-2001, Atlantic sturgeon in spawning condition were caught between rkm 52.8 and rkm 74 of the Kennebec River during the months of June and July, the likely spawning season. The removal of the Edwards Dam (rkm 74) in 1999 allowed Atlantic sturgeon to access 21 rkm of historic spawning habitat, up to Ticonic Falls/Lockwood Dam (rkm 103). From 2009 to 2011, 31 Atlantic sturgeon, including 6 ripe males, were caught in the Kennebec River between rkm 70 and rkm 75 (Wippelhauser 2012; Wippelhauser and Squiers 2015). Spawning was confirmed in the restored Kennebec River habitat (above the former Edwards Dam) when two larvae were captured (July 11-12, 2011) in the Upper Kennebec Estuary, 1 to 1.6 rkm upstream of the former Edwards Dam site (rkm 74). One larva was also captured at rkm 72 during the same time span (Wippelhauser 2012; Wippelhauser *et al.* 2017).

5.8.1.5 Spawning in the Androscoggin River

From 2009-2017, 11 adult Atlantic sturgeon have been captured and/or detected in the Androscoggin River near rkm 7.7. One of the sturgeon (captured on June 21, 2011) was a spawning condition (i.e., ripe) male (188.5 cm TL). Two of the sturgeon, including the ripe male, had been caught and PIT tagged in the Saco River the previous year (Wippelhauser *et al.* 2017; Wippelhauser pers. comm. 2018). With one exception, all of the sturgeon had left the spawning area by the end of July (one left on August 7). While these captures confirm likely spawning, Atlantic sturgeon eggs and larvae have not yet been recovered in the Androscoggin (Wippelhauser pers. comm. 2018).

5.8.1.6 Expected Seasonal Distribution of Atlantic Sturgeon in the Action Area

Unpublished data provided by Wippelhauser (2019)describes acoustic telemetry detections (from 2007–2017) in the lower Kennebec River, where receivers were deployed at rkm 4.5 (from April to December 2012–2017), rkm 16 (from March to November 2007–2017), and at rkm 18 (from August to October in 2011 only) for Atlantic sturgeon tagged in the Kennebec, Penobscot, Saco, and Merrimack Rivers (Table 11). The receiver was, on average, deployed for the full duration for the months of May through October. Receivers were not deployed from January to February (only in March on one occasion); therefore, no data on Atlantic sturgeon in the Kennebec River were collected during these months.

Table 11: Average number of days per month acoustic receivers were deployed at rkm 4.5 and rkm 16 from 2007–2017 (Wippelhauser (2019) unpublished data, used with permission)

Receiver Location (at rkm)	***Years Deployed***	***Mar***	***Apr***	***May***	***Jun***	***Jul***	***Aug***	***Sep***	***Oct***	***Nov***	***Dec***
4.5	2012-2017	0	8	24	25	29	31	30	31	20	2
16	2007-2017[1]	7[1,2]	13	30	30	31	29	30	31	20	2

[1] There was a gap in data collection at station rkm 16 during a portion of March–July 2010 due to a lost receiver.
[2] 2010 is the only year that data is available for the month of March.
Note: No data are available from stations during the months of January or February.

Wippelhauser (2019) was further summarized to describe to the average number of days per month Atlantic sturgeon were detected and also the number of monthly individual Atlantic sturgeon detections (2007–2017) in the lower Kennebec River at rkm 4.5, rkm 16, and rkm 18 (Table 12, Figure 7). The number of Atlantic sturgeon that were acoustically tagged in the Kennebec include 5 in 2009, 8 in 2010, 11 in 2011, 16 in 2012, and 15 in 2013. Other detections came from fish tagged in the Penobscot, Saco, and Merrimack Rivers. Across all years and all river mile markers, the first detection of an Atlantic sturgeon occurred in March at rkm 16 and was intermittent through the end of November. Receiver stations were not deployed past the second day of December for any year. Based on the trend in these data (Figure 7), Atlantic sturgeon are not likely to occur in the proposed action area in the late winter months as they would be likely to move out to sea by December of each year.

Table 12: Average number of days per month individual Atlantic sturgeon were detected by acoustic tagging study (Wippelhauser (2019) unpublished data, used with permission)

Species	***Receiver Location (at rkm)***	***# Years Deployed***	***Mar[1]***	***Apr***	***May***	***Jun***	***Jul***	***Aug***	***Sep***	***Oct***	***Nov***	***Dec[2]***
Atlantic sturgeon	4.5	6		3.3	4.0	4.7	2.4	2.6	3.0	3.7	4.2	3.0
Atlantic sturgeon	16	11	5.5	5.6	7.9	5.7	3.4	2.8	2.6	2.3	1.6	
Atlantic sturgeon	18	1						1.9	4.4	2.8		

[1] Only two individual fish detected in March at rkm 16 for the 3 days data was collected.
[2] Only one individual fish detected in December at rkm 4.5 for the 11 days data was collected.

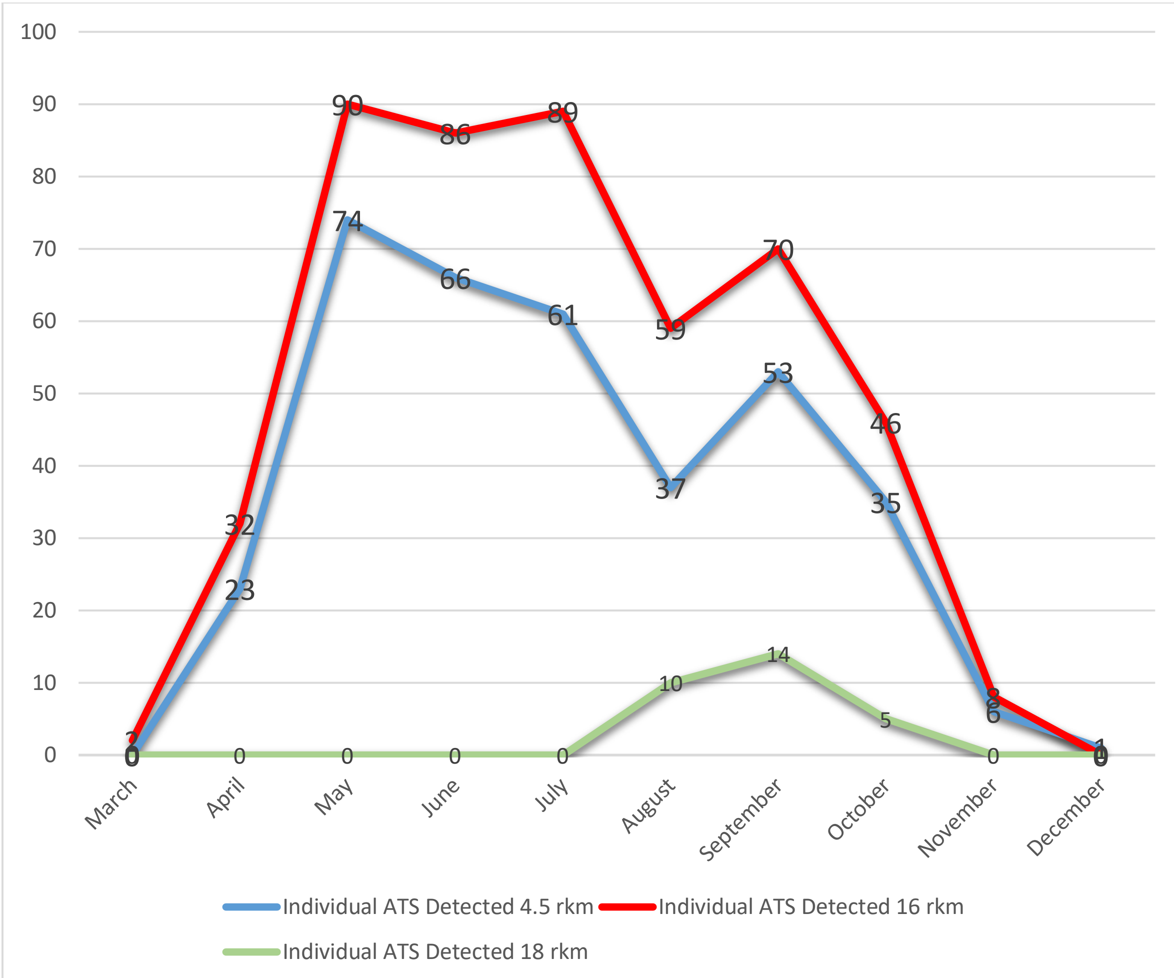

Figure 7: Number of individual Atlantic sturgeon detected in the Kennebec River from 2007–2017 at rkm 4.5, 16, and 18 (Wippelhauser (2019) unpublished data, used with permission)

Additional data from a trawl survey in the Kennebec River in the late 1990s near the BIW shipyard shows captures of subadult Atlantic sturgeon from April 17 through November 17 (Atlantic Sturgeon Status Review Team 2007). Atlantic sturgeon were not captured from December 1997 through February 1998. However, the researchers were able to track tagged fish around BIW until ice impeded the researchers' navigation, providing evidence that Atlantic sturgeon are likely present year-round. Atlantic sturgeon were also tracked in the Bath region of the river (near rkm 20) in 1998 and 1999. Two Atlantic sturgeon were tracked in October and November 1998, and one was present in December 1998 in Merrymeeting Bay (presumably overwintering with shortnose sturgeon). An overwintering site has not been identified for the Atlantic sturgeon in the Kennebec River; therefore, it is thought adults and subadults would mostly move out to sea by December of each year (Wippelhauser and Squiers 2015). Atlantic sturgeon were tracked again from April through November 1999. They were observed to move in and out of BIW, up to Swan Island (in the mouth of the Penobscot River) and Chops Point, and down to Hospital Point (near the Doubling Point dredge site in the lower Kennebec River) (Atlantic Sturgeon Status Review Team 2007).

Table 13: Timing of Atlantic sturgeon lifestages and behaviors in the action area

Lifestage	Time of Year Present in Action Area	Behavior in Action Area
Adults	April 1 – November 30	Adults are expected to be present and actively foraging from April through November. Spawning adults will migrate upstream in the spring and downstream in the fall. Adults are not known to overwinter in the action area.
Subadults	April 1 – November 30	Subadults are expected to be present and actively foraging from April through November. Subadults are not known to overwinter in the action area.
Juveniles	Year-round	Juveniles are expected to be present and actively foraging from April through November. Presence in the action area from December through March is expected to be rare and limited to a few individuals.

6.0 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 on listed species and critical habitat in the action area over the lifespan of the proposed project (2019-2029). 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, below.

