NATIONAL MARINE FISHERIES SERVICE
ENDANGERED SPECIES ACT SECTION 7
BIOLOGICAL OPINION

Title: Biological Opinion and Conference on Issuing an Incidental Take Permit (File No. 27106) to the North Carolina Division of Marine Fisheries for the bycatch from the Commercial Anchored Gill Net Fisheries in the internal coastal waters of North Carolina.

Consultation Conducted By: Endangered Species Act Interagency Cooperation Division, Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce

Action Agency: Marine Mammal and Sea Turtle Conservation Division and Endangered Species Conservation Division, Office of Protected Resources, National Marine Fisheries Service

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1 INTRODUCTION

The Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. 1531 et seq.) establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat they depend on. Section 7(a)(2) of the ESA requires Federal agencies to insure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or adversely modify or destroy their designated critical habitat. Federal agencies must do so in consultation with National Marine Fisheries Service (NMFS) for threatened or endangered species (ESA-listed), or designated critical habitat that may be affected by the action that are under NMFS jurisdiction (50 CFR §402.14(a)).

Section 7(a)(4) of the ESA requires federal agencies to confer with the Secretary on any action that is likely to jeopardize the continued existence of proposed species or result in the destruction or adverse modification of proposed critical habitat. For actions that are not likely to jeopardize the continued existence of a proposed species or adversely modify critical habitat, a conference can be requested by the action agency though it is not required. If requested by the federal action agency and deemed appropriate, the conference may be conducted in accordance with the procedures for formal consultation in 50 CFR §402.14. An opinion issued at the conclusion of the conference may be adopted as the biological opinion when the species is listed or critical habitat is designated.

Section 7 (b)(3) of the ESA requires that at the conclusion of consultation, NMFS provide an opinion stating whether the Federal agency's action is likely to jeopardize ESA-listed species or destroy or adversely modify critical habitat. Similarly, when conferring on proposed species or proposed critical habitat, we also reach a conclusion as to whether the action will satisfy 7(a)(2) for those entities, as proposed. If NMFS determines that the action is likely to jeopardize listed species or destroy or adversely modify critical habitat, NMFS provides a reasonable and prudent alternative that allows the action to proceed in compliance with section 7(a)(2) of the ESA. If an incidental take is expected, section 7(b)(4) requires NMFS to provide an incidental take statement that specifies the impact of any incidental taking and includes reasonable and prudent measures to minimize such impacts and terms and conditions to implement the reasonable and prudent measures.

The action agency for this consultation is NMFS' Office of Protected Resources (NMFS-OPR) represented by two separate divisions: the Marine Mammal and Sea Turtle Conservation Division and Endangered Species Conservation Division (Conservation Divisions) in Silver Spring, Maryland. The Conservation Divisions propose to issue an incidental take permit (ITP) to the North Carolina Division of Marine Fisheries (NCDMF), under section 10(a)(1)(B) of the ESA of 1973 as amended (16 U.S.C. 1531 et seq.), and the regulations governing the incidental taking of endangered and threatened species (50 CFR §222.307). The ITP would authorize the incidental capture, with some mortality, of endangered and threatened sea turtles and sturgeon, including the North Atlantic and South Atlantic distinct population segments (DPSs) of green (*Chelonia mydas*), Kemp's ridley (*Lepidochelys kempii*), hawksbill (*Eretmochelys imbricata*), leatherback (*Dermochelys coriacea*), and Northwest Atlantic Ocean DPS of loggerhead (*Caretta caretta*) sea turtles, Gulf of Maine, New York Bight, Chesapeake, Carolina, and South Atlantic DPSs of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*), and shortnose sturgeon (*Acipenser* *brevirostrum*), associated with the otherwise lawful commercial fisheries operating in North Carolina (NC) internal coastal (inshore estuarine) waters using large- and small-mesh anchored gill nets. The ITP would be valid for ten years. As part of their conservation plan, NCDMF would continue to regulate these gill net fisheries through the fisheries rules adopted by the NC Marine Fisheries Commission and proclamations issued by the NCDMF Director. Regulations include mandatory net attendance, yardage limits, soak-time restrictions, net shot limits, net height tie-down requirements, closed areas, mesh size restrictions, minimum distance between fishing operations, marking requirements, permit mandates, and observer requirements.

Updates to the regulations governing interagency consultation (50 CFR part 402) were effective on May 6, 2024 (89 Fed. Reg. 24268). We are applying the updated regulations to this consultation. The 2024 regulatory changes, like those from 2019, were intended to improve and clarify the consultation process, and, with one exception from 2024 (offsetting reasonable and prudent measures), were not intended to result in changes to the Services' existing practice in implementing section 7(a)(2) of the Act (89 Fed. Reg. at 24268; 84 Fed. Reg. at 45015). We have considered the prior rules and affirm that the substantive analysis and conclusions articulated in this biological opinion and incidental take statement would not have been any different under the 2019 regulations or pre-2019 regulations.

This consultation, biological and conference opinion (opinion), and incidental take statement, were completed by NMFS-OPR Endangered Species Act Interagency Cooperation Division (hereafter referred to as "we" or "us") in accordance with section 7(a)(2), 7(b)(3), and 7(b)(4) of the ESA, associated implementing regulations (50 CFR §402), and agency policy and guidance. A complete record of this consultation is maintained electronically at the NMFS Office of Protected Resources in Silver Spring, Maryland.

1.1 Background

On December 2, 2022, NCDMF submitted a complete application for an ESA section 10(a)(1)(B) ITP, including a conservation plan with an adaptive management program for the operation of their commercial inshore estuarine large- and small-mesh anchored gill net fisheries to further monitor, minimize, and mitigate the impacts of incidental take of sea turtles and sturgeon in these fisheries to the maximum extent practicable. NMFS has a statutory responsibility to authorize take of threatened and endangered species pursuant to the ESA, section 10(a)(1)(B) after receipt and review of an application and if certain findings and determinations are made.

1.2 Past Consultations

- Since 2000, NMFS has issued six separate ITPs to NCDMF for the incidental take of sea turtles and sturgeon in inshore estuarine gill net fisheries.
- In the fall of 2000, NMFS issued ITP No. 1259 to NCDMF, which authorized the incidental take of sea turtles in the deep and shallow-water gill net fishery in Pamlico Sound. The ITP established the Pamlico Sound Gill Net Restricted Area (PSGNRA).

- In the fall of 2001, NMFS issued ITP No. 1348 to NCDMF, which authorized the incidental take of sea turtles in the fall gill net fisheries in Pamlico Sound and mandated further restrictions for the 2001 fishing season.
- In the summer of 2002, NMFS issued ITP No. 1398 to NCDMF which authorized the incidental take of sea turtles in shallow-water, large-mesh gill nets in Pamlico Sound for a period of 3 years, including the fall seasons of 2002, 2003, and 2004.
- The PSGNRA was incorporated into NMFS regulations in 2002 (67 FR 56931; 50 CFR §223.206 (d)(7) Exceptions to prohibitions relating to sea turtles).
- In 2005, NMFS issued ITP No. 1528 to NCDMF, which authorized the incidental take of sea turtles in shallow-water, large-mesh gill nets in Pamlico Sound for a period of 6 years, including the fall seasons between 2005 and 2010.
- In the fall of 2013, NMFS issued ITP No. 16230 to NCDMF for the incidental take of sea turtles associated with the otherwise lawful commercial NC inshore large- and small-mesh anchored gill net fisheries for a period of ten years.
- In 2012, Atlantic sturgeon were listed under the ESA and as a result NCDMF submitted an ITP application and conservation plan, resulting in NMFS issuing ITP No. 18102 to NCDMF, in the summer of 2014, for the incidental take of Atlantic sturgeon associated with the otherwise lawful NC commercial inshore large- and small-mesh anchored gill net fisheries for a period of ten years.

1.3 Consultation History

- With ITPs No. 16230 and 18102 coming to the end of their coverage duration, NCDMF submitted a complete application on December 2, 2022 for an ITP that would permit the incidental take of green (North Atlantic and South Atlantic DPSs), Kemp's ridley, hawksbill, leatherback, and loggerhead (Northwest Atlantic Ocean DPS) sea turtles, and Atlantic (Gulf of Maine, New York Bight, Chesapeake, Carolina, and South Atlantic DPSs) and shortnose sturgeon in the large- and small-mesh commercial gill net fisheries operating in NC inshore estuarine waters.
- 22 December 2022, NMFS, published (78 FR 41034) Notice of Receipt of NCDMF's ITP application and conservation plan (submitted December 2, 2022) for the incidental take of ESA-listed sturgeon and sea turtles. NMFS published a Federal Register notice to inform the public and allow for comments to be submitted in the ITP application and conservation plan (ITP #27106).
- 23 January 2023, NMFS published a notice in the *Federal Register* (88 FR 3971) extending the comment period by 30 days. The public comment period ended on February 22, 2023 and 231 comments were received.
- 01 May 2023 NMFS received a revised Application for an Individual Incidental Take Permit from NCDMF.

- 19 May 2023, NMFS Conservation Divisions request for consultation was received.
- 08 August 2023, NMFS received a Draft Environmental Assessment from Conservation Divisions
- 20 September 2023, consultation was initiated.
- 02 November 2023, NMFS received a Revised Application for an Individual Incidental Take Permit from NCDMF.
- December 2023 to May 2024, the Conservation Divisions, NCDMF and the Endangered Species Act Interagency Cooperation Division conducted meetings and corresponded via email to discuss the number of requested takes of sturgeon. The Divisions discussed historical take versus requested take with NCDMF, and Conservation Divisions decided to reevaluate requested take.
- On 31 May 2024, NCDMF concurred with the Conservation Divisions that the proposed ITP should consider fishery effort at current levels for the next 10 years.
- On 12 June 2024, the Conservation Divisions notified us that the commercial fishery effort, and, therefore, amount of anticipated bycatch, would be consistent at current levels for the duration of this ITP, letter also updated Sturgeon take levels.
- 22 August 2024 the Conservation Divisions sent a letter to NCDMF to provide a more detailed definition of the covered activity and to suggest request for incidental take of loggerhead sea turtles be aligned to incidental take that is reasonably certain to occur.
- On 20 September 2024, NMFS received response to letters dated May 31, 2024, and August 22, 2024, regarding suggested changes in requested take levels from those originally outlined in North Carolina Division of Marine Fisheries' (NCDMF) Incidental Take Permit (ITP) application (No. 27106) under Section 10 of the Endangered Species Act.

2 The Assessment Framework

Section 7(a)(2) of the ESA requires Federal agencies, in consultation with NMFS, to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species; or adversely modify or destroy their designated critical habitat.

"Jeopardize the continued existence of" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of an ESA-listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR §402.02).

"Destruction or adverse modification" means a direct or indirect alteration that appreciably diminishes the value of designated critical habitat as a whole for the conservation of an ESA-listed species (50 CFR §402.02).