6.1 Background Information on Global climate change

In its Fifth Assessment Report (AR5) from 2014, the Intergovernmental Panel on Climate Change (IPCC) stated that the globally averaged combined land and ocean surface temperature data has shown a warming of 0.85°C (likely range: 0.65° to 1.06°C) over the period of 1880-2012. Similarly, the total increase between the average of the 1850-1900 period and the 2003-2012 period is 0.78°C (likely range: 0.72° to 0.85°C). On a global scale, ocean warming has been largest near the surface, with the upper 75 m of the world's oceans having warmed by 0.11°C (likely range: 0.09° to 0.13°C) per decade over the period of 1971-2010 (IPCC 2014). In regards to resultant sea level rise, it is very likely that the mean rate of global averaged sea level rise was 1.7 millimeters/year (likely range: 1.5 to 1.9 millimeters/year) between 1901 and 2010, 2.0 millimeters/year (likely range: 1.7 to 2.3 millimeters/year) between 1971 and 2010, and 3.2 millimeters/year (likely range: 2.8 to 3.6 millimeters/year) between 1993 and 2010.

Climate model projections exhibit a wide range of plausible scenarios for both temperature and precipitation over the next several decades. The global mean surface temperature change for the period 2016-2035 relative to 1986-2005 will likely be in the range of 0.3° to 0.7°C (medium confidence). This assessment is based on multiple lines of evidence and assumes there will be no major volcanic eruptions or secular changes in total solar irradiance. Relative to natural internal variability, near-term increases in seasonal mean and annual mean temperatures are expected to be larger in the tropics and subtropics than in mid- and high latitudes (high confidence). 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 also resulted in increased river discharge and glacial and sea-ice melting (Greene *et al.* 2008). The strongest ocean warming is projected for the surface in tropical and Northern Hemisphere subtropical regions. At greater depths, the warming will be most pronounced in the Southern Ocean (high confidence). Best estimates of ocean warming in the top 100 m are about 0.6° to 2.0°C, and about 0.3° to 0.6°C at a depth of about 1,000 m by the end of the 21st century (IPCC 2014).

Under Representative Concentration Pathway (RCP) 8.5, the projected change in global mean surface air temperature and global mean sea level rise for the mid- and late 21st century relative to the reference period of 1986-2005 is as follows. Global average surface temperatures are likely to be 2.0°C higher (likely range: 1.4° to 2.6°C) from 2046-2065 and 3.7°C higher (likely range: 2.6° to 4.8°C) from 2081-2100. Global mean sea levels are likely to be 0.30 m higher (likely range: 0.22 to 0.38 m) from 2046-2065 and 0.63 m higher (likely range: 0.45 to 0.82 m) from 2081-2100, with a rate of sea level rise during 2081-2100 of 8 to 16 millimeters/year (medium confidence).

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 (IPCC 2007; Greene *et al.* 2008). With respect specifically to the North Atlantic Oscillation (NAO), changes in salinity and temperature are thought to be the result of changes in the Earth's atmosphere caused by anthropogenic forces (IPCC 2007). The NAO impacts climate variability throughout the Northern Hemisphere (IPCC 2007). Data from the 1960s through the 2000s showed that the NAO index increased from minimum values in the 1960s to strongly positive index values in the 1990s and somewhat declined since (IPCC 2007). This warming extends over 1,000 m deep and is deeper than anywhere in the world's oceans and is particularly evident under the Gulf Stream/North Atlantic Current system (IPCC 2007). On a global scale, large discharges of freshwater into the North Atlantic subarctic seas can lead to intense stratification of the upper water column and a disruption of North Atlantic Deepwater (NADW) formation (IPCC 2007; Greene *et al.* 2008). There is evidence that the NADW has already freshened significantly (IPCC 2007). This in turn can lead to a slowing down of the global ocean thermohaline (large-scale circulation in the ocean that transforms low-density upper ocean waters to higher density intermediate and deep waters and returns those waters back to the upper ocean), which can have climatic ramifications for the entire world (Greene *et al.* 2008).

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 pollutants released into the air can have major adverse impacts on the calcium balance in the oceans. Changes to the marine ecosystem due to climate change include shifts in ranges and changes in algal, plankton, and fish abundance (IPCC 2007). These trends have been most apparent over the past few decades, although this may also be due to increased research. Information on future impacts of climate change in the action area is discussed below.

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 action area, 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. Additional information on potential effects of climate change specific to the action area is discussed below. Warming is very likely to continue in the U.S. over the next 50 years regardless of reduction in greenhouse gases, 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 50 years, and it is possible that they 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).

Expected consequences of climate change for river systems 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 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 along the U.S. Atlantic coast 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 will 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°C per decade; and 3) a rise in sea level (NAST 2000). Sea level is expected to continue rising; during the 20th century global sea level has increased 15 to 20 centimeters. It is also important to note that ocean temperature in the U.S. Northeast Shelf and surrounding Northwest Atlantic waters have warmed faster than the global average over the last decade (Pershing *et al.* 2015). New projections for the U.S. Northeast Shelf and Northwest Atlantic Ocean suggest that this region will warm two to three times faster than the global average and thus existing projections from the IPCC may be too conservative (Saba *et al.* 2015).

6.2 Anticipated Effects of Climate Change in the Action Area to Atlantic and shortnose sturgeon and the Kennebec River Critical Habitat Unit

Information on how climate change will impact the action area is extremely limited. According to Fernandez *et al.* (2015), the Intergovernmental Panel on Climate Change (IPCC) models predict that Maine's annual temperature will increase another 3.0–5.0 °F (1.7–2.8 °C) by 2050. The IPCC models predict that precipitation will continue to increase across the Northeast by 5–10% by 2050, although the distribution of this increase is likely to vary across the climate zones (Fernandez *et al.* 2015); model predictions show greater increases in precipitation in interior Maine. Total accumulated snow is predicted to decline in Maine especially along the coast where total winter snow loss could exceed 40% relative to recent climate (Fernandez *et al.* 2015). Since 2004, sea surface temperatures in the Gulf of Maine have accelerated to 0.41 °F (0.23 °C) per year; a rate that is faster than 99% of the world's oceans (Fernandez *et al.* 2015).

According to the most recent National Climate Assessment (Melillo *et al.* 2014), a global sea level is projected to rise an additional 0.5 to 2.0 ft (0.2 to 0.6 m) or more by 2050. Rising sea levels would likely shift the salt wedge in the Kennebec River and other rivers in the GOM DPS; however the action area is relatively far from the current upper limits of the salt wedge where Merrymeeting Bay empties into the lower Kennebec River estuary (at least 15 rkm), and is buffered to some extent by Merrymeeting Bay. 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 Atlantic salmon.

Water availability, either too much or too little, as a result of global climate change is expected to have an effect on the features essential to successful sturgeon spawning and recruitment of the offspring to the marine environment (for Atlantic sturgeon). The increased rainfall predicted by some models in some areas may increase runoff, scour spawning areas, and create flooding events that dislodge early life stages from the substrate where they refuge in the first weeks of life. High freshwater inputs during juvenile development can influence juveniles to move further downriver and, conversely, lower than normal freshwater inputs can influence juveniles to move further upriver potentially exposing the fish to threats they would not typically encounter. Increased number or duration of drought events (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 spawning season(s) may also expose eggs and larvae in rearing habitats. If a river becomes too shallow or flows become intermittent, all sturgeon life stages, including adults, may become susceptible to stranding or habitat restriction. Low flow and drought conditions are also expected to cause additional water quality issues including effects to the combined interactions of dissolved oxygen, water temperature, and salinity. Elevated air temperatures can also impact dissolved oxygen levels in the water, particularly in areas of low water depth, low flow, and elevated water temperature. Rising temperatures predicted for all of the U.S. could exacerbate existing water quality problems affecting dissolved oxygen and temperature.

The action area encompasses as estuarine, mesohaline portion of the Kennebec River. The relatively short timeframe of the proposed action (2019-2029) makes any prediction of large scale and long-term climate change effects difficult. That said, over the next ten years, we do not expect the salinity of the action area to change in any way that would meaningfully alter the use of the habitat for sturgeon foraging or resting.

In the action area, it is possible that changing seasonal temperature regimes could result in shifts in the timing of seasonal migrations through the area as sturgeon move throughout the river. 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, Atlantic sturgeon may be excluded from some habitats. Additionally, temperature 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. 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.

Spawning and overwintering behaviors are 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 difficult to predict how any change in water temperature or river flow will affect the seasonal movements of sturgeon through the action area. However, it seems most likely that spawning would shift to earlier in the year, and that overwintering may begin later and end earlier.

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 is 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. Rising temperatures could meet or exceed the preferred temperature of shortnose and Atlantic sturgeon (28°C) on more days and/or in larger areas. This could result in shifts in the distribution of sturgeon out of certain areas during the warmer months. Information from southern river systems suggests that during peak summer heat, sturgeon are most likely to be found in deep water areas where temperatures are coolest. Thus, we could expect that over time, sturgeon would shift out of shallow habitats on the warmest days. This could result in reduced foraging opportunities if sturgeon were foraging in shallow waters.

As described above, over the long term, global climate change may affect shortnose and Atlantic sturgeon by affecting the location of the salt wedge, distribution of prey, water temperature and water quality. 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.

Additional modeling for climate change impacts, particularly salt water intrusion, are needed for the action area, to better assess the potential effects on shortnose and Atlantic sturgeon, as well as Atlantic sturgeon critical habitat.

7.0 EFFECTS OF THE ACTION

This section of the Opinion assesses the direct and indirect effects of the proposed action on threatened and endangered species or critical habitat, together with the effects of other activities that are interrelated or interdependent (50 CFR § 402.02). Indirect effects are those that are caused later in time, but are still reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend upon the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration (50 CFR § 402.02). We have not identified any interrelated or interdependent actions.

This Opinion examines the likely effects of the proposed action on the shortnose sturgeon, Atlantic sturgeon (GOM DPS), and the Kennebec River Unit of critical habitat designated for Atlantic sturgeon (GOM DPS). We consider these effects on the species and their habitat within the context of the species status now and projected over the course of the action, the environmental baseline, and cumulative effects.

As explained in the "Description of the Proposed Action" section (3.0), the action under consideration in this Opinion is ten years of maintenance dredging (2019-2029) of the Kennebec River FNP, specifically at Doubling Point and Popham Beach, with open water disposal at Bluff Head and Jackknife disposal areas. You anticipate maintenance dredging to be needed every three years; however, future Navy ship movements from the BIW shipyard to the open ocean or shoaling conditions could increase the need for dredging to possibly five times over the next ten years. When possible, dredge events will occur from December 1 to March 1; however, you are proposing that as many as two dredge events may occur from March 2 to November 30 between 2019 and 2029.

We also consider the long-term effects associated with the permanent structures resulting from the proposed action. We have divided the following sections by the project related stressors we have identified that may have an effect on listed species or critical habitat.

7.1 Dredging Entrainment and Entrapment

The scope of the Proposed Action includes ten years of maintenance dredging. Based on previous dredging requirements, you anticipate maintenance dredging to be needed every three years; however, future Navy ship movements from the BIW shipyard to the open ocean, or shoaling conditions could increase the need for dredging to possibly five times over the next ten years. You have estimated that during a typical dredging event, approximately 50,000 cubic yards (cy) of clean sand will be removed from the Doubling Point section over an area up to 45 acres, and approximately 20,000-30,000 cy of clean sand will be removed over an area up to 31 acres from the channel in the Popham Beach section. The two dredge areas account for a total of approximately 70,000–80,000 cy of material per dredge event. While dredging of the Kennebec River FNP has historically been performed with a hopper dredge, you have noted that it is also possible that dredging will be completed with a mechanical dredge.

7.1.1 Hopper Dredging

Hopper dredges are self-propelled seagoing vessels that are equipped with propulsion machinery, sediment containers (hoppers), dredge pumps, and trailing suction drag-heads required to perform their essential function of excavating sediments from the channel bottom. Hopper dredges have propulsion power adequate for required free-running speed and dredge against strong currents. They also have excellent maneuverability. This allows hopper dredges to provide a safe working environment for crew and equipment dredging bar channels or other areas subject to rough seas. Hopper dredges also are more practical when interference with vessel traffic must be minimized.

Dredged material is raised by dredge pumps through dragarms connected to drags in contact with the channel bottom and discharged into hoppers built in the vessel. Hopper dredges are equipped with large centrifugal pumps similar to those employed by other hydraulic dredges. Suction pipes (dragarms) are hinged on each side of the vessel with the intake (drag) extending downward toward the stern of the vessel. The drag is moved along the bottom as the vessel moves forward at speeds up to three mph (2.6 knots). The dredged material is sucked up the pipe and deposited and stored in the hoppers of the vessel.

A hopper dredge removes material from the bottom of the channel in relatively thin layers, usually 2-12 inches, depending upon the density and cohesiveness of the dredged material. Pumps located within the hull, but sometimes mounted on the drag arm, create a region of low pressure around the dragheads and force water and sediment up the drag arm and into the hopper. The more closely the draghead is maintained in contact with the sediment, the more efficient the dredging, provided sufficient water is available to slurry the sediments. Hopper dredges can efficiently dredge non-cohesive sands and cohesive silts and low density clay. Draghead types may consist of IHC and California type dragheads.

California type dragheads sit flatter in the sediment than the IHC configuration, which is more upright. Individual draghead designs (i.e. dimensions, structural reinforcing/configuration) vary between dredging contractors and hopper vessels. Port openings on the bottom of dragheads also vary between contractors and draghead design. Generally speaking, the port geometry is typically rectangular or square with minimum openings of ten inch by ten inch or twelve inch by twelve inch or some rectangular variation.

Industry and government hopper dredges are equipped with various power and pump configurations and may differ in hopper capacity with different dredging capabilities. An engineering analysis of the known hydraulic characteristics of the pump and pipeline system on the USACE hopper dredge “Essayons” (a 6,423 cy hopper dredge) indicates an operational flow rate of 40 ft^3/s with a flow velocity of 11 ft/s at the draghead port openings. The estimated force exerted on a one-foot diameter turtle (i.e. one-foot diameter disc shaped object) at the pump operational point in this system was estimated to be twenty-eight pounds of suction or drag force on the object at the port opening of the draghead. Though tested as a proxy for turtles, we expect the potential suction force on a sturgeon to be comparable.

Dredging is typically parallel to the centerline or axis of the channel. Under certain conditions, a waffle or crisscross pattern may be utilized to minimize trenching or during clean-up dredging operations to remove ridges and produce a more level channel bottom. This movement up and down the channel while dredging is called trailing and may be accomplished at speeds of 1-3 knots, depending on the shoaling, sediment characteristics, sea conditions, and numerous other factors. In the hopper, the slurry mixture of the sediment and water is managed by a weir system to settle out the dredged material solids and overflow the supernatant water. When an economic load is achieved, the vessel suspends dredging, the drag arms are raised, and the dredge travels to the designated placement site. Because dredging stops during the trip to the placement site, the overall efficiency of the hopper dredge is dependent on the distance between the dredging location and placement sites; the more distance to the placement site, the less efficient the dredging operation resulting in longer contract periods to accomplish the work.

Sea turtle deflectors utilized on hopper dredges are rigid V-shaped attachments on the front of the dragheads and are designed and intended to plow the sediment in front of the draghead. The plowing action creates a sand wave that rolls in front of the deflector. The propagated sand wave is intended to shed a turtle (or in this case, sturgeon) away from the deflector and out of the path of the draghead. The effectiveness of the rigid deflector design and its ability to reduce entrainment was studied by the USACE through model and field testing during the 1980s and early 1990s (Banks and Alexander 1994, Nelson and Shafer 1996). The deflectors are most effective when operating on a uniform or flat bottom. The deflector effectiveness may be diminished when significant ridges and troughs are present that prevent the deflector from plowing and maintaining the sand wave and the dragheads from maintaining firm contact with the channel bottom.

7.1.2 Hopper Dredging Effects on Sturgeon

Sturgeon are vulnerable to entrainment in hopper dredges. Entrainment is believed to occur primarily when the draghead is not in firm contact with the channel bottom, so the potential exists that sturgeon feeding or resting on or near the bottom may be vulnerable to entrainment. Additionally, the size and flow rates produced by the suction power of the dredge, the condition of the channel being dredged, and the method of operation of the dredge and draghead all relate to the potential of the dredge to entrain sturgeon (Reine et al. 2014). These parameters also govern the ability of the dredge to entrain other species of fish, sea turtles, and shellfish.

The risk of interactions is related to both the amount of time sturgeon spend on the bottom and the behavior the fish are engaged in (i.e., whether the fish are overwintering, foraging, resting or migrating) as well as the intake velocity and swimming abilities of sturgeon in the area (Clarke 2011). Intake velocities at a typical large self-propelled hopper dredge are 11 ft/s. As noted above, exposure to the suction of the draghead intake is minimized by not turning on the suction until the draghead is properly seated on the bottom sediments and by maintaining contact between the draghead and the bottom.

A significant factor influencing potential entrainment is based upon the swimming stamina and size of the individual fish at risk (Boysen and Hoover 2009). Swimming stamina is positively correlated with total fish length. Entrainment of larger sturgeon is less likely due to the increased swimming performance and the relatively small size of the draghead opening. Juvenile entrainment is possible depending on the location of the dredging operations and the time of year in which the dredging occurs. Typically, major concerns of juvenile entrainment relate to fish below 200 mm (Boysen and Hoover 2009, Hoover et al. 2011). Juvenile sturgeon are not as powerful swimmers as older, larger fish and they are prone to bottom-holding behaviors, which make them more vulnerable to entrainment when in close proximity to dragheads (Hoover et al. 2011).

In general, entrainment of large mobile animals, such as sturgeon, is relatively rare. Several factors are thought to contribute to the likelihood of entrainment. In areas where animals are present in high density, the risk of an interaction is greater because more animals are exposed to the potential for entrainment. The risk of entrainment is likely to be higher in areas where the movements of animals are restricted (e.g., in narrow rivers or confined bays) where there is limited opportunity for animals to move away from the dredge than in unconfined areas such as wide rivers or open bays. The hopper dredge draghead operates on the bottom and is typically at least partially buried in the sediment. Sturgeon are benthic feeders and are often found at or near the bottom while foraging or while moving within rivers. Sturgeon at or near the bottom could be vulnerable to entrainment if they were unable to swim away from the draghead. A best management practice for hopper dredge operation is not to turn on the dredge suction until the draghead is seated on the ground. While this practice should help eliminate sturgeon exposure to the highest suction velocities, sturgeon are known to rest and feed in deep holes and sand waves. When a draghead passes over a sand wave or hole, it is possible that contact with the benthos will be broken and sturgeon will be exposed to suction velocities that increase the risk of entrainment.

As noted in Table 1, sturgeon have been entrained in hopper dredge operations of the Kennebec River FNP in the past. Depending on the time of year and location, the risk of sturgeon entrainment varies. October is the only month during which hopper dredging resulted in the take of shortnose sturgeon (2 lethal entrainments in 1991; 3 lethal and 2 non-lethal entrainments in 2003). April is the only month during which hopper dredging resulted in the take of an Atlantic sturgeon (1 lethal entrainment in 2017). Therefore, we used those two months, and all of the dredge events that occurred during those months, to calculate a baseline entrainment risk index for both species. We calculated a rate of one shortnose sturgeon take per 13,044 cy dredged in October (total dredged volume in 1991 and 2003 (91,310 cy) divided by the total number of shortnose sturgeon takes (7) in those years). Similarly, we calculated a rate of one Atlantic sturgeon take per 83,935 cy dredged in April (total dredged volume in 2002 and 2017 (83,935 cy) divided by the total number of Atlantic sturgeon takes (1) in those years).

Maine DMR provided sturgeon catch per unit effort (CPUE) data for sampling surveys conducted on the Kennebec River between 1996-2012 (Table 15)(Pers. Comm. Maine DMR 2019).

Table 14: Maine DMR Sturgeon CPUE in the Lower Kennebec Estuary (1996-2012)

Month	Total Soak Hours (h)	Total Atlantic Sturgeon (ANS) Catch (Sum)	CPUE ANS	Total Shortnose Sturgeon (SNS) Catch (Sum)	CPUE SNS
May	22.87	13	0.57	1	0.04
July	47.75	19	0.40	97	2.03
August	37.40	13	0.35	59	1.58
September	317.18	70	0.22	311	0.98
October	510.83	95	0.19	527	1.03
November	101.27	12	0.12	66	0.65
TOTAL	1037.3	222	0.21	1061	1.02

Maine DMR did not sample for sturgeon from December through March, which is why those months are not represented in the CPUE data. As noted in the Environmental Baseline section above, the literature suggests that shortnose sturgeon will have moved to overwintering grounds upstream of the action area by the end of November. Similarly, Atlantic sturgeon juveniles will have moved back upstream, while subadults and adults will likely have left the river system all together by the end of November. However, given that Maine DMR did not sample the action area during the winter, and acoustic receivers have generally been removed from the action area to avoid damage from ice dams, the absence of both sturgeon species from the action area is not certain. Both species of sturgeon have been documented in the action area into mid-November (Wippelhauser and Squiers 2015; Pers. Comm. Maine DMR 2019). We expect their movement out of the action area is partially triggered by water temperature, which can vary seasonally, and is likely to warm in the future due to climate change. Therefore, it is possible some sturgeon may remain in the action area into December, overlapping the December 1 – March 1 dredge window. Given the past history of sturgeon entrainments with a hopper dredge in the action area, we expect as many as one shortnose sturgeon (juvenile or adult) and one Atlantic sturgeon (juvenile, subadult, or adult) will be entrained per dredge event occurring December 1 – March 1.

Table 15: Estimated Entrainment Rate of Shortnose Sturgeon based on Maine DMR CPUE Data

Month	CPUE SNS	Weighting Coefficient (CPUE / 1.03)	Estimated CY Dredged Per Sturgeon Take	Take Estimate Per Dredge Event (80,000 cy)	Take Estimate per Dredge Event (rounded up to the nearest whole fish)
April	0.04*	0.04	307,719.17	0.26	1
May	0.04	0.04	307,719.17	0.26	1
June	2.03*	1.97	6,624.50	12.08	**13**
July	2.03	1.97	6,624.50	12.08	**13**
August	1.58	1.53	8,530.44	9.38	10
September	0.98	0.95	13,724.66	5.83	6
October	1.03	1.00	13,044.29	6.13	**7**
November	0.65	0.63	20,647.82	3.87	4

* Maine DMR did not sample for sturgeon in April or June; therefore, we estimated the CPUE in those months by applying Maine DMR's CPUE from the next closest months, May and July, respectively.