In order to reach our conclusions about whether the Conservation Divisions are able to insure that the issuance of this ITP is not likely to jeopardize listed species or destroy or adversely modify critical habitat, we produce an opinion that summarizes our risk analysis. The sections of the opinion are as follows:

Description of the Proposed Action (Section 3: We describe the activities being proposed by the action agency, including conservation measures to reduce the effects to ESA-listed resources. We also analyze the physical, chemical, and biological changes to land, water, and air that result from those actions.

Action Area (Section 4): We describe the action area as the spatial extent of the physical, chemical, and biological changes to land, water, and air from the action (stressors). Action area means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR §402.02).

Species and Critical Habitat That May Be Adversely Affected (Section 5): We identify the ESA-listed species and designated or proposed critical habitat under NMFS' jurisdiction that may occur within the action area and that may be affected by the proposed action.

Status of Species and Critical Habitat Likely to be Adversely Affected (Section 6): We examine the status of the ESA-listed species and designated or proposed critical habitat that are likely to be adversely affected by the proposed action.

Environmental Baseline (Section 7): We describe the environmental baseline in the action area as the condition of the ESA-listed species and designated or proposed critical habitat in the action area, without the consequences to the listed species or designated or proposed critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, 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 which are contemporaneous with the consultation in process. The impacts to ESA-listed species or designated critical habitat from Federal agency activities or existing Federal agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR §402.02).

Effects of the Action (Section 8): Effects of the action are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action but that are not part of the action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (50 CFR §402.02). We identify the number, age (or life stage), and gender of ESA-listed individuals that are likely to be exposed to the stressors and the populations or subpopulations to which those individuals belong. We also consider whether the stressors caused by the action co-occur in time and space with the physical or biological features essential to the conservation of the species (PBFs) that are identified for designated or proposed critical habitat. This is our exposure analysis. We evaluate the available evidence to determine how individuals of those ESA-listed species are likely to respond given their probable exposure. We also consider whether exposure to the stressors produced by the action are likely to adversely affect the PBFs for designated or proposed critical habitat. This is our response analysis. We summarize the exposure and response of listed species and designated or proposed critical habitat to identify the effects of the action.

Cumulative Effects (Section 9): Cumulative effects are the effects to ESA-listed species and designated or proposed critical habitat of future state or private activities that are reasonably certain to occur within the action area (50 CFR §402.02). Effects from future Federal actions that are unrelated to the proposed action are not considered because they require separate ESA section 7 compliance.

Integration and Synthesis (Section 10): In this section, we add the Effects of the Action (Section 8) to the Environmental Baseline (Section 7) and the Cumulative Effects (Section 9), taking into account the status of the species, critical habitat, and recovery planning, to formulate the agency's opinion as to whether the conservation divisions can insure the proposed action is not likely to: (1) reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated or proposed critical habitat as a whole for the conservation of the species. If, in completing the last step in the analysis, we determine that the action under consultation is likely to jeopardize the continued existence of ESA-listed species or destroy or adversely modify designated or proposed critical habitat, then we must identify reasonable and prudent alternative(s) to the action, if any, or indicate that to the best of our knowledge there are no reasonable and prudent alternatives (see 50 CFR §402.14).

Conclusion (Section 11): Here, we state the conclusions of our opinion, identifying whether the action is likely to jeopardize listed species or destroy or adversely modify designated and proposed critical habitat.

An Incidental Take Statement (Section 12) is included for those actions for which incidental take of ESA-listed species is reasonably certain to occur (see 50 CFR §402.14(g)(7), §402.14(i)). The Incidental Take Statement (ITS) specifies the amount or extent of take, reasonable and prudent measures to minimize the impact of the take to the species, and applicable regulations with regard to such taking, and terms and conditions to implement the reasonable and prudent measures (ESA section 7 (b)(4); 50 CFR §402.14(i)).

We also provide discretionary Conservation Recommendations (Section 13) that may be implemented by the action agency and their applicant (50 CFR §402.14(j)).

Finally, we identify the circumstances in which the action agency is required to request Reinitiation of Consultation (Section 14; 50 CFR §402.16(a)).

2.1 Evidence Available for the Consultation

To comply with our obligation to use the best scientific and commercial data available, we collected information identified through searches of Google Scholar and literature cited sections of peer-reviewed articles, species listing documentation, and reports published by government and private entities. This opinion is based on our review and analysis of various information sources, including:

- Information submitted by the NCDMF and the Conservation Divisions;
- Government reports (including other NMFS' opinions and stock assessment reports);
- NOAA technical memos; and
- Peer-reviewed scientific literature.

These resources were used to identify information relevant to the potential stressors and responses of ESA-listed species, and designated and proposed critical habitat, under NMFS' jurisdiction that may be affected by the proposed action to draw conclusions on risks the action may pose to the continued existence of these species and the value of designated or proposed critical habitat for the conservation of ESA-listed species.

2.2 Modeling used for assessment

Take Estimation Methods

Two methods were explored to estimate incidental takes of protected species in NC's estuarine anchored gill net fishery: a model-based method and a proportion-based method. Both methods incorporate observer data and Trip Ticket Program (TTP) fishing effort data. Although the model-based method is a more robust approach to estimate incidental takes, applying this approach in real time to estimate total takes from observed takes is not feasible. As a result, both methods were used to retrospectively calculate unobserved bycatch from 2013-2021 to determine if they produced similar results, informing the proper approach to estimate incidental takes and monitor incidental takes in real time for the next 10 years.

Model-Based Method

A generalized linear model (GLM) framework was used to predict incidental takes of protected species in NC's commercial estuarine anchored gill net fishery. Only those variables available in all data sources could be considered as potential covariates in the model. Available variables included year, season, Management Unit (MU), and mesh-size category. Seasons were designated as winter (December– February), spring (March–May), summer (June–August), and fall (September–November). Throughout this analysis, the term "year" is based on the ITP year (September through August) such that a year includes the months of September through December from the one calendar year and the months January through August from the subsequent calendar year. Mesh sizes were categorized as large (≥5 Inches Stretched Mesh [ISM], ≥12.7 Centimeters Stretched Mesh [CSM]) or small (<5 ISM, <12.7 CSM) to be consistent with categories included in the TTP. Modeling was based on data collected during ITP years 2013–2021 (September 2012–August 2021).

The Poisson distribution is commonly used to model species abundance; however, if there are more zeros in the data than expected for a Poisson distribution (not uncommon for incidental catches of protected species), models that can account for these excess zeros should be considered. There are two types of models that are commonly used for count data that contain excess zeros. Those models are zero-altered (two part or hurdle models) and zero-inflated (mixture) models (see (Minami 2007) and (Zuur 2009) for detailed information regarding the differences of these models). Minami (2007) suggests that zero-inflated models may be more appropriate for catches of rarely encountered species; therefore, zero-inflated models were considered here.

Both Poisson and zero-inflated Poisson (ZIP) models were developed independently for each species for which there were a sufficient number of observed bycatch incidents to support a model. A minimum of five to ten positive events (bycatch records) per model parameter should reduce bias and risk of overfitting (Harrell Jr 1984; Peduzzi 1996; Stokes 2012). The numbers of bycatch events were modeled by a set of explanatory variables and an offset term for effort (number of trips). The variables investigated (and available) included ITP year, season, MU, and mesh-size category, all of which were treated as categorical variables. The offset term was included in the model to account for differences in fishing effort among observations (Crawley 2012; Zuur 2016; Zuur 2009). Using effort as an offset term in the model assumes that the number of bycatch events is proportional to fishing effort. Due to the small sample size and in order to maintain parsimony, no interactions between covariates were considered in the model. Once the number of bycatch events could be estimated, the observed rate of mortality was used to determine the proportion of those bycatch events that were likely alive or dead.

For the development of the Poisson models, all available covariates were included in the initial models and assessed for significance using an analysis of deviance test (Zuur 2009). Non-significant covariates were removed using backwards selection to find the best-fitting predictive model for each species. For the development of the ZIP models, all available covariates were included in both parts of the initial model (count part and zero-inflation part). The significance of each covariate was assessed by applying likelihood ratio tests to sub-models in which individual terms were dropped from either the count part or zero-inflation part of the model (Zuur 2009). Non-significant covariates were removed using this approach to find the best-fitting predictive model.

Estimated numbers of total annual incidental takes were computed using the best-fitting generalized linear model (GLM) for each species and applying effort levels equivalent to those observed in ITP years 2013–2021 (September 2012–August 2021). The GLM coefficients were applied to the corresponding predictor variables from the total fishing effort data to predict the total numbers of incidental takes for each ITP years by season, MU, and mesh-size category. If ITP year, season, MU, or mesh-size category was not found to be significant, estimates for the significant covariates were distributed among non-significant stratum levels based on the observed proportion of total fishery effort in those strata. Because each species was modeled independent of disposition, the initial estimates of bycatch for each species represented the total over all dispositions (live plus dead).

Estimates of variability for the predicted incidental takes were calculated for each species using standard bootstrapping techniques (Efron 1993). Bootstrap replicates were generated by resampling the observer data with replacement 2,000 times and the coefficients for the best fitting model for each species were re-estimated with each replicate. Each “new” model was then applied to the total fishery effort to predict the number of annual bycatch events. The number of estimated live and dead individuals was then computed for each replicate and coefficients of variation (CV) and lower (L95) and upper (U95) 95% confidence intervals were then calculated using the bootstrap-estimated numbers of bycatch events. The bootstrap analysis was performed in R (version 4.2.1, R Core Team (2021).

Proportion-Based Method

The second method used to predict protected species bycatch in NC's commercial estuarine anchored gill net fishery expanded the number of individuals observed based on the proportion of total fishing trips observed within each mesh-size category/ITP year/season/MU stratum; that is, the number of individuals observed within the stratum was divided by the proportion of total fishing trips observed in that stratum to predict the numbers of bycatch events for each species. Estimates were made separately for each disposition. The numbers of predicted catches were summed by ITP year to compute the annual estimates of predicted interactions for each species and disposition.

3 Description of the Proposed Action

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies in the United States or upon the high seas (50 CFR §402.02).

The NCDMF submitted an application on December 2, 2022 for an ITP to take ESA-listed sea turtles and sturgeon incidental to NC commercial inshore estuarine anchored gill net fisheries, and a revised application and conservation plan by NCDMF on November 3, 2023. The potential for take of ESA-listed sea turtles and sturgeon warrants a take authorization from NMFS in the form of an ITP. NMFS is proposing to issue an ITP to NCDMF pursuant to section 10(a)(1)(B) of the ESA and the regulations governing the incidental taking of endangered and threatened species (50 CFR §222.307). The ITP would be valid for 10 years from the date issued and would authorize the incidental lethal and nonlethal take of ESA-listed sea turtles and sturgeon in the proposed fishery, propose specific levels of observer monitoring, reporting protocols, PIT tagging and collection of genetic materials from sturgeon prior to release, and regulatory measures to reduce take of ESA-listed species. NMFS's proposed action is a direct outcome of NCDMF's request for an ITP to take ESA-listed sea turtles and sturgeon. The activities associated with commercial fisheries operating in North Carolina's inshore estuarine waters, using large and small-mesh anchored gill nets will be the basis of the assessment to determine if the issuance of the proposed ITP, the federal action, is likely to jeopardize the continued existence of ESA listed species or result in the destruction or adverse modification of critical habitat.

3.1 Proposed Activities

The North Carolina estuaries are habitat for numerous finfish species which are harvested by recreational and commercial fishers. Estuarine gill nets are used by commercial fishers and, to a lesser extent, recreational fishers to harvest a variety of finfish species. Gill nets are highly regulated through fisheries rules adopted by the Marine Fisheries Commission (MFC) (General Statute 113132(a)) and proclamations issued by the NCDMF Director (General Statute 143B-289.52). Most regulations are specific to particular management units (MU; A, B, C, D1, D2, and

E; see Figure 1) that are represented in the current ITP for sea turtles, shortnose sturgeon and Atlantic sturgeon. Examples of these regulations include mandatory attendance, mesh-size restrictions, yardage limits, soak-time restrictions, net height and tie-down requirements, closed areas, marking requirements, permit mandates, and observer requirements.

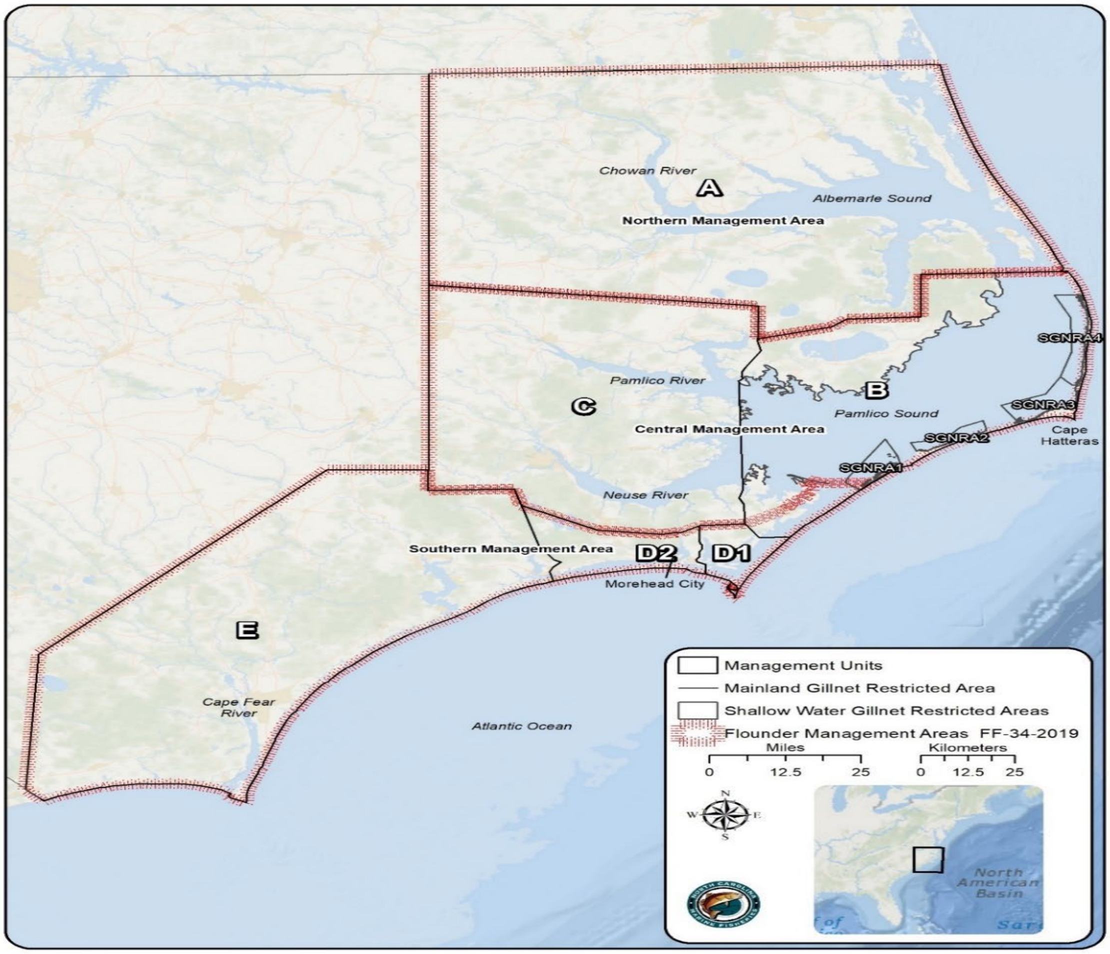


Figure 1. Management units (MUs; A, B, C, D1, D2, and E). The three Southern Flounder Management Areas described in Proclamation FF-34-2019 are also shown with red hatched lines: northern, central, and southern.

Fishery management regulations, which can be found in Section 3.2, have been put in place to lessen impacts caused by the fishery. The predominant gill net method used in NC is set (anchored) gill nets. Anchored gill nets do not include the following types of gill nets: run-around, strike, drop or drift gill nets. Mesh sizes used in gill nets, including set gill nets, are selected according to the target species. Commonly used mesh sizes in NC inshore waters range from 2.5 to 6.5 ISM (6.35 to 16.5 CSM) and cover the range of allowable mesh sizes in NC inshore waters (MFC Rule 15A NCAC 03.J.0103). Limitations on mesh size are established by fisheries rules and proclamations, some of which are borne out of various Fishery Management Plans (FMPs).

3.1.1 Large Mesh Gill Nets

Anchored large-mesh gill nets are used in NC's inshore waters to target Southern flounder (*Paralichthys lethostigma*), American shad (*Alosa sapidissima*), and catfishes (*Ictalurus* spp.). Striped bass (*Morone saxatilis*) and red drum (*Sciaenops ocellatus*) are also harvested from anchored large-mesh gill nets but are managed as a non-targeted bycatch fishery. From April 15 through December 15, gill nets cannot be used in internal waters if they are between 5.0-5.5 ISM (12.7-14 CSM) (MFC Rule 15A NCAC 03J.0103 (a) (2)).

The Southern flounder gill net fishery occurs statewide, but most gill net effort and landings come from Albemarle and Pamlico sounds (NCDMF 2019). The State's regulations require that any landings of flounder coming from gill nets only be harvested using a mesh size between 6.0-6.5 ISM (15.2-16.5 CSM) to reduce bycatch of undersized flounder (NCDMF Proclamations M-16-2021 and M-17-2021). Gill net fisheries for American shad primarily occur during February and March in MUs A and C. The maximum amount of gill net yardage allowed in the shad fishery is currently 700 yards (yd; 0.64 kilometers [km]) in MU A (NCDMF Proclamation M-5-2022) and 1,500 yd (1.37 km) in MU C (NCDMF Proclamation M-4-2022). The allowed season for anchored gill nets configured for harvesting American shad in MU A is March 3 through March 24, since 2014 (NCWRC 2017). In MU C, the American shad harvest season is from February 15 through April 14, although Proclamation M-6-2019, effective March 2019, prohibited the use of all gill nets upstream of the Bayview to Aurora ferry line in the Tar-Pamlico River and the Minnesott Beach to Cherry Branch ferry line in the Neuse River. However, this prohibition is currently being debated and is under review by the MFC. The anchored gill net fishery for American shad in the upper Cape Fear River was closed in April 2016 due to an observed incidental take of a shortnose sturgeon and the documented presence of shortnose sturgeon from NCDMF research surveys (Proclamation M-5-2016; See Section 15.2 for full list of NCDMF Proclamations).

Starting in 2001, large-mesh gill nets operating in Pamlico Sound during fall were confined to specific subunits (Shallow Water Gill Net Restricted Areas 1–4, and Mainland Gill Net Restricted Area) and in corridors near Ocracoke, Hatteras, and Oregon inlets (Gearhart 2003). In October 2001, NMFS closed the rest of Pamlico Sound to gill nets with ≥4.25 ISM (≥10.8 CSM) from September 28 through December 15, 2001, in an interim Final Rule (66 FR 50350). In September 2002, NMFS published the Final Rule closing the deep waters of Pamlico Sound (PSGNRA) annually from September 1 through December 15 (67 FR 56931; 50 CFR §223.206 (d)(7)). NCDMF reflected this deep-water closure in their own proclamations for the fall flounder fishery. In May 2010, Proclamation M-8-2010 was issued by NCDMF that included regulations implemented primarily for gill nets targeting Southern flounder with ≥4 ISM (≥10.2 CSM).

Although Southern flounder cannot be harvested from gill nets with a mesh size of <6 ISM (<15.2 CSM) fishing effort targeting other species from gill nets with a mesh size of ≥4 and <6 ISM (≥10.2 and <15.2 CSM) have also been subject to these regulations. These restrictions are implemented through proclamation (e.g., Proclamation M-31-2013). They include minimization measures such as restricting soak time and days of the week, limiting net lengths, requiring separations between net shots in a single string, requiring low-profile net configurations, and implementing time/area closures.

3.1.2 Small Mesh Gill Nets

NC fishers also use small-mesh gill nets to target striped mullet (*Mugil cephalus*), bluefish (*Pomatomus saltatrix*), Atlantic menhaden (*Brevoortia tyrannus*), spanish mackerel (*Scomberomorus maculatus*), spotted seatrout (*Cynoscion nebulosus*), spot (*Leiostomus xanthurus*), and white perch (*Morone americana)* (NCDMF 2018). While mesh sizes vary, the most common mesh sizes are between 3.0-3.75 ISM (7.6-9.5 CSM). NCDMF has implemented yardage and attendance requirements for small-mesh gill nets, including anchored nets, to minimize bycatch of undersized finfish, reduce mortality of discards, or to limit total catch per trip for quota-managed species. NC has developed shallow water gill net restricted areas (SGRNA) to further manage against bycatch of sturgeon and sea turtles following the provisions laid out in the N.C. Southern Flounder Fishery Management Plan and the Incidental Take Permits issued to NCDMF.

In NC, relatively few inshore anchored gill nets are used with a mesh size ≥4 and <5 ISM (≥10.2 and <12.7 CSM; Byrd 2022; NCDMF 2018). Only 1.3 % (122 out of the 9,425) observed trips during ITP years 2013 through 2021 used gill nets with this mesh size and almost half of them (52 out of 122) also used large-mesh gill nets on the same trip (NCDMF, unpublished data). There have been only limited allowances for inshore anchored gill nets with a mesh size ≥4 and <5 ISM (≥10.2 and <12.7 CSM). Limiting the use of this mesh-size range in NC is primarily related to reducing the potential for undersized striped bass and Southern flounder bycatch consistent with management strategies of those corresponding FMPs.