Table 16: Estimated Entrainment Rate of Atlantic Sturgeon based on Maine DMR CPUE Data

Month	CPUE ANS	Weighting Coefficient (CPUE / 0.57)	Estimated CY Dredged Per Sturgeon Take	Take Estimate Per Dredge Event (80,000 cy)	Take Estimate per Dredge Event (rounded to the nearest whole fish)
April	0.57*	1.00	83,935.00	0.95	1
May	0.57	1.00	83,935.00	0.95	1
June	0.40*	0.70	119,923.24	0.67	1
July	0.40	0.70	119,923.24	0.67	1
August	0.35	0.61	137,281.44	0.58	1
September	0.22	0.39	216,220.02	0.37	1
October	0.19	0.33	256,589.69	0.31	1
November	0.12	0.21	402,688.15	0.20	1

* Maine DMR did not sample for sturgeon in April; however, since that was the month of the only recorded entrainment in the Kennebec River FNP (2017), we decided to apply Maine DMR's CPUE rate from the next closest month, May, and use that as a baseline for weighting entrainment during other months. Similarly, we applied Maine DMR's CPUE rate from July to June, another month that had no sampling.

For our calculations, we have conservatively assumed that each dredge event will result in 80,000 cy of dredged material. You have stated that when possible, dredge events will occur from December 1 to March 1; however, given the aforementioned unpredictability of environmental conditions (e.g., sediment transport), you are proposing that as many as two dredge events may occur from March 2 to November 30 between 2019 and 2029.

Based on this information, we anticipate that from 2019 to 2029, as many as five dredge events may occur, with two of the five events occurring at any time of year, and the other three occurring from December 1 to March 1. To estimate the total take that could occur from a hopper dredge event taking place at any time of year, we will use take estimates from months with the highest estimated abundance (CPUE) of sturgeon: June and July for shortnose sturgeon (13 takes per dredge event); April and May for Atlantic sturgeon (1 take per dredge event).

Table 17: Total Sturgeon Entrainment Estimate for Hopper Dredging (2019-2029)

Dredge Timing	Number of Events (over 10 years)	Atlantic sturgeon take (per event)	Total Atlantic sturgeon takes (over 10 years)	Shortnose sturgeon take (per event)	Total Shortnose sturgeon takes (over 10 years)
Dec. 1 – Mar. 1	3	1	3	1	3
Mar. 2 – Nov. 30	2	1	2	13	26
TOTAL	5	NA	**5**	NA	**29**

There is evidence that some sturgeon, particularly juveniles and small subadults, could be entrained in the dredge and survive. However, as the extent of internal injuries and the likelihood of survival is unknown, and the size of the fish likely to be entrained is impossible to predict, it is reasonable to conclude that any sturgeon entrained in the hopper dredge is likely to be killed.

As noted in the Status and Environmental Baseline sections, we expect 93% of adult and subadult Atlantic sturgeon in the action area to be from the Gulf of Maine DPS, and 7% from the New York Bight DPS. Given the low numbers of New York Bight DPS fish in the action area and the low number of mortalities anticipated over 10 years, it is unlikely that there will be any mortality of New York Bight DPS Atlantic sturgeon adults or subadults. Therefore, we expect that all 7 anticipated takes of Atlantic sturgeon, whether they be adults, subadults, or juveniles, would be from the Gulf of Maine DPS.

7.1.3 Mechanical Dredging

Mechanical dredging entails lowering the open bucket or clamshell through the water column, closing the bucket after impact on the bottom, lifting the bucket up through the water column, and emptying the bucket into a barge. The bucket operates without suction or hydraulic intake, moves relatively slowly through the water column and impacts only a small area of the aquatic bottom at any time. In order to be captured in a dredge bucket, an animal must be on the bottom directly below the dredge bucket as it impacts the substrate and remain stationary as the bucket closes. Species captured in dredge buckets can be injured or killed if entrapped in the bucket or buried in sediment during dredging and/or when sediment is deposited into the dredge scow. Species captured and emptied out of the bucket can suffer stress or injury, which can lead to mortality.

7.1.4 *Mechanical Dredging Effects on Sturgeon*

Sturgeon may be injured or killed from entrapment in the bucket or burial in sediment during dredging and/or when sediment is deposited into the dredge scow. Sturgeon captured and emptied out of the bucket could suffer severe stress or injury, which could also lead to mortality.

In 2012, USACE provided us with a list of all documented interactions between dredges and sturgeon reported along the U.S. East Coast; reports dated as far back as 1990. This list included four incidents of sturgeon captured in dredge buckets. These include the capture of a decomposed Atlantic sturgeon in Wilmington Harbor in 2001. The condition of this fish indicated it was not killed during the dredging operation and was likely dead on the bottom or in the water column and merely scooped up by the dredge bucket. Another record was of the capture of an Atlantic sturgeon in Wilmington Harbor in 1998; however, this record is not verified and not considered reliable. An Atlantic sturgeon was captured in a clamshell bucket, deposited in the dredge scow, and released apparently unharmed during dredging operations at BIW in 2001 (Maine DMR 2002). On April 30, 2003, a shortnose sturgeon was captured in a clam-shell bucket dredge operating in the BIW sinking basin in the Kennebec River; the fish was nearly cut in half. This fish was killed during the last hour of a 24-hour a day dredging operation that had been ongoing for approximately six weeks. One shortnose sturgeon was captured in a clamshell bucket and detected in the dredge scow on June 1, 2009 during dredging operations at BIW. Observer coverage at dredging operations at the BIW facility has been 100 percent for approximately 20 years, with dredging occurring every one to two years.

Monitoring has been ongoing at dredging projects associated with the Tappan Zee Bridge replacement project on the Hudson River. The first stage of dredging occurred in 2013. Two dredges were used between August 2 and October 30, 2013 and a total of 844,120 cy of material were removed using a bucket dredge. NMFS-approved observers were present to monitor 100 percent of all dredging. All dredge observer forms were submitted to us on December 31, 2013. While fish and other biological materials were observed in 279 loads (out of approximately 1,500), no shortnose or Atlantic sturgeon were observed. Dredging occurred again in 2015 with approximately 150,000 cy of material removed; observer coverage was 100 percent and no shortnose or Atlantic sturgeon were observed. The area where dredging occurred is a high use area for shortnose and Atlantic sturgeon.

Historically, maintenance at Doubling Point and in the channel near Popham Beach (the proposed dredge sites) has been completed with a hopper dredge. As such, there is no history of sturgeon captures with a mechanical dredge in the action area. However, the BIW facility is just slightly upstream of the action area; therefore, we assume that the relative risk to sturgeon from capture in a mechanical dredge is approximately equal to that at BIW.

You are proposing as many as five dredge events from 2019-2029, with two of the five events occurring at any time of year, and the other three occurring from December 1 to March 1. Based on the occurrence of sturgeon in the action area, and the documented vulnerability of this species to capture with mechanical dredges at BIW, it is likely that a small number of sturgeon will be captured by a mechanical dredge operating to remove sediment at Doubling Point or Popham Beach. Since 1997 when endangered species observers began staffing dredging projects at BIW, two shortnose sturgeon (April 2003; June 2009) and one Atlantic sturgeon (June 2001) have been documented to be captured with a mechanical dredge. Based on the best available information, the risk that a shortnose or Atlantic sturgeon would be captured in the slow moving dredge bucket is relatively low. This is evidenced by the small number of sturgeon captured during dredging operations at BIW since 1997, despite the occurrence of approximately 20 dredge events since this time.

Based on the Maine DMR CPUE data (see Table 16; Table 17), the greatest risk for interactions between mechanical dredges and individual sturgeon at Doubling Point or Popham Beach is likely in June, July, and October for shortnose sturgeon, and July and September for Atlantic sturgeon, when fish are present in larger numbers. We expect the majority of both sturgeon species to have left the action area between December 1 and March 1. Compared to a hopper dredge, the likelihood of a dropping dredge bucket interacting with an individual sturgeon is low due to the slow speed at which the bucket moves and the relatively small area of the bottom it interacts with at any one time. Therefore, it is extremely unlikely that a sturgeon would be captured during mechanical dredging activities between December 1 and March 1, and effects are discountable.

Based on the dredging history at BIW, and the consistently documented presence of sturgeon throughout most of the spring, summer, and fall, we expect that one sturgeon (Atlantic or shortnose) may be captured during each of the two potential dredge events that occur from March 2 through November 30. Thus, a total of no more than two shortnose sturgeon or two Atlantic sturgeon are likely to be captured by a mechanical dredge operating to conduct maintenance dredging over the 10 years of proposed maintenance dredging (2019-2029).

Sturgeon captured in a dredge bucket could be injured or killed. Sources of mortality include injuries suffered during contact with the dredge bucket or burial in the dredge scow. Of the three captures of sturgeon with mechanical dredges at BIW (two shortnose, 1 Atlantic), one of the shortnose sturgeon was killed. This fish suffered from a large laceration, likely experienced due to contact with the dredge bucket. The Atlantic sturgeon reportedly captured in the Cape Fear River was also killed. As the risk of mortality once captured is high, it is reasonable to expect that any of the sturgeon likely to be captured in the dredge bucket could suffer injury or mortality due to contact with the dredge bucket or through suffocation due to burial in the scow. Furthermore, we do not know if the captured and released sturgeon survived. Therefore, it is reasonable to expect that any captured sturgeon will suffer mortality.

As noted in the Status and Environmental Baseline sections, we expect 93% of adult and subadult Atlantic sturgeon in the action area to be from the Gulf of Maine DPS, and 7% from the New York Bight DPS. Given the low numbers of New York Bight DPS fish in the action area and the low number of mortalities anticipated over 10 years, it is unlikely that there will be any mortality of New York Bight DPS Atlantic sturgeon adults or subadults. Therefore, the two anticipated takes of Atlantic sturgeon, whether they be adults, subadults, or juveniles, would be from the Gulf of Maine DPS.

7.2 Sedimentation and Turbidity

7.2.1 Proposed activities that may produce sedimentation and turbidity

Dredging operations cause sediment to be suspended in the water column. This results in a sediment plume in the water, typically present from the dredge site and decreasing in concentration as sediment falls out of the water column as distance increases from the dredge site. The nature, degree, and extent of sediment suspension around a dredging operation are controlled by many factors including: the particle size distribution, solids concentration, and composition of the dredged material; the dredge type and size, discharge/cutter configuration, discharge rate, and solids concentration of the slurry; operational procedures used; and the characteristics of the hydraulic regime in the vicinity of the operation, including water composition, temperature and hydrodynamic forces (i.e., waves, currents, etc.) causing vertical and horizontal mixing (USACE 1983).

7.2.2 Hopper Dredge

Resuspension of fine-grained dredged material during hopper dredging operations is caused by the dragheads as they are pulled through the sediment, turbulence generated by the vessel and its prop wash, and overflow of turbid water during hopper filling operations. During the filling operation, dredged material slurry is often pumped into the hoppers after they have been filled with slurry in order to maximize the amount of solid material in the hopper. The lower density, turbid water at the surface of the filled hoppers overflows and is usually discharged through ports located near the waterline of the dredge. Use of this "overflow" technique results in a larger sediment plume than if no overflow is used. In 1998, a study was done of overflow and nonoverflow hopper dredging using the McFarland hopper dredge (USACE 2013). Monitoring of the sediment plumes was accomplished using a boat-mounted 1,200-kHz Broad-Band Acoustic Doppler Current Profiler (ADCP). The instrument collects velocity vectors in the water column together with backscatter levels to determine the position and relative intensity of the sediment plume. Along with the ADCP, a MicroLite recording instrument with an Optical Backscatterance (OBS) Sensor was towed by the vessel at a depth of 15 ft. The MicroLite recorded data at 0.5-sec intervals. Navigation data for monitoring were obtained by a Starlink differential Global Positioning System (GPS). The GPS monitors the boat position from the starting and ending points along each transect.

Transects were monitored in the test area to obtain the background levels of suspended materials prior to dredging activities. A period of eight minutes following the dredge passing during non-overflow dredging showed the level of suspended material to be returning to background levels. No lateral dispersion of the plume out of the channel was observed during the non-overflow dredging operation. During overflow dredging, a wider transect was performed to determine the lateral extent of the plume. At one-hour elapsed time following the end of the overflow dredging operation, the levels of suspended material returned to background conditions. Again, no lateral dispersion of the plume out of the channel area was observed. Overflow dredging is not proposed during deepening or maintenance dredging operations.

Near-bottom plumes caused by hopper dredges may extend approximately 2,300 to 2,400 ft (701-731 m) downcurrent from the dredge (USACE 1983). TSS concentrations may be as high as several hundred mg/L near the discharge port and as high as several tens of mg/L near the draghead. In a literature review conducted by Anchor Environmental (2003), near-field concentrations ranged from 80.0-475.0 mg/L. TSS and turbidity levels in the near-surface plume usually decrease exponentially with increasing time and distance from the active dredge due to settling and dispersion, quickly reaching ambient concentrations and turbidities. In almost all cases, the majority of re-suspended sediments resettle close to the dredge within one hour, although very fine particles may settle during slack tides only to be re-suspended by ensuing peak ebb or flood currents (Anchor Environmental 2003).

7.2.3 Mechanical Dredge

Mechanical dredges include many different bucket designs (e.g., clamshell, closed versus open bucket, level-cut bucket) and backhoe dredges, representing a wide range of bucket sizes. TSS concentrations associated with mechanical clamshell bucket dredging operations have been shown to range from 105 mg/L in the middle of the water column to 445 mg/L near the bottom (210 mg/L, depth-averaged) (USACE 2001). Furthermore, a study by Burton (1993) measured TSS concentrations at distances of 500, 1,000, 2,000 and 3,300 ft (152, 305, 610 and 1006 m) from dredge sites in the Delaware River and were able to detect concentrations between 15 mg/L and 191 mg/L up to 2,000 ft (610 m) from the dredge site. In support of the New York/New Jersey Harbor Deepening Project, USACE conducted extensive monitoring of mechanical dredge plumes (USACE 2015). The dredge sites included Arthur Kill, Kill Van Kull, Newark Bay, and Upper New York Bay. Although briefly addressed in the report, the effect of currents and tides on the dispersal of suspended sediment were not thoroughly examined or documented. Independent of bucket type or size, plumes dissipated to background levels within 600 ft (183 m) of the source in the upper water column and 2,400 ft (732 m) in the lower water column. Based on these studies, elevated suspended sediment concentrations at several hundreds of mg/L above background may be present in the immediate vicinity of the bucket, but would settle rapidly within a 2,400- ft (732 m) radius of the dredge location.

7.2.4 In-River and Nearshore Open Water Disposal

During the discharge of sediment at offshore disposal sites, suspended sediment concentrations have been reported as high as 500 mg/L within 250 ft (76 m) of the disposal vessel and decreasing to background levels (i.e., 15.0–100.0 mg/L depending on location and sea conditions within 1,000-6,500 ft (305–1,981 m) (USACE 1983). Plume concentrations are generally less likely to exceed baseline levels of suspended sediments in excess of 4,000 ft (1,219 m). Additionally, at disposal sites, the TSS near the center of the sediment plume body have been observed to return to near background levels in 35 to 45 minutes (USACE 2010). At Bluff’s Head, deposited sediment may be carried upstream or downstream by flood currents and return to background conditions in short duration. At Jackknife Ledge, deposited sand is expected to remain in the nearshore system due to the sand-circulation cell that involves the exchange of bedload among the Kennebec estuary channel, adjacent beaches, nearshore environment, and offshore region (FitzGerald et al. 2000). Additionally, the dredged material is considered mostly medium grain sand with very low silt content, limiting the potential for dispersion estimate. Given this information, the potential area of effect at the disposal sites could be conservatively characterized as 4,000 ft (1,219 m) from the disposal location.

7.2.5 Effects of Turbidity and Suspended Sediments on Sturgeon

Studies of the effects of turbid water on fish suggest that concentrations of suspended solids can reach thousands of milligrams per liter before an acute toxic reaction is expected (Burton 1993). The TSS levels expected for all of the proposed activities (ranging from 80 mg/L to 500 mg/L) are below those shown to have adverse effects on fish (580 mg/L for the most sensitive species, with 1,000 mg/L more typical; see summary of scientific literature in Burton 1993). We expect sturgeon to either swim through the plumes associated with dredging or disposal activities, or make small evasive movements to avoid them. Based on the best available information, we will not be able to meaningfully detect, evaluate, or measure the effects of re-suspended sediment on sturgeon when added to baseline conditions. Therefore, effects on sturgeon are insignificant.

7.3 Vessel Traffic

7.3.1 Background Information on the Risk of Vessels to Sturgeon

The factors relevant to determining the risk to Atlantic and shortnose sturgeon from vessel strikes are currently unknown, but based on what is known for other species we expect they are 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 sturgeon in the area (e.g., foraging, migrating, etc.). Geographic conditions (e.g. narrow channels, restrictions, etc.) may also be relevant risk factors. Large vessels have been typically implicated because of their deep draft relative to smaller vessels, which increases the probability of vessel collision with demersal fishes like sturgeon, even in deep water (Brown and Murphy 2010). Larger vessels also draw more water through their propellers given their large size and therefore may be more likely to entrain sturgeon in the vicinity. Miranda and Killgore (2013) estimated that the large towboats on the Mississippi River, which have a propeller diameter of 2.5 m, a draft of up to nine feet, and travel at approximately the same speed as tugboats (less than ten knots), kill a large number of fish by drawing them into the propellers. They indicated that shovelnose sturgeon (*Scaphirhynchus platorynchus*), a small sturgeon (~50-85 cm in length) with a similar life history to shortnose sturgeon, were being killed at a rate of 0.02 individuals per kilometer traveled by the towboats.

As the Mississippi and Kennebec River systems differ significantly, and as we do not have the data necessary to compare shovelnose sturgeon densities in the Mississippi to shortnose or Atlantic sturgeon populations in the Kennebec River system, this estimate cannot directly be used for this analysis. We also cannot modify the rate for this analysis because we do not know (a) the difference in traffic on the Mississippi and Kennebec rivers; (b) the difference in density of shovelnose sturgeon and shortnose and/or Atlantic sturgeon; and, (c) if there are risk factors that increase or decrease the likelihood of strike in the Kennebec. However, this information does suggest that large vessel traffic can be a major source of sturgeon mortality. In larger water bodies it is less likely that fish would be killed since they would have to be close to the propeller to be drawn in. In a relatively shallow or narrow area a big vessel with a deep draft and a large propeller would leave little space for a nearby fish to maneuver.

Although smaller vessels have a shallower draft and entrain less water, they often operate at higher speeds, which is expected to limit a sturgeon's opportunity to avoid being struck. There is evidence to suggest that small fast vessels with shallow draft are a source of vessel strike mortality on Atlantic and shortnose sturgeon. As noted above, in November 2008, in the

Kennebec River, Maine, Maine DMR staff observed a small (<20 foot) boat transiting a known shortnose sturgeon overwintering area at high speeds. When Maine DMR approached the area after the vessel had passed, a fresh dead shortnose sturgeon was discovered. The fish was collected for necropsy, which later confirmed that the mortality was the result of a propeller wound to the right side of the mouth and gills. In another case, a 35-foot recreational vessel travelling at 33 knots on the Hudson River was reported to have struck and killed a 5.5 foot Atlantic sturgeon (NYSDEC sturgeon mortality database (9-15-14)). Additionally, Barber (2017) found correlations between channel morphology and vessel strike risk in the James River. Because risk varies depending on a number of factors, speed from smaller vessels may pose risk at similar levels to deep-draft vessels depending on the physical environment where the fish are found. Given these incidents and studies, we conclude that interactions with vessels are not limited to large, deep draft vessels.

7.3.2 Effects of Project Vessel Traffic on Sturgeon

Vessel traffic resulting from the proposed action will be limited to dredging, disposal, and support vessels. The exact type and number of vessel depends on the dredging method and the capacity of the hopper or scow. Most recently, in 2017, a medium-class hopper dredge (265 ft long, 52 ft wide), the NEWPORT, was used at Doubling Point and Popham Beach. Hopper dredges are typically, slow-moving (i.e., 2-3 mi per hour while dredging). Mechanical bucket dredging involves the use of a stationary barge-mounted crane, backhoe, or cable-arm with an attached bucket to excavate the bottom-material. The material is lifted from the bottom and placed in a scow for transport to the disposal site by tug. Though a mechanical dredge has never been used to complete dredging at Doubling Point and Popham Beach, the dredge cycle of a mechanical dredge most likely presents a similar scenario as the hopper dredge operation in that there will be periods of active and inactive dredging, followed by a period of time when dredging would stop while the scow is taken to the disposal site.

A typical dredging and disposal cycle (as seen in 2017) required 26 loads dredged from Doubling Point and placed at the in-river disposal site. The average time between disposal events was 3 hours and 5 minutes. At Popham Beach, six loads were removed and placed at the Jackknife Ledge disposal site. The average time between disposal events was 3 hours and 16 minutes. The maximum speed of a typical dredge vessel moving to the Jackknife Ledge disposal site would be in the range of 10–15 knots. In total, the proposed action is expected to take 5-7 days, and be completed from December 1 to March 1 whenever possible.

The proposed ten years of maintenance dredging the Kennebec River FNP (up to 5 events in 10 years) will maintain the baseline condition in the action area that allows for the access for naval warships to navigate from the BIW shipyard to the open ocean.