The NC Estuarine Striped Bass FMP implemented in January 1994 limited unattended anchored small-mesh gill nets in the Albemarle Sound Management Area (ASMA–Albemarle, Currituck, Croatan, Roanoke sounds and associated tributaries) to 800 yd per operation to reduce undersized discards of Striped Bass (NCDMF 1993). The NCDMF issued a proclamation in spring 2020 reducing the yardage limit of estuarine anchored gill nets with a mesh size of <4 ISM to 800 yd statewide in MUs south of A (i.e., B, C, D1, D2, and E) and required year-round attendance of anchored gill nets with a mesh size of <5 ISM in portions of Pamlico River, Bay River, Neuse River, and western Pamlico Sound (Proclamations M-4-2020 and M-9-2020).

3.2 Restrictions implemented for anchored gill nets ≤4 inches stretched mesh

Net deployment details and restrictions are outlined in Table 1. Soak times will all be one hour before sunset to one hour after sunrise, except MU A and C, as noted in Table 1. To minimize bycatch of undersized striped bass and red drum, net attendance is required from May 1 through November 30 in the ASMA. Year-round anchored small mesh gill net attendance is required within 200 yd (183 m) of shore below the ferry lines in the Pamlico and Neuse rivers. From May 1 through November 30, small-mesh gill nets must be attended in all primary and permanent secondary nursery areas, modified no-trawl areas, within 200 yd (183 m) of shore in Bay River and western Pamlico Sound, within 50 yd (45.8 m) of shore in Pamlico and Core sounds, and all inshore waters south to the NC/South Carolina state line. An exemption to this rule lifts the attendance requirement for the region from Core Sound to the South Carolina border in October for the spot fishery.

In addition to regulations, fishing activities are subject to adaptive management measures, which are implemented in real time through proclamations by the NCDMF Director when incidental takes approach thresholds of authorized takes. The Director has statutory authority to issue proclamations that carry the force and effect of law that can become effective in as little as 48 hours from issuance. Adaptive management measures primarily consist of gear restrictions, seasonal closures, and/or area closures. Implementing management measures through proclamation allows for rapid response when take levels are approaching thresholds of authorized takes. The NCDMF has a history of responding to these occurrences in prior ITP years. Historical observer data have been used in a study to detect hotspots of Atlantic sturgeon interactions in Albemarle Sound and sea turtle interactions in Pamlico Sound (Hoos 2019). Depending on how immediate large-scale area closures are needed to maintain estimated takes below permitted levels, smaller area closures can be implemented using information on known hotspots. Alternatively, where monitoring is minimal, one observed take can extrapolate to a number so close to permitted levels, a more drastic time/area closure is required.

Table 1 (revised from ITP application) Restrictions implemented for estuarine gill nets ≥4 inches stretched mesh included in the current NCDMF sea turtle (No. 16230) and Atlantic Sturgeon (No. 18102) Incidental Take Permits and additional restrictions. Included in the requested ITP. (*) indicates that coordinates of the US Highway 64 bypass bridge are in the text.

MU	Soak time	Days of the week	Net Length	Gear configuration	Low-profile requirements	Time/Area Closure
A north of US Hwy 64 bridge*	*one hour before sunset to one hour after sunrise except for the shad gill-net fishery*		Maximum net length per fishing operation is 2,000 yd (1.83 km).			Western Albemarle Sound in the vicinity of the mouth of the Roanoke River including the entire Roanoke River up to the dam in Weldon, permanently closed to all gill nets.
A south of US Hwy 64 bridge*	one hour before sunset to one hour after sunrise	Monday night - Friday morning	Maximum net length per fishing operation is 2,000 yd (1.83 km).	Net-shot lengths ≤ 100 yd with a 25-yd separation between each net-shot	Nets must not exceed 15 meshes in height and must have a lead core or leaded bottom line. Nets must not have cork, floats, or other buoys except those required for identification.	
B	one hour before sunset to one hour after sunrise	Monday night - Friday morning	Maximum net length per fishing operation is 2,000 yd (1.83 km).	Net-shot lengths ≤ 100 yd with a 25-yd separation between each net-shot	Nets must not exceed 15 meshes in height and must have a lead core or leaded bottom line. Nets must not have cork, floats, or other buoys except those required for identification.	Prohibition in the deep-water portions of the Pamlico Sound and in Oregon, Hatteras, and Ocracoke inlets September 1 through December 15.
C	*one hour before sunset to one hour after sunrise except for the shad gill-net fishery*		Maximum net length per fishing operation is 2,000 yd (1.83 km).			
D1	one hour before sunset to one hour after sunrise	Monday night - Friday morning	Maximum net length per fishing operation is 2,000 yd (1.83 km).	Net-shot lengths ≤ 100 yd with a 25-yd separation between each net-shot	Nets must not exceed 15 meshes in height and must have a lead core or leaded bottom line. Nets must not have cork, floats, or other buoys except those required for identification.	Prohibition south of 34° 48.27' N May 8 through October 14
D2	one hour before sunset to one hour after sunrise	Sunday night - Friday morning	Maximum net length per fishing operation is 1,000 yd (0.91 km).	Net-shot lengths ≤ 100 yd with a 25-yd separation between each net-shot	Nets must not exceed 15 meshes in height and must have a lead core or leaded bottom line. Nets must not have cork, floats, or other buoys except those required for identification.	
E	one hour before sunset to one hour after sunrise	Sunday night - Friday morning	Maximum net length per fishing operation is 1,000 yd (0.91 km).	Net-shot lengths ≤ 100 yd with a 25-yd separation between each net-shot	Nets must not exceed 15 meshes in height and must have a lead core or leaded bottom line. Nets must not have cork, floats, or other buoys except those required for identification.	*Upper Cape Fear River closed to gill nets with a mesh-size of 4-6.5 ISM (Proclamation M-5–2016)*

3.3 Observer Program

The NCDMF will implement an Observer program, which will monitor bycatch of protected species in the inshore estuarine anchored gill net fisheries. The NC General Assembly established the NC Commercial Fishing Resource Fund (CFRF; North Carolina General Statute [NCGS] 113-173.1) for the purpose of providing funding for the development of sustainable commercial fishing in the State. The CFRF is funded through NCDMF's fishing license fees (G.S. 113-173.1). By law, the CFRF must first fully fund the State's ITP for the State's commercial fishing industry. Currently the fund provides for five permanent observer positions and four biologist positions, including the biologist supervisor. There are sufficient funds to hire temporary observers to increase capacity, especially during peak fishing seasons. Should decreased license sales limit funds available for the State's Observer Program to maintain required observer coverage levels statewide, NCDMF will assess the expected spatiotemporal distribution of remaining fishing effort and the number of observed trips that are possible with reduced funding. Based on that assessment, NCDMF will consult with the Conservation Divisions on an adaptive management approach to use time-area closures that would allow for required observer coverage levels to be met in all areas open to anchored gill nets.

Monitoring of the inshore estuarine anchored gill net fisheries will be done through onboard and alternative platform observers as well as NCDMF Marine Patrol. Observer coverage will be distributed state-wide across the six MUs (A, B, C, D1, D2, and E) and across four seasons of each ITP year: fall (September–November), winter (December–February), spring (March–May), and summer (June–August).

A sea-day schedule of observer trips will be developed by NCDMF to obtain 7–10% observer coverage of the estimated inshore estuarine anchored large-mesh gill net fishing trips, and 1–2% observer coverage of the estimated inshore estuarine anchored small-mesh gill net fishing trips per season proportional to fishing effort in each MU within each season. Projecting observer trips for the sea-day schedule will be similar to NCDMF's current practices, in which they typically calculate the number of needed observer trips based on the average of reported anchored small-mesh and large mesh gill net trips by month and MU from the previous five years. The Observer Program will strive to reach the upper range of the observer coverage for each season and MU within each mesh-size category: 10% of large mesh gill net trips and 2% of small mesh gill net trips. This approach helps account for differences between estimated fishing trips and reported fishing trips. Observer coverage goals will be based on estimated fishing effort. NCDMF will meet with NMFS-OPR prior to the start of each new ITP year, but after finalized TTP data are provided in the annual reports to assess whether adjustments to estimating observer coverage need to be made (e.g., calculate the five-year average number of reported trips and add 5%).

Observers are trained to identify, measure, tag, evaluate condition of, and resuscitate sturgeon and sea turtles by experienced NCDMF, North Carolina Wildlife Resources Commission (NCWRC), and NMFS Southeast Fisheries Science Center (SEFSC, Beaufort, NC) staff. Sturgeon handling instructions are based on best practices identified in NOAA Technical Memorandum documents (Damon-Randall 2010; Moser 2000). Sea turtle handling instructions are based on best practices identified by NCWRC sea turtle biologists and NMFS (SEFSC sea turtle research permit 21233-03, Application Appendix 2). Data collected on observed interactions include: date, time, location (latitude and longitude, when possible), condition (e.g., no apparent harm, injury including a description of the nature of the injury, or mortality), species, sex (if determinable), tag numbers, and morphometrics (sea turtles: curved carapace length [CCL, mm], and curved carapace width [CCW, mm]; sturgeon: total length [TL, mm], and fork length [FL, mm]). Trained observers will apply PIT (Passive Integrated Transponders) tags and t-bar tags to live sturgeon and animal-safe paint pens will be used for short-term marking and identification of live hard-shell sea turtles. Photographs of the protected species and environmental parameters (e.g., salinity, water temperature) will be collected when feasible. Photographs will be used by the NCDMF in training and education materials, including on the Observer Program website. Starting in the fall of 2023, observers are taking video of sea turtles while on board and during release and recording additional information on behavior to inform post-interaction mortality assessments (NMFS 2022b). Dead and live, debilitated sea turtles will be retained by the observer when possible and delivered to the NCWRC sea turtle biologist for necropsy or examination and treatment. Observers will be instructed to retain any dead sturgeon when possible. Dead sturgeon will be sampled and retained by NCDMF to be used in training sessions for identification and tagging techniques.

3.3.1 PIT Tagging and Acoustic Tagging

As part of the Observer Program, experienced NCDMF staff would train observers to apply PIT and t-bar tags to live sturgeon. Observers will be trained to identify, measure, evaluate condition of, and resuscitate sturgeon and sea turtles by experienced NCDMF, NCWRC, and NMFS Southeast Fisheries Science Center (Beaufort, NC) staff. Experienced NCDMF staff will train observers to apply PIT (Passive Integrated Transponders) and t-bar tags to live sturgeon. Sturgeon handling instructions are based on best practices identified in NOAA Technical Memorandum documents (Damon-Randall 2010; Moser 2000). Sea turtles will not be tagged based on information from the NMFS in August 2020 Memo, provided in Appendix CNCDMF (2023), stating that two sizes of flipper tags would be needed to accommodate two size categories and that revised NMFS PIT-tagging protocols require specialized experience which is not realistic for observers.

NCDMF currently orders PIT tags from Biomark and t-bar tags are provided by USFWS (Mike Mangold). Fin clips are collected from live and dead sturgeon when feasible and provided to the Atlantic Coast Sturgeon Tissue Research Repository (ACSTRR) at the USGS Leetown Science Center for genetic analyses. As long as marine conditions allow, all sturgeon in healthy condition will be tagged with both PIT, as long as the individual is ≥330mm TL, and t-bar tags, for individuals that are ≥250 mm TL. Sea turtles will be marked with animal-safe paint pens for short-term identification. NMFS researchers are currently using animal-safe paint pens for short-term identification of hard-shell sea turtles. The division has consulted with Dr. Larisa Avens at NMFS, Beaufort, NC, to develop protocols for observers to use these paint pens, ensure their consistency with NMFS protocols, and ensure that the marking scheme is distinguishable from NMFS sea turtle research projects in NC. The marking scheme, including any changes to it over time, will be communicated to the NCWRC sea turtle biologists. Observers are also trained to take photographs of identifying characteristics that may be used in photo-identification studies (e.g., Dunbar 2021). Under certain circumstances, such as inclement weather or poor condition of the animal, some sea turtles may not receive the full work up.

Incidental takes of listed species provide unique and highly valuable information. For sea turtles, information on species, size, and location add to current population data in NC. Temporary marking of sea turtles may also provide information on movement patterns and post-interaction mortality of sea turtles that are re-sighted or recaptured. Additional behavior data collection (e.g., via video, photo) would also provide information on post-interaction mortality in gill nets. The data collected from tagged and recaptured sturgeon (e.g., by observers, academic researchers) provide important information that can be used to understand the movements of sturgeon using NC inshore waters.

In addition to conventional t-bar and PIT tags, NCDMF also actively maintains a telemetry array throughout the inshore waters of NC for the detection of animals that have had acoustic tags applied by NCDMF staff or other researchers. The Manteo office maintains an array of four receivers in Roanoke Sound, Oregon Inlet, and Hatteras Inlet. The Elizabeth City office maintains an array of approximately 41 receivers in Albemarle Sound and Roanoke River. The Washington Regional office maintains an array of approximately 64 receivers located throughout the Tar-Pamlico, Pungo, Bay and Neuse river systems. The Wilmington office partners with researchers at the University of NC at Wilmington to maintain an array of approximately 35 receivers in the Cape Fear River basin. The array extends from the mouth of the Cape Fear River at Bald Head Island to Elwell Ferry on the main stem, from the confluence in Wilmington to Kenansville on the Northeast Cape Fear, and to Ivanhoe on the Black River. These arrays are serviced and downloaded by the respective offices on a quarterly basis or as needed. Once the detections have been downloaded, the data are entered into the NCDMF Biological Database, in addition to being submitted to the Mid-Atlantic Acoustics Telemetry Observation System, ensuring sturgeon researchers and other agencies have access to the data and the ability to track detections of acoustically tagged sturgeon through NC inshore waters.

While the telemetry data can be utilized to inform managers on ESA species within the action area and ensure adaptive management of those ESA species within the action area, this proposed action does not include the actual tagging of ESA listed sturgeon with acoustic transmitters. These arrays will be used for monitoring the disposition of sturgeon that are captured and released, that had telemetry tags installed as part of another approved action.

3.4 Potential Stressors

In this section of the opinion, we assess the probable modifications to land, water, or air resulting from the issuance of the 10(a)(1)(B) permit (the ITP) and implementation of the Conservation Plan and other permit conditions.

The stressors associated with the proposed action are capture in set gill nets, handling, and release of captured individuals by fishermen and observers, and monitoring by observers, as well as NCDMF biologists, to include PIT tagging of sturgeon and genetic sampling of individuals prior to release.

4 ACTION AREA

Action area means all areas affected directly, or indirectly, by the Federal action, and not just the immediate area involved in the action (50 CFR §402.02).

The affected environment is described as all portions of the NC internal coastal (inshore estuarine) waters that are open to commercial anchored small-mesh and large-mesh gill net fishing. The estuarine system in NC is the second largest in the United States (Epperly and Ross 1986). This system is created by a chain of barrier islands along the coast that is separated by inlets, allowing saline ocean water to mix with freshwater flowing from a network of river systems. The Albemarle-Pamlico estuarine system comprises the largest portion of NC's estuarine system (Epperly and Ross 1986). The inshore estuarine anchored gill net fisheries occur throughout inland coastal and joint waters (NCGS § 113-132) of NC.

For management purposes, these inshore estuarine waters are divided into six MUs (A, B, C, D1, D2, E) presented in Figure 2 and defined below.

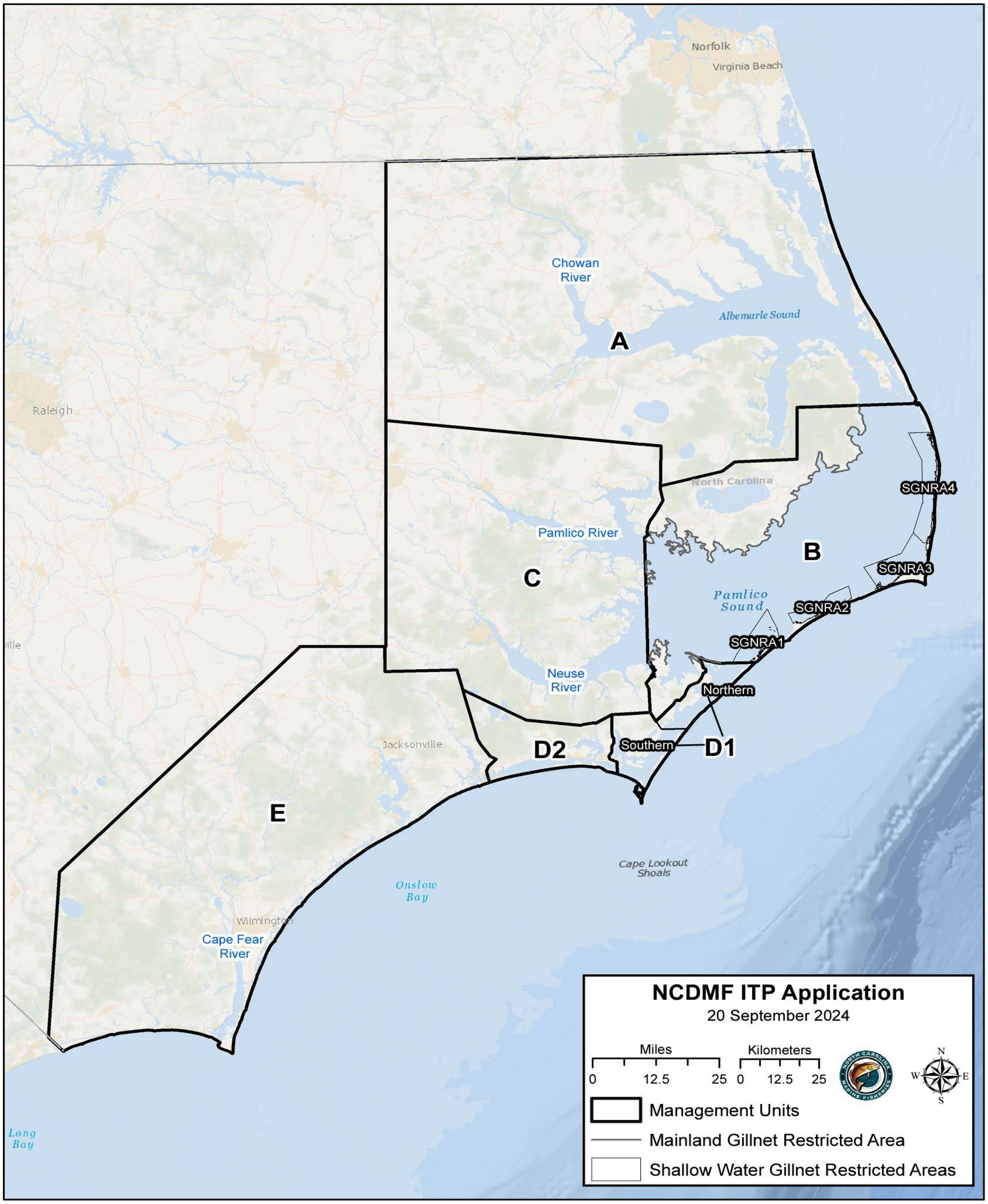


Figure 2. Management units (MUs; A, B, C, D1, D2, and E)

4.1 Management Unit A

MU A encompasses all estuarine waters north of 35° 46.30' N to the NC/Virginia state line (Figure 3). This includes all of Albemarle, Currituck, Croatan, and Roanoke sounds as well as the contributing river systems in this area. Most of this area is currently defined as the ASMA.