Adding the aforementioned project vessels to the existing baseline will not increase the risk that any vessel in the area will strike an individual, or will increase it to such a small extent that the effect of the action (i.e., any increase in risk of a strike caused by the project) cannot be meaningfully measured or detected. While we know vessel strikes of sturgeon do occur in the Kennebec River, the baseline risk of a vessel strike in the action area is unknown. The increase in traffic associated with the proposed project is extremely small, intermittent (project vessels for one week approximately every three years, and a small number of naval warship movements per year), and restricted to a small portion of the overall action area on any given day. As such, any increased risk of a vessel strike caused by the project will be too small to be meaningfully measured or detected. As a result, the effect of the action on the increased risk of a vessel strike in the action area is insignificant.

7.4 Habitat Modification from Dredging and Disposal Activities

Shortnose and Atlantic sturgeon feed on a variety of benthic invertebrates. While shortnose sturgeon feed on shellfish and other benthic invertebrates, shellfish typically make up a very small percentage of the prey base of Atlantic sturgeon; Atlantic sturgeon prey primarily on soft bodied invertebrates such as worms (Guilbard *et al.* 2007, Savoy 2007). The proposed dredging will occur in the navigation channel. Dredging is likely to entrain and kill at least some of these potential sturgeon forage items. Turbidity and suspended sediments from dredging activities, as well as the placement of dredged material at Bluff Head and Jackknife disposal sites may also affect benthic resources in those areas. As noted in Section 7.2.5, some of the TSS levels expected for all of the proposed activities (ranging from 80 mg/L to 500 mg/L) exceed the levels shown to have adverse effects on benthic communities (390 mg/L (EPA 1986)).

Benthic sampling done by O'Herron and Hastings (1985) in association with past USACE maintenance dredging in the Delaware River found that *Corbicula* (a river clam) recolonized the dredge areas during the subsequent growing season. However, the post-dredge individuals collected were smaller than pre-dredge individuals and provided less biomass. O'Herron and Hastings (1985) found that adult shortnose sturgeon may not be able to efficiently utilize new molluscan colonizers due to the limited biomass until the end of the second growing season after dredging. Based on this information, sturgeon should only be exposed to a reduction in forage in the areas where dredging occurs every one to two years.

Effects on benthic invertebrates from dredge material disposal depends on the quantity disposed and consequently the depth of the overburden (i.e. the thickness of the dredged material layer) as well as the frequency of deposition (Wilber and Clarke 2007). Burrowing Polychaeta worms, amphipods, and mollusks can migrate vertically through sediment 15 to 32 cm deep (Maurer *et al.* 1982, Robinson *et al.* 2005). Benthic fauna that survived the dredging and dumping process can also contribute to quick recovery of the depositional sediment. Recovery of dredged disposal sites usually occur within a year in temperate waters (Wilber and Clarke 2007). However, the annual use of the site for open water sediment disposal may cause a chronic reduction in the quantity of fauna and the quality of the site for sturgeon foraging (Hatin *et al.* 2007a).

Based on your description of the proposed action, dredging and disposal in the action area may occur once every two years (5 events in 10 years). Both of the disposal sites are dynamic areas where we expect dredged material (which is primarily sand) to be transported elsewhere in the system (i.e., downstream or onto surrounding beaches, depending on the site), potentially lessening the effects of prey item burial.

Both species of sturgeon may forage in the full extent of the action area, primarily over soft substrates. Using the data you have provided, dredging and disposal activities will affect approximately 133.4 acres of potential foraging habitat. This area may be slightly larger due to the effects of turbidity plumes from these activities. This area represents approximately 10% of the overall action area. Given the limited area where benthic resources will be removed or displaced, and the expectation that both dredging and disposal sites will be fully recovered and available for foraging for at least a year prior to the next event, effects on sturgeon from reductions in benthic resources will be too small to be meaningfully measured or detected, and are therefore insignificant.

8.0 CUMULATIVE EFFECTS

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

Impacts to Atlantic sturgeon and shortnose sturgeon from non-federal activities are largely unknown in the Kennebec River. It is possible that occasional recreational fishing for anadromous fish species may result in the illegal capture of these species. Within the action area, despite strict state and federal regulations, sturgeon remain vulnerable to injury and mortality due to incidental capture by recreational anglers.

Commercial fisheries for elvers (juvenile eels) and alewives may also capture Atlantic sturgeon and shortnose sturgeon as bycatch. No estimate of the numbers of these ESA-listed species caught incidentally in recreational or commercial fisheries exists.

Pollution from point and non-point sources has been a major problem in this river system, which continues to receive discharges from sewer treatment facilities and paper production facilities (metals, dioxin, dissolved solids, phenols, and hydrocarbons). Atlantic sturgeon and shortnose sturgeon are vulnerable to impacts from pollution and are likely to continue to be impacted by water quality impairments in the Kennebec River and its tributaries.

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

Sources of contamination in the action area include atmospheric loading of pollutants, stormwater runoff from development, groundwater discharges, and industrial development. Chemical contamination may have an effect on listed species reproduction and survival. As noted above, impacts to listed species from all of these activities are largely unknown. However, we have no information to suggest that the effects of future activities in the action area will be any different from effects of activities that have occurred in the past.

9.0 INTEGRATION & SYNTHESIS

In the effects analysis outlined above, we considered potential effects to Atlantic and shortnose sturgeon from the following sources: (1) maintenance dredging of the Kennebec River FNP at Doubling Point and Popham beach; (2) disposal at Bluff Head and at a nearshore disposal site near Jackknife Ledge; and (3) physical alteration of the action area including effects to benthic communities in the action area. In addition to these categories of effects, we considered the potential for collisions between listed species and project vessels, and the potential effects to vessel traffic in the action area as a result of maintenance dredging.

Over the 10-year duration of the action, you have proposed 5 dredge events using either a hopper or a mechanical dredge. As analyzed in Section 7.1, we have concluded that these two types of dredge equipment present different levels of risk to sturgeon, with hopper dredges presenting a higher risk of a lethal interaction (entrainment). Historically, all dredging of the Kennebec FNP has been performed with a hopper dredge. Therefore, relying on past precedent and our conclusion that hopper dredges are more detrimental to sturgeon than mechanical dredges, our jeopardy analyses below will rely on the anticipated take from 5 hopper dredging events.

As a result of dredging operations, we anticipate the mortality of as many as 5 Gulf of Maine DPS Atlantic sturgeon (adults, subadults, or juveniles) and 29 shortnose sturgeon (adults or juveniles)(see Table 18). We do not anticipate any mortality of sturgeon due to any of the other effects including vessel traffic, turbidity related to dredging or disposal, or habitat removal.

In the discussion below, we consider whether the effects of the proposed action reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of Atlantic sturgeon (GOM DPS) and shortnose sturgeon in the wild by reducing the reproduction, numbers, or distribution of sturgeon affected by the action. The purpose of this analysis is to determine whether the proposed action, in the context established by the status of the species, environmental baseline, and cumulative effects, would jeopardize the continued existence of either species of sturgeon in the action area or result in destruction or adverse modification of critical habitat. In the NMFS/USFWS Section 7 Handbook, for the purposes of determining jeopardy, survival is defined as, “the species’ persistence as listed or as a recovery unit, beyond the conditions leading to its endangerment, with sufficient resilience to allow for the potential recovery from endangerment. Said in another way, survival is the condition in which a species continues to exist into the future while retaining the potential for recovery. This condition is characterized by a species with a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, which exists in an environment providing all requirements for completion of the species’ entire life cycle, including reproduction, sustenance, and shelter.” Recovery is defined as, “Improvement in the status of listed species to the point at which listing is no longer appropriate under the criteria set out in Section 4(a)(1) of the Act.” Below, for the listed species that may be affected by the proposed action, we summarize the status of the species and consider whether the proposed action will result in reductions in reproduction, numbers or distribution of Atlantic and shortnose sturgeon and then we 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 Atlantic and shortnose sturgeon, as those terms are defined for purposes of the Federal Endangered Species Act.

9.1 Shortnose Sturgeon

Historically, shortnose sturgeon are believed to have inhabited nearly all major rivers and estuaries along nearly the entire east coast of North America. Today, only 19 populations remain. The 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 et al. (2016), adult abundance is less than the minimum estimated viable population abundance of 1,000 adults for 5 of 11 surveyed northern populations and all natural southern populations. The only river systems likely supporting populations close to expected abundance are the St John, Hudson and possibly the Delaware and the Kennebec (Kynard et al. 2016), making the continued success of shortnose sturgeon in these rivers critical to the species as a whole.

The Schnabel estimate of approximately 9,500 adult shortnose sturgeon, based on Maine DMR survey data from 1998-2000 is the most recent population estimate for the Kennebec River shortnose sturgeon population; however, this estimate includes fish from the Androscoggin and Sheepscot rivers, as well, and does not include an estimate of the size of the juvenile population. A comparison of the population estimate for the estuarine complex from 1982 (Squiers et al. 1982) to 2000 (Maine DMR 2003; Wippelhauser and Squiers 2015) suggests that the adult population grew by approximately 90% in the intervening twenty years. Based on this information, NMFS believes that the shortnose sturgeon population in the Kennebec River is increasing.

While no reliable estimate of the size of either the shortnose sturgeon population in the Northeastern US or of the species throughout its range exists, it is clearly below the size that could be supported if the threats to shortnose sturgeon were removed. Based on the number of adults in population for which estimates are available, there are at least 104,662 adult shortnose sturgeon, including 18,000 in the Saint John River in Canada. The lack of information on the status of some populations, such as that in the Chesapeake Bay, adds uncertainty to any determination on the status of this species as a whole. Based on the best available information, we consider the status of shortnose sturgeon throughout their range to be stable.

As described in the Status of the Species, Environmental Baseline, and Cumulative Effects sections above, shortnose sturgeon in the Kennebec River are affected by habitat alteration, bycatch in commercial and recreational fisheries, water quality and in-water construction activities, and vessel traffic.

We have estimated that proposed maintenance dredging activities from 2019-2029 will kill up to 29 shortnose sturgeon (of the potential hopper and mechanical dredging scenarios proposed, this is the maximum anticipated take, and would occur if hopper dredging is used for all dredging events; see Table 20). The best available population estimates indicate that there are approximately 9,500 shortnose sturgeon in the Kennebec River and an unknown number of juveniles (Wippelhauser and Squiers 2015). While the death of 29 juvenile or adult shortnose sturgeon will reduce the number of shortnose sturgeon in the population compared to the number that would have been present absent the proposed action, it is not likely that this reduction in numbers will change the status of this population or its increasing trend as this loss represents a very small percentage of the population of adult shortnose sturgeon in the Kennebec River (0.31%), and it is not likely that this reduction in numbers would be detectable at the population scale. The effect of this loss is also lessened as it will be experienced slowly over time, with the death of an average of two to three (2.9) shortnose sturgeon adults or juveniles per year during the next 10 years of maintenance dredging.