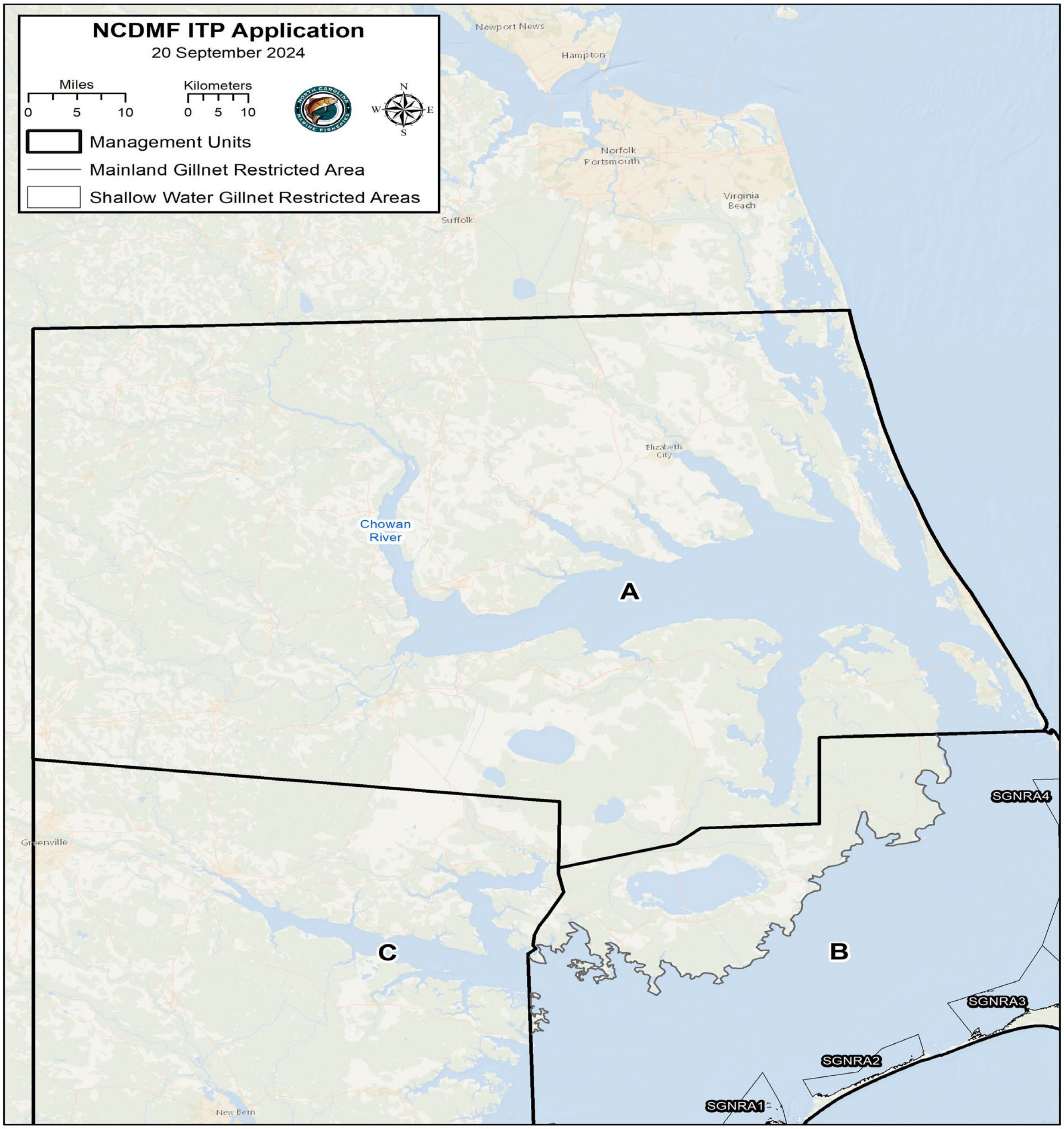


Figure 3. Management Unit A

4.2 Management Unit B

MU B Internal Coastal and Joint Fishing Waters of Pamlico Sound, including its bays and tributaries, bounded on the north by 35° 46.3000’ N latitude which runs approximately from the north end of Pea Island (old Coast Guard station) westerly to a point on the shore at Point Peter Canal, bounded on the east by barrier islands, bounded on the west by 76 30.000’ W longitude, and bounded to the south across the mouth of Core Sound at 35° 0.000' N latitude; Internal Coastal Fishing Waters of West Bay, West Thorofare Bay, and Long Bay (Figure 4).

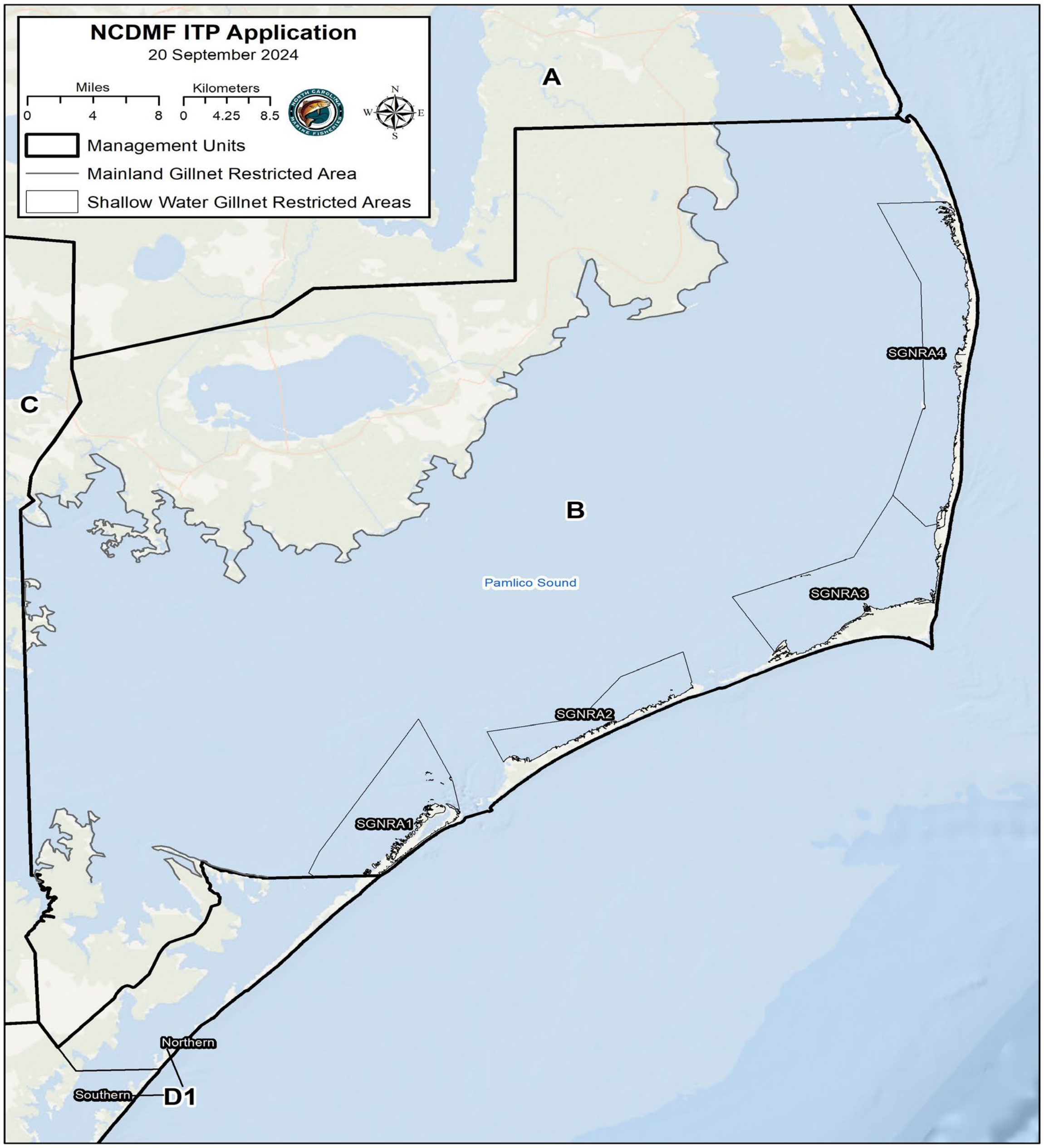


Figure 4. Management Unit B

Shallow Water Gill Net Restricted Area (SGNRA) 1

The area from Portsmouth Island to Ocracoke Inlet bound by the following points: Beginning at a point on Core Banks at 35° 00.000' N – 76° 07.828' W, running west to 35° 00.000' N – 76° 11.760' W, then turning northwest to near Marker # 2CS at the mouth of Wainwright Channel at 35° 00.2780' N – 76° 12.1682' W, then running northeasterly near Marker "HL" at 35° 01.5665' N – 76° 11.4277' W, then running northeasterly near Marker #1 at 35° 09.7058' N – 76° 04.7528' W, then running southeasterly to a point at Beacon Island at 35° 05.9352' N – 76° 02.7408' W, then running south to a point on the northeast corner of Portsmouth Island at 35° 03.7014' N – 76° 02.2595' W, then running southwesterly along the shore of Core Banks to the point of beginning.

SGNRA 2

The area from Ocracoke Inlet to Hatteras Inlet bound by the following points: Beginning at a point near Marker #7 at the mouth of Silver Lake at 35° 06.9091' N – 75° 59.3882' W, running north to a point at 35° 08.7925' N – 76° 00.3627' W near Big Foot Slough Entrance, then running easterly to a point at 35° 09.4994' N – 75° 54.2943' W, then running northeasterly to a point at 35° 11.9803'N – 75° 51.6396' W, then running easterly to a point at 35° 13.4489' N – 75° 47.5534' W, then running southerly to just northwest of the Ocracoke/Hatteras Ferry terminal on the Ocracoke side at 35° 11.5985' N – 75° 47.0768' W, then southwesterly along the shore to the point of beginning.

SGNRA 3

The area from Hatteras to Avon Channel bound by the following points: Beginning at a point near Marker "HR" at 35° 13.3152 'N – 75° 41.6694' W, running northwest near Marker "42 RC" at Hatteras Channel at 35° 16.7617'N – 75° 44.2341' W, then running easterly to a point off Marker #2 at Cape Channel at 35° 19.0380' N – 75° 36.2993' W, then running northeasterly near Marker #1 at the Avon Channel Entrance at 35° 22.8212' N – 75° 33.5984' W, then running southeasterly near Marker #6 on Avon Channel at 35° 20.8224' N – 75° 31.5708' W, then running easterly near Marker #8 at 35° 20.9412' N – 75° 30.9058' W, then running to a point on shore at 35° 20.9562' N – 75° 30.8472' W, then following the shoreline in a southerly and westerly direction to the point of beginning.

SGNRA 4

The area from Avon Channel to Rodanthe bound by the following points: Beginning at a point near Marker #1 at the Avon Channel Entrance at 35° 22.8212' N – 75° 33.5984' W, then running northerly to a point on Gull Island at 35° 28.4495' N – 75° 31.3247' W, then running north near Marker "ICC" at 35° 35.9891'N – 75° 31.2419' W, then running northwesterly to a point at 35° 41.0000'N – 75° 33.8397'W, then running easterly to a point on shore at 35° 41.0000'N – 75° 29.3271' W, then following the shoreline in a southerly direction to a point on shore near Avon Harbor at 35° 20.9562' N – 75° 30.8472' W, then running westerly near Marker #8 at 35° 20.9412' N –75° 30.9058' W, then running westerly near Marker #6 on Avon Channel at 35° 20.8224' N – 75° 31.5708' W, then running northwesterly to the point of beginning..

Ocracoke Corridor (OC)

The area in Ocracoke Inlet bound by the following points: Beginning at a point at 35° 07.9390' N, 76° 03.8080' W, then running northeasterly to Marker #9 at Nine Foot Shoal Entrance at 35° 08.4411' N, 76° 02.6848' W, then running northeasterly to Marker "1" BF" at 35° 09.3627' N, 76° 00.6259' W, then running southeast to Marker #7 at the mouth of Silver Lake at 35° 06.9091' N, 75° 59.3882" W, then following the shoreline southwesterly to a point at the north side of Ocracoke Inlet at 35° 04.4200' N, 75° 59.9245' W, then crossing the inlet to a point on Portsmouth Island at 35° 03.7014' N, 76° 02.2595' W, then in a northerly direction to a point on Beacon Island at 35° 05.9352' N, 76° 02.7408' W, then running in a northwesterly direction to the point of beginning.

Hatteras Corridor (HC)

The area in Hatteras Inlet bound by the following points: Beginning at a point at 35° 13.4489' N, 75° 47.5531' W, running east to the site of an old platform at 35° 14.0100' N, 75° 45.8097' W, then running northeast to Marker "42 RC" at the mouth of Hatteras Channel at 35° 16.7617' N, 75° 44.2341' W, then following the channel to Marker "HR" at 35° 13.3152' N, 75° 41.6694' W, then following the shoreline to a point on the north side of Hatteras Inlet at 35° 11.3408' N, 75° 44.9907' W, then crossing the inlet to the south side to a point on Ocracoke Island at 35° 11.0793' N, 75° 45.9645' W, then following the shoreline northwest to a point northwest of the Ocracoke/Hatteras ferry terminal at 35° 11.5985' N, 75° 47.0768' W, then running in a northerly direction to the point of beginning.