A reduction in the number of shortnose sturgeon in the Kennebec River would have the effect of reducing the amount of potential reproduction in this system as the fish killed would have no potential for future reproduction. However, it is estimated that on average, approximately 1/3 of adult females spawn in a particular year and approximately 1/2 of males spawn in a particular year. Given that the best available estimates indicate that there are more than 9,000 adult shortnose sturgeon in the Kennebec River, it is reasonable to expect that there are at least 3,000 adults spawning in a particular year. It is unlikely that the loss of 29 shortnose sturgeon over the course of 10 years would affect the success of spawning in subsequent years. Additionally, this small reduction in potential spawners is expected to result in an insignificant reduction in the number of eggs laid or larvae produced in future years and similarly, an insignificant effect on the strength of subsequent year classes. Additionally, the proposed action will not affect spawning habitat in any way and will not create any barrier to pre-spawning sturgeon accessing the overwintering sites or the spawning grounds.

The proposed action is not likely to reduce distribution because the action will not impede shortnose sturgeon from accessing any seasonal concentration areas, including foraging, spawning or overwintering grounds in the Kennebec River. Further, the action is not expected to reduce the river by river distribution of shortnose sturgeon, Additionally as the number of shortnose sturgeon likely to be killed as a result of the proposed action is approximately 0.31% of the Kennebec River population, there is not likely to be a loss of any unique genetic haplotypes and therefore, it is unlikely to result in the loss of genetic diversity.

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

Based on the information provided above, the death of up to 29 shortnose sturgeon resulting from the proposed dredging will not appreciably reduce the likelihood of survival (i.e., it will not increase the risk of extinction faced by this species) for this species given that: (1) the population trend of shortnose sturgeon in the Kennebec River is increasing; (2) the death of 29 shortnose sturgeon represents an extremely small percentage of the number of shortnose sturgeon in the Kennebec River and a even smaller percentage of the species as a whole; (3) the loss of these shortnose sturgeon is not likely to have an effect on the levels of genetic heterogeneity in the population (4) the loss of these shortnose sturgeon will not change the status or trends of the species as a whole; (5) the loss of these shortnose sturgeon is likely to have an undetectable effect on reproductive output of the Kennebec River population of shortnose sturgeon or the species as a whole; (6) the action will have only a minor and temporary effect on the distribution of shortnose sturgeon in the action area and no effect on the distribution of the species throughout its range; and (7) the action will have no effect on the ability of shortnose sturgeon to shelter or overwinter and only an insignificant effect on foraging shortnose sturgeon.

In rare instances, an action that does not appreciably reduce the likelihood of a species' survival might affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, we have determined that the proposed action will not appreciably reduce the likelihood that shortnose sturgeon 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 under ESA Section 4(a) as "in danger of extinction throughout all or a significant portion of its range" (endangered) or "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range…" (threatened) is no longer warranted. Thus, we have considered whether the proposed action will appreciably reduce the likelihood that shortnose sturgeon can rebuild to a point where shortnose sturgeon are no longer in danger of extinction through all or a significant part of their range.

A Recovery Plan for shortnose sturgeon was published in 1998 pursuant to Section 4(f) of the ESA. The Recovery Plan outlines the steps necessary for recovery and indicates that each population may be a candidate for downlisting (i.e., to threatened) when it reaches a minimum population size that is large enough to prevent extinction and will make the loss of genetic diversity unlikely. However, the plan states that the minimum population size for each population has not yet been determined. The Recovery Plan contains three major tasks, (1) establish delisting criteria; (2) protect shortnose sturgeon populations and habitats; and, (3) rehabilitate habitats and population segments. We know that in general, to recover, a listed species must have a sustained positive trend of increasing population over time. To allow that to happen for sturgeon, individuals must have access to enough habitat in suitable condition for foraging, migrating, resting and spawning. Conditions must be suitable for the successful development of early life stages. Mortality rates must be low enough to allow for recruitment to all age classes so that successful spawning can continue over time and over generations. Habitat connectivity must also be maintained so that individuals can migrate between important habitats without delays that impact their fitness. Here, we consider whether this proposed action will affect the Kennebec River population of shortnose sturgeon in a way that would affect the species' likelihood of recovery.

The Kennebec River population of shortnose sturgeon is growing. This action will not change the status or trend of the Kennebec River population of shortnose sturgeon or the species as a whole. This is because the reduction in numbers will be small and the impact on reproduction and future year classes will also be small enough not to affect the growing trend of the population. The proposed action will have only insignificant effects on habitat and forage and will not impact the river in a way that makes additional growth of the population less likely, that is, it will not reduce the river's carrying capacity. This is because the impact to forage will be limited to temporary loss of prey in areas being dredged. Impacts to habitat will be limited to temporary increases in suspended sediment during dredging and disposal and increased water depth; however, as discussed in the Opinion, we do not anticipate any changes to substrate type, nor do we anticipate that any impacts to habitat will impact how shortnose sturgeon use the action area.

The proposed action will not affect shortnose sturgeon outside of the Kennebec River. Because it will not reduce the likelihood that the Kennebec River population can recover, it will not reduce the likelihood that the species as a whole can recover. Therefore, the proposed action will not appreciably reduce the likelihood that shortnose sturgeon can be brought to the point at which they are no longer listed as endangered or threatened. Based on the analysis presented herein, the proposed action is not likely to appreciably reduce the survival and recovery of this species.

9.2 Atlantic Sturgeon (Gulf of Maine DPS)

The GOM DPS is listed as threatened. While Atlantic sturgeon occur in several rivers in the GOM DPS, recent spawning has only been documented in the Kennebec; spawning is suspected to also occur in the Androscoggin River. No total population estimates are available for any river population or the DPS as a whole. As discussed in the Status of the Species section, we have estimated a total of 7,455 GOM DPS adults and subadults in the ocean (1,864 adults and 5,591 subadults). This estimate is the best available at this time and represents only a percentage of the total GOM DPS population as it does not include young of the year or juveniles and does not include all adults and subadults. 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 proposed maintenance dredging activities from 2019-2029 will kill up to 5 Atlantic sturgeon (of the potential hopper and mechanical dredging scenarios proposed, this is the maximum anticipated take, and would occur if hopper dredging is used for all dredging events; see Table 20). Based on mixed-stock analysis, we expect 93% of adult and subadult Atlantic sturgeon in the action area to be from the GOM DPS, and 7% from the NYB DPS. Given the low numbers of NYB DPS fish in the action area and the low number of mortalities anticipated over 10 years, it is unlikely that there will be any mortality of NYB DPS Atlantic sturgeon adults or subadults. Therefore, all 5 Atlantic sturgeon, be they juveniles, subadults, or adults, will be from the GOM DPS.

The 5 GOM DPS Atlantic sturgeon mortalities (juvenile, subadult, or adult) estimated from all dredging activities over a 10-year period represents a very small percentage of the population (considering the minimum population estimate of 7,455 GOM DPS adults and subadults, this represents 0.07% of the population. The effect of this loss is also lessened as it will be experienced slowly over time, with the death of less than one (0.5) GOM DPS Atlantic sturgeon juvenile, subadult, or adult per year during the next 10 years of maintenance dredging. While the death of these juvenile, subadult, or adult Atlantic sturgeon will reduce the number of GOM DPS Atlantic sturgeon compared to the number that would have been present absent the proposed action, it is not likely that this reduction in numbers will change the status of this species as this loss represents a very small percentage of the juvenile and subadult population and an even smaller percentage of the overall population of the DPS (juveniles, subadults and adults combined).

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 as many as 5 female juveniles, subadults, or adults over a 10-year period (less than one per year on average) 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. 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. The loss of as many as 5 male juveniles, subadults, or adults may have less of an impact on future reproduction as other males are expected to be available to fertilize eggs in a particular year. 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. The proposed action will also not affect the spawning grounds within the rivers where GOM DPS fish spawn, since all dredging and disposal activities do not take place in spawning habitat. The proposed action will not create any barrier to pre-spawning sturgeon accessing the overwintering sites or the spawning grounds used by GOM DPS fish.

The proposed action is not likely to reduce distribution because while sturgeon may temporarily avoid areas where dredging or disposal activities are underway, all of these changes in distribution will be temporary and limited to movements to relatively nearby areas. We do not anticipate that any impacts to habitat will impact how GOM DPS sturgeon use the action area and all impacts will be insignificant. Additionally, given the small percentage of the species that will be killed as a result of the proposed actions, there is not likely to be any loss of unique genetic haplotypes and no loss of genetic diversity

Based on the information provided above, the death of up to 5 GOM DPS Atlantic sturgeon (juveniles, subadults, or adults) over the life of the proposed action, 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 5 GOM DPS Atlantic sturgeon represents an extremely small percentage of the population of the DPS (approximately 0.07% of the population of adults and subadults); (2) the death of 5 GOM DPS Atlantic sturgeon will not change the status or trends of the DPS as a whole; (3) the loss of 5 GOM DPS Atlantic sturgeon is not likely to have an effect on the levels of genetic heterogeneity in the population; (4) the loss of 5 GOM DPS Atlantic sturgeon is likely to have such a small effect on reproductive output that the loss of this individual will not change the status or trends of the DPS; (5) the action 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 DPS throughout its range; and, (6) the action will have no effect on the ability of GOM DPS Atlantic sturgeon to overwinter or shelter and only an insignificant effect on 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 from the perspective of ESA Section 4. As noted above, recovery is defined as the improvement in status such that listing under Section 4(a) as "in danger of extinction throughout all or a significant portion of its range" (endangered) or "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range…" (threatened) is no longer warranted. Thus, we have considered whether the proposed action will appreciably reduce the likelihood that the GOM DPS of Atlantic sturgeon can rebuild to a point where it is no longer in danger of becoming endangered within the foreseeable future throughout all or a significant portion of its range.