Oregon Inlet Corridor (OIC)

The area in Oregon Inlet bound by the following points: Beginning at a point at Marker #12 at Old House Channel at 35° 45.0883' N, 75° 35.9600' W, then following the channel in a northeasterly direction to Marker #53 at 35° 47.2157' N, 75° 34.4264' W, then running easterly to Marker #13 near Oregon Inlet Fishing Center harbor entrance at 35° 47.7076' N, 75° 32.9762' W, then running southerly to a point on the south side of Oregon Inlet at 35° 46.0500' N, 75° 31.6166' W, then running in a southerly direction along the shoreline to a point at 35° 41.0000' N, 75° 29.3271' W, then running west to a point at 35° 41.000' N, 75° 33.8397' W, then in a northerly direction to the point of beginning.

Mainland Gill Net Restricted Area (MGNRA)

The area on the mainland side of Pamlico Sound, from the shoreline of Dare, Hyde, Pamlico, and Carteret Counties out to 200 yd between 76° 30.00' W and 75° 42.00' W.

West Bay Gillnet Restricted Area (WBGNRA):

Internal Coastal Fishing Waters of West Bay, West Thorofare Bay, and Long Bay.

4.3 Management Unit C

MU C includes Internal Coastal and Joint Fishing Waters of the Pamlico, Pungo, Bay, and Neuse rivers drainages, Pamlico Sound west of 76° 30.0000’W, and Turnagain Bay. In Turnagain Bay north of the 35th parallel and east of 76° 30.0000’W out to 200 yards from shore (Figure 5).

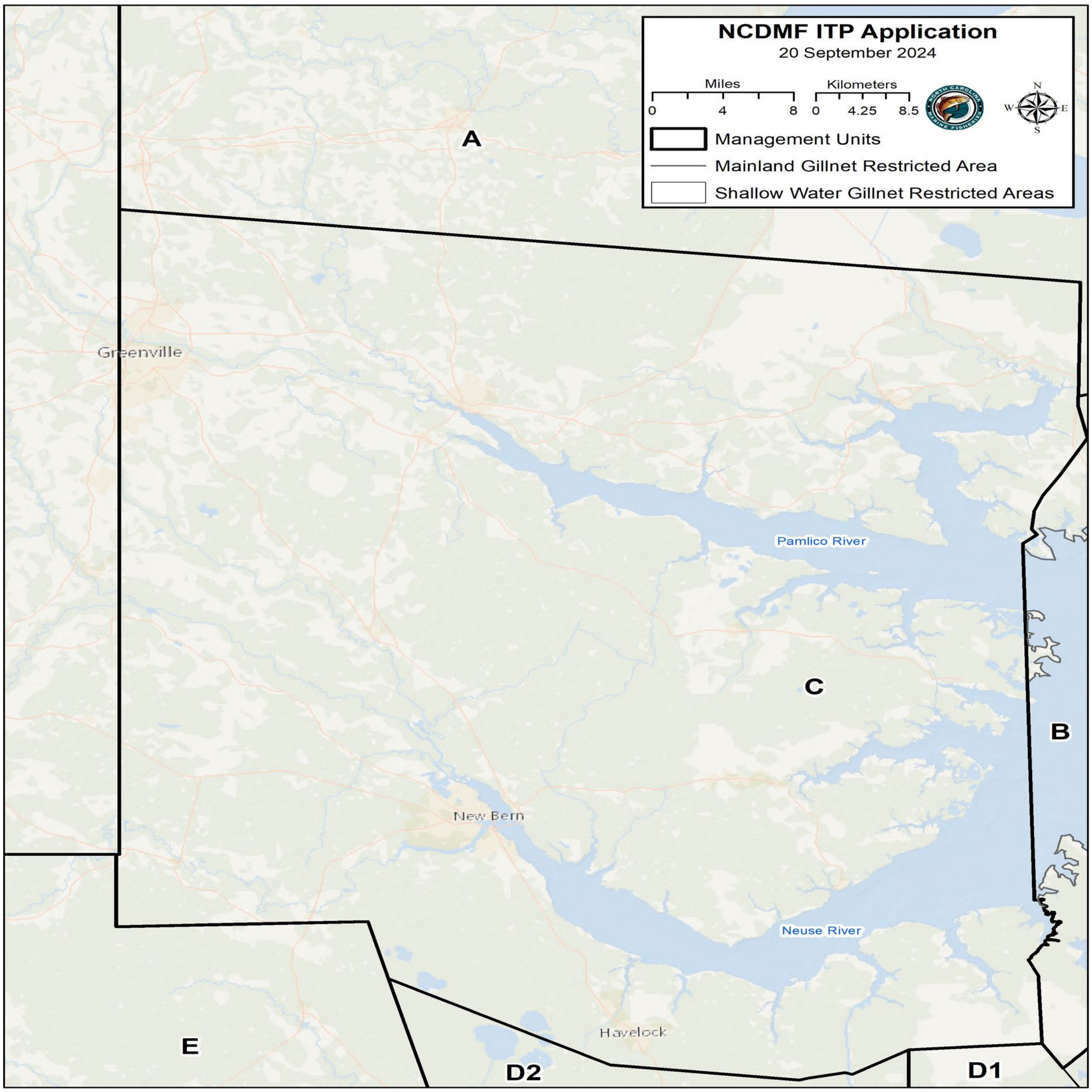


Figure 5. Management Unit C

4.4 Management Unit D1

MU D1 includes the Internal Coastal and Joint Fishing Waters in Core Sound south of 35° 0.000' N latitude running south and west to the Management Units D1 and D2 boundary at 34° 40.6750’ N – 76° 37.0000’ W to 34° 42.4800’ N – 76° 37.0000’W then to the head of Turner Creek, and northerly up the western shoreline of the North River. Management Unit D1 includes Core Sound, Back Sound, The Straits, and North River, including all creeks and their tributaries (Figure 6).

MU D1 is broken into two subunits as described below:

<u>Northern D1 Subunit:</u>

Internal Coastal and Joint Fishing Waters in Core Sound and its tributaries south of 35° 0.000' N latitude running south and west to the Management Units D1 and D2 boundary at 34° 40.6750’N – 76° 37.0000’W to 34° 42.4800’N – 76° 37.0000’W then to the head of Turner Creek, and northerly up the western shoreline of the North River. Management Unit D1 includes Core Sound, Back Sound, The Straits, and North River, including all creeks and their tributaries.

<u>Southern D1 Subunit</u>:

Internal Coastal Fishing Waters south of latitude 34° 48.2700’N and east of a line running from 34° 40.6740’ N – 76° 37.0000’ W to 34° 42.4800’ N – 76° 37.0000’ W then to the head of Turner Creek, and northerly up the western shoreline of the North River. The Southern D1 subunit includes the southern portion of Core Sound, Back Sound, The Straits, and North River.

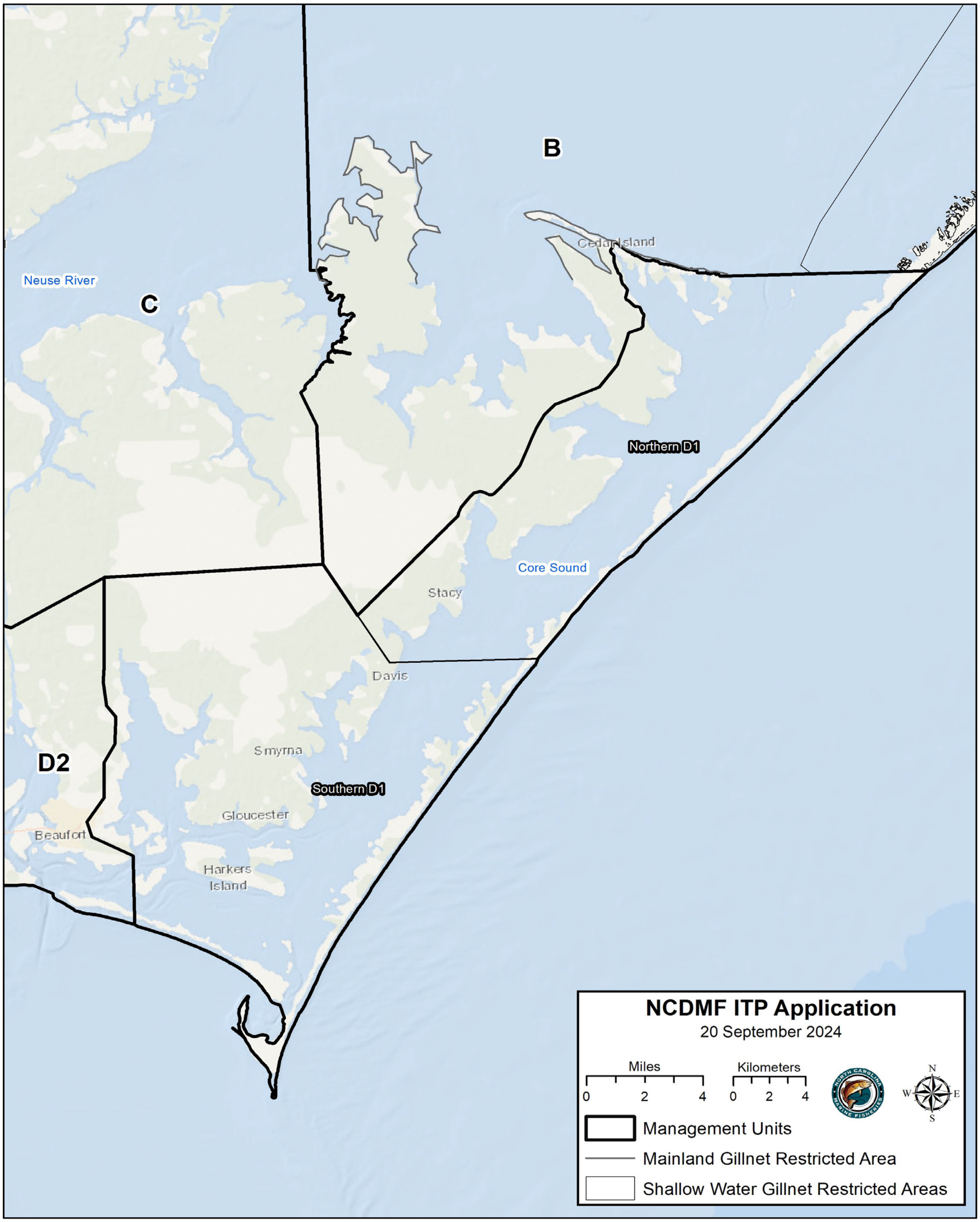


Figure 6. Management Unit D1

4.5 Management Unit D2

MU D2 includes: Internal Coastal Waters west of a line running from 34° 40.6740' N – 76° 37.0000'W to 34° 42.4800'N – 76° 37.0000'W then to the head of Turner Creek, and northerly up the western shoreline of the North River; and east of the NC Hwy 58 Bridge. Management Unit D2 includes Newport River (including the Atlantic Intracoastal Waterway and Harlowe Creek up to NC Hwy 101 Bridge) and Bogue Sound (Figure 7).