A Recovery Plan for the GOM DPS has not yet been developed. 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 listed species must have a sustained positive trend of increasing population over time. In order for that to happen for GOM Atlantic sturgeon, individuals must have access to enough habitat in suitable condition for foraging, migrating, resting, and spawning. Conditions must be suitable for the successful development of early life stages. Mortality rates must be low enough to allow for recruitment to all age classes so that successful spawning can continue over time and over generations. For Atlantic sturgeon, habitat conditions must be suitable both in the natal river and in other rivers and estuaries where foraging by subadults and adults will occur and in the ocean where subadults and adults migrate, overwinter and forage. Habitat connectivity must also be maintained so that individuals can migrate between important habitats without delays that impact their fitness. Here, we consider whether this proposed action will affect the GOM DPS likelihood of recovery. The proposed action is not expected to modify, curtail or destroy the range of the species since it will result in an extremely small reduction in the number of 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 GOM DPS Atlantic sturgeon to carry out any necessary behaviors or functions including spawning, migration, overwintering, and foraging. Any impacts to available forage will also be insignificant. The proposed action will result in an extremely small amount of mortality over the life of the project (seven individuals) and a subsequent small reduction in future reproductive output. For these reasons, it is not expected to affect the persistence of the GOM DPS of Atlantic sturgeon. This action 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 action will not reduce the likelihood of improvement in the status of the GOM DPS of Atlantic sturgeon. The effects of the proposed action will not delay the recovery timeline or otherwise decrease the likelihood of recovery. The effects of the proposed action will also not reduce the likelihood that the status of the species can improve to the point where it is recovered and could be delisted. Therefore, the proposed action will not appreciably reduce the likelihood that the GOM DPS of Atlantic sturgeon can be brought to the point at which they are no longer listed as threatened. Based on the analysis presented herein, the proposed 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 action 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 action. 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 action, resulting in the mortality of 5 GOM DPS Atlantic sturgeon (juveniles, subadults, or adults) over the life span of the project, is 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 our jurisdiction, the environmental baseline for the action area, the effects of the 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 the shortnose sturgeon and GOM DPS of Atlantic sturgeon and is not likely to adversely affect GOM DPS of Atlantic salmon, Kemp's ridley sea turtles, Northwest Atlantic DPS of loggerhead sea turtles, North Atlantic DPS of green sea turtles, or leatherback sea turtles. The proposed action is not likely to adversely affect critical habitat designated for the GOM DPS of Atlantic sturgeon 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. On December 21, 2016, we issued *Interim Guidance on the Endangered Species Term "Harass"*[6]. For use on an interim basis, we interpret "harass" to mean to "…create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, 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)

[6] http://www.nmfs.noaa.gov/op/pds/documents/02/110/02-110-19.pdf

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 the purpose 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 you so that they become binding conditions for the exemption in section 7(o)(2) to apply. You have a continuing duty to regulate the activity covered by this Incidental Take Statement. If you (1) fail to assume and implement the terms and conditions or (2) fail to require any contractors to adhere to the terms and conditions of the Incidental Take Statement through enforceable terms that are added to 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, you 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). This ITS exempts take for activities that have not yet occurred as of the date of the Biological Opinion.

11.1 Amount or Extent of Incidental Take

The proposed action has the potential to result in the mortality of shortnose sturgeon and individuals from the GOM DPS of Atlantic sturgeon due to entrainment in hopper dredges or capture in a mechanical dredge. In this Opinion, we determined that the following levels of take are not likely to jeopardize the continued existence of listed species.

This ITS exempts the following lethal take from dredging through 2029:

- Shortnose sturgeon:
  - 29 juveniles or adults
- GOM DPS Altantic sturgeon:
  - 5 juveniles, subadults, or adults

As explained in the accompanying Opinion, some of the entrained or captured sturgeon may survive and be released. As the risk of injury or mortality once entrained or captured is high, and survival if captured and released is unknown, it is reasonable to expect that any captured sturgeon will suffer mortality.

11.2 Reasonable and Prudent Measures, Terms and Conditions, and Justifications

We believe the following reasonable and prudent measures (RPMs) are necessary and appropriate to minimize and monitor impacts of incidental take resulting from the proposed action. In order to be exempt from prohibitions of section 9 of the ESA, you must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize and monitor the impact of incidental take that might otherwise result from the proposed action. Specifically, these RPMs and Terms and Conditions will keep us informed of when and where dredging and disposal activities are taking place and will require you to report any take in a reasonable amount of time, as well as implement measures to monitor for entrainment during dredging. The third column below explains why each of these RPMs and Terms and Conditions are necessary and appropriate to minimize or monitor the level of incidental take associated with the proposed action and how they represent only a minor change to the action as proposed by you.

Table 18: RPMs, TCs, and Justifications Applicable to the Action

Reasonable and Prudent Measures (RPMs)	Terms and Conditions (TCs)	Justifications for RPMs & TCs
1. We must be contacted prior to the commencement of dredging and again upon completion of the dredging and disposal activity.	1. You must contact us at incidental.take@noaa.gov 3 days before the commencement of each dredging activity and again within 3 days of the completion of the activity. This correspondence will serve both to alert us of the commencement and cessation of dredging activities and to give us an opportunity to provide you with any updated contact information or reporting forms. At the start of dredging activities, you must include an estimate of the total volume (cy) and area (acres) of dredge work and the location where dredging and disposal will occur. At the end of the dredging event, you must report to us the actual volume and area removed and location where dredging and disposal occurred.	These RPMs and TCs are necessary and appropriate because they serve to ensure that we are aware of the dates and locations of all dredging that may result in take. This will allow us to monitor the duration and seasonality of dredging activities as well as give us an opportunity to provide you with any updated species information or contact information for our staff. This is only a minor change because it is not expected to result in any delay to the project and will merely involve occasional e-mails between you and our staff.
2. For all dredge operations in the Kennebec River, including dredging at Doubling Point and Popham Beach, a NMFS-approved observer must	2. The observer(s) must conduct daily inspections for biological materials, including sturgeon or sturgeon parts and must be able to identify parts and the difference between species. 100% inspection coverage (with all	These RPMs and TCs are necessary and appropriate to ensure that any direct take is accounted for during maintenance dredging operations. These RPMs and TCs represent only a minor change as compliance will not

Reasonable and Prudent Measures (RPMs)	Terms and Conditions (TCs)	Justifications for RPMs & TCs
be present on board the dredge is operating in the river.	appropriate schedules and procedures sufficient enough to ensure a high likelihood of documenting entrained or captured sturgeon) must occur (depending on the dredge type, hopper or mechanical, this may involve inspections of the cage and/or the hopper or scow where dredged material is deposited).	delay the project or cause a decrease in the efficiency of the dredging operations
3. If operationally feasible, you shall ensure that hopper dredges are outfitted with state-of-the-art deflectors on the draghead and operated in a manner that will reduce the risk of interactions with sturgeon.	3. Hopper dredges must be equipped with the rigid deflector draghead as designed by the USACE Engineering Research and Development Center, formerly the Waterways Experimental Station (WES), or if that is unavailable, a rigid sea turtle deflector attached to the draghead. Deflectors must be checked and/or adjusted by a designated expert prior to a dredge operation to insure proper installment and operation during dredging. The deflector must be checked after every load throughout the dredge operation to ensure that proper installation is maintained. Since operator skill is important to the effectiveness of the WES-developed draghead, operators must be properly instructed in its use.	These RPMs and TCs are necessary and appropriate to minimize the risk of sturgeon entrainment in hopper dredges. The use of draghead deflectors is accepted standard practice for hopper dredges operating in places and at times of year when sea turtles are known to be present, and we expect that the use of draghead deflectors will also reduce the potential for entrainment of sturgeon. The requirement to use draghead deflectors represents only a minor change as all of the hopper dredges likely to be used for this project, (including the USACE owned dredge McFarland which could potentially be used for the proposed maintenance dredging), already have draghead deflectors, dredge operators are already familiar with their use, and the use

Reasonable and Prudent Measures (RPMs)	**Terms and Conditions (TCs)**	**Justifications for RPMs & TCs**
	4. To the best of the operator's ability, hopper dredge suction will not be turned on until the draghead is properly seated on the riverbed or seafloor. Similarly, hopper dredge suction will be turned off before the draghead is lifted from the riverbed or seafloor.	will not affect the efficiency of the dredging operation. As sturgeon are primarily a benthic species, ensuring that hopper dredge suction is only on when the draghead is seated on the riverbed or seafloor reduces the risk of sturgeon entrainment.
4. All sturgeon captures, injuries, mortalities in the immediate dredging area must be reported to us within 24 hours.	5. In the event of any observed captures or entrainment of sturgeon (lethal or non-lethal), you must follow the Sturgeon Take Standard Operating Procedures (SOPs) found at: https://www.fisheries.noaa.gov/new-england-mid-atlantic/consultations/section-7-take-reporting-programmatics If the cause of death is unknown, NMFS will have the mortality assigned to the incidental take statement **unless** a necropsy determines that the death was due to injuries other than those sustained from an interaction with dredge gear. We shall have the final say in determining if the take should count towards the Incidental Take Statement.	These RPMs and TCs are necessary and appropriate to ensure the documentation of any interactions with listed species as well as requiring that these interactions are reported to us in a timely manner with all of the necessary information. In some cases, when the cause of death is uncertain, a necropsy may be necessary to aid in the determination of whether or not a mortality should count toward the ITS. This is essential for monitoring the level of incidental take associated with the proposed action. These RPMs and TCs represent only a minor change as compliance will not result in delay of the project or decrease in the efficiency of the dredging operations.

Reasonable and Prudent Measures (RPMs)	Terms and Conditions (TCs)	Justifications for RPMs & TCs
	Take reporting forms and sturgeon salvage forms are available at https://www.fisheries.noaa.gov/new-england-mid-atlantic/consultations/section-7-take-reporting-programmatics These forms must be used. All take should be reported to incidental.take@noaa.gov.	
5. Any and all Atlantic sturgeon captured must have a fin clip taken for genetic analysis. This sample must be transferred to a NMFS-approved laboratory capable of performing the genetic analysis.	6. You must ensure that fin clips are taken according to the procedures outlined on our website at https://www.fisheries.noaa.gov/new-england-mid-atlantic/consultations/section-7-take-reporting-programmatics (Sturgeon Genetics Sampling_Revised June 2019) of any Atlantic sturgeon captured during the project and that the fin clips are sent to a NMFS-approved laboratory capable of performing genetic analysis. Fin clips must be taken prior to preservation of other fish parts or whole bodies. To the extent authorized by law, you are responsible for the cost of the genetic analysis.	These RPMs and TCs are necessary and appropriate to ensure the proper handling and documentation of any interactions with listed species as well as requiring that these interactions are reported to us in a timely manner with all of the necessary information. This is essential for monitoring the level of incidental take associated with the proposed action. Genetic analysis must be conducted on Atlantic sturgeon samples to determine the appropriate DPS of origin and accurately record take of this species. These RPMs and TCs represent only a minor change as compliance will not result in delay of the project or decrease in the efficiency of the dredging operations.

12.0 CONSERVATION RECOMMENDATIONS

In addition to Section 7(a)(2), which requires agencies to ensure that all projects will not jeopardize the continued existence of listed species, Section 7(a)(1) of the ESA places a responsibility on all federal agencies to "utilize their authorities in furtherance of the purposes of this Act by carrying out programs for the conservation of endangered species." Conservation Recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. As such, we recommend that you, consistent with your authorities, consider implementing the following Conservation Recommendations:

1. When at all possible, dredging of the Kennebec River FNP should occur from December 1 to March 1 to avoid the times of year when both species of sturgeon are most likely to be present.

2. Support or conduct studies that further characterize use of the lower Kennebec estuary by GOM DPS Atlantic and shortnose sturgeon from December to March.

3. Support or conduct study to update population estimates of shortnose sturgeon and GOM DPS Atlantic sturgeon in the Kennebec River system.

13.0 REINITIATION OF CONSULTATION

This concludes formal consultation on your proposal to maintenance dredge the Kennebec River FNP from 2019 through 2029. As provided in 50 CFR § 402.16, reinitiation of formal consultation is required and shall be requested by the Federal agency or by the Service, where discretionary Federal involvement or control over the action has been retained or is authorized by law and: (1) the amount or extent of taking specified in the incidental take statement is exceeded; (2) new information reveals effects of the action that may not have been previously considered; (3) if the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion; or; or (4) a new species is listed or critical habitat designated that may be affected by the identified action.

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