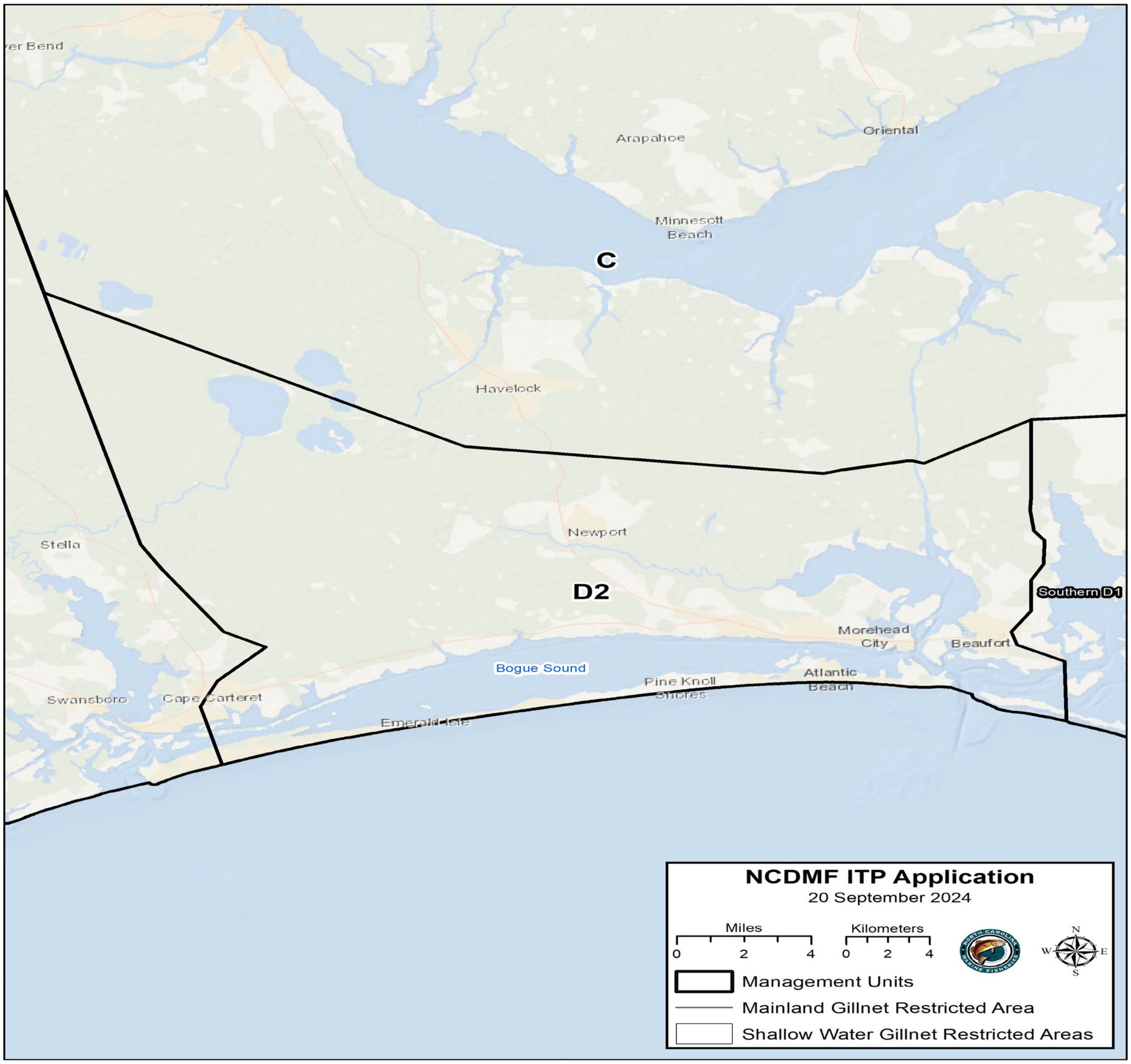


Figure 7. Management Unit D2

4.6 Management Unit E

MU E includes: Internal Coastal and Joint Fishing Waters south and west of the Highway 58 Bridge to the North Carolina/South Carolina state line. This includes the Atlantic Intracoastal Waterway and adjacent sounds and the New, Cape Fear, Lockwood Folly, White Oak, and Shallotte rivers (Figure 8).

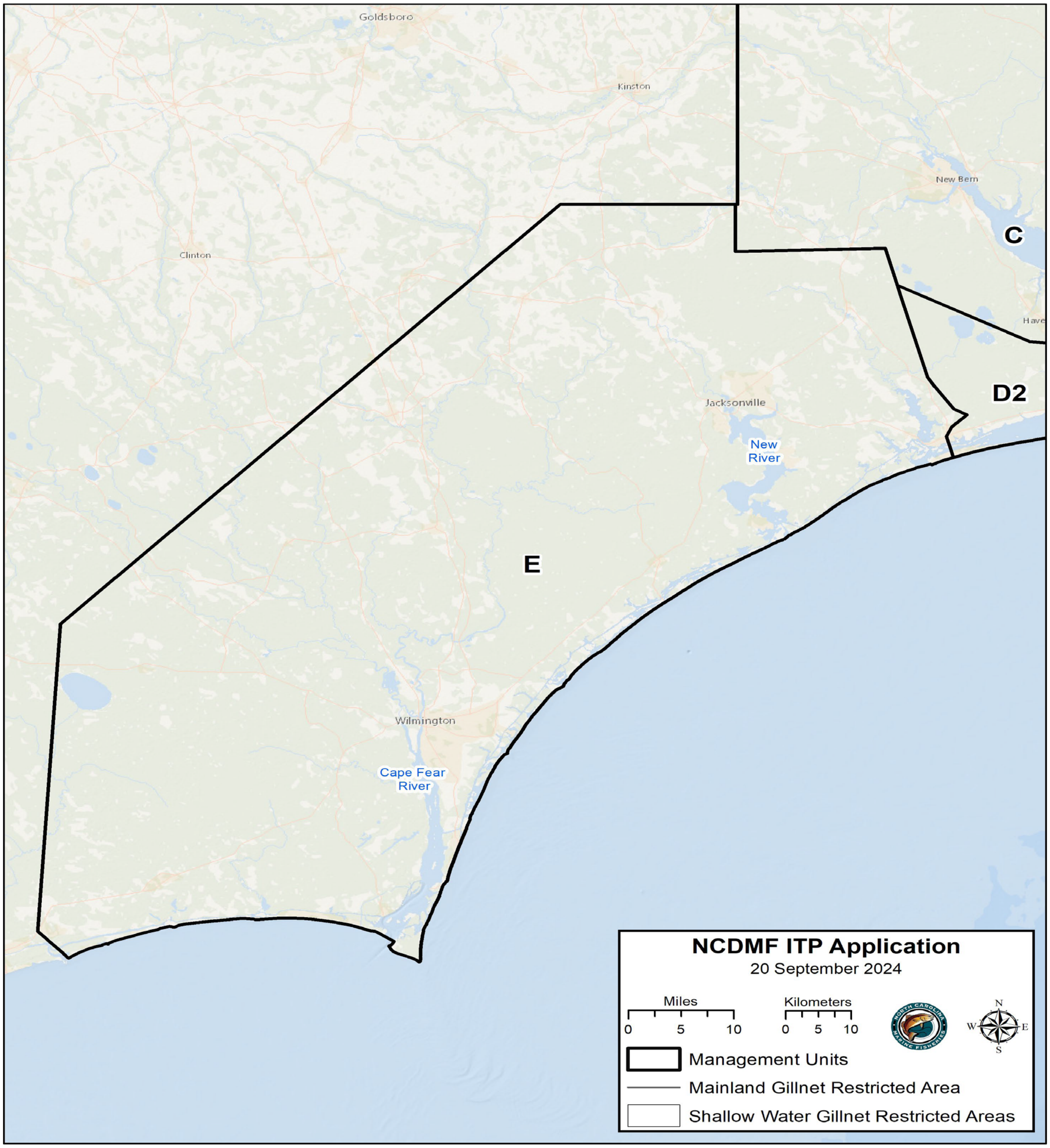


Figure 8. Management Unit E

5 Species and Critical Habitat That May be Affected

This section identifies the ESA-listed species that occur within the action area (see Section 4 and Figure 2) that may be adversely affected by issuance of an ITP to NCDMF pursuant to section 10(a)(1)(B) of the ESA and its implementing regulations (50 CFR §222.307). All of the ESA species potentially occurring within the action area are listed in Table 2, along with their regulatory status.

Table 2. Species and Critical Habitat Likely to be Adversely Affected

Species	ESA Status	Critical Habitat	Recovery Plan
Marine Reptiles			
Leatherback Turtle (*Dermochelys coriacea*)	E – 35 FR 8491	44 FR 17710 77 FR 4170	63 FR 28359
Green Turtle (*Chelonia mydas*) North Atlantic DPS	T – 81 FR 20057	88 FR 46572 (Proposed)	63 FR 28359
Green Turtle (*Chelonia mydas*) South Atlantic DPS	E – 81 FR 20057	88 FR 46572 (Proposed)	63 FR 28359
Hawksbill Turtle (*Eretmochelys imbricata)*	E – 35 FR 8491	63 FR 46693	63 FR 28359
Loggerhead Turtle (*Caretta caretta*) North West Atlantic DPS	E – 76 FR 58868	79 FR 39856	63 FR 28359
Kemps Ridley Sea Turtle (*Lepidochelys kempii)*	E- 35 FR 18319	-- --	75 FR 12496
Fishes			
Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus)* Carolina DPS	E-77 FR 5914	82 FR 39160	2018 Recovery Outline
Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus)* Chesapeake Bay DPS	E- 77 FR 5880	82 FR 39160	2018 Recovery Outline
Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus)* New York Bight DPS	E- 77 FR 5880	82 FR 39160	2018 Recovery Outline
Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus)* South Atlantic DPS	E-77 FR 5914	82 FR 39160	2018 Recovery Outline
Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus)* Gulf of Maine DPS	T-77 FR 5880	82 FR 39160	2018 Recovery Outline
Shortnose sturgeon *(Acipenser brevirostrum)*	E- 32 FR 4001 (39 FR 41370)	-- --	63 FR 69613

5.1 Critical Habitat that is Not Likely to be Adversely Affected

5.1.1 Critical Habitat for the Carolina DPS of Atlantic sturgeon

NMFS designated critical habitat for each ESA-listed DPS of Atlantic sturgeon in September of 2017 (82 FR 39160; Figure 10). This action will only occur within the critical habitat designation for Carolina DPS Atlantic sturgeon. Within the action area of this opinion, the designated critical habitat for the Carolina DPS includes the Roanoke River (16) in MU A, the Tar-Pamlico (17) and Neuse (18) Rivers in MU C, and the Cape Fear (20) and Northeast Cape Fear (19) Rivers in MU E (Figure 9).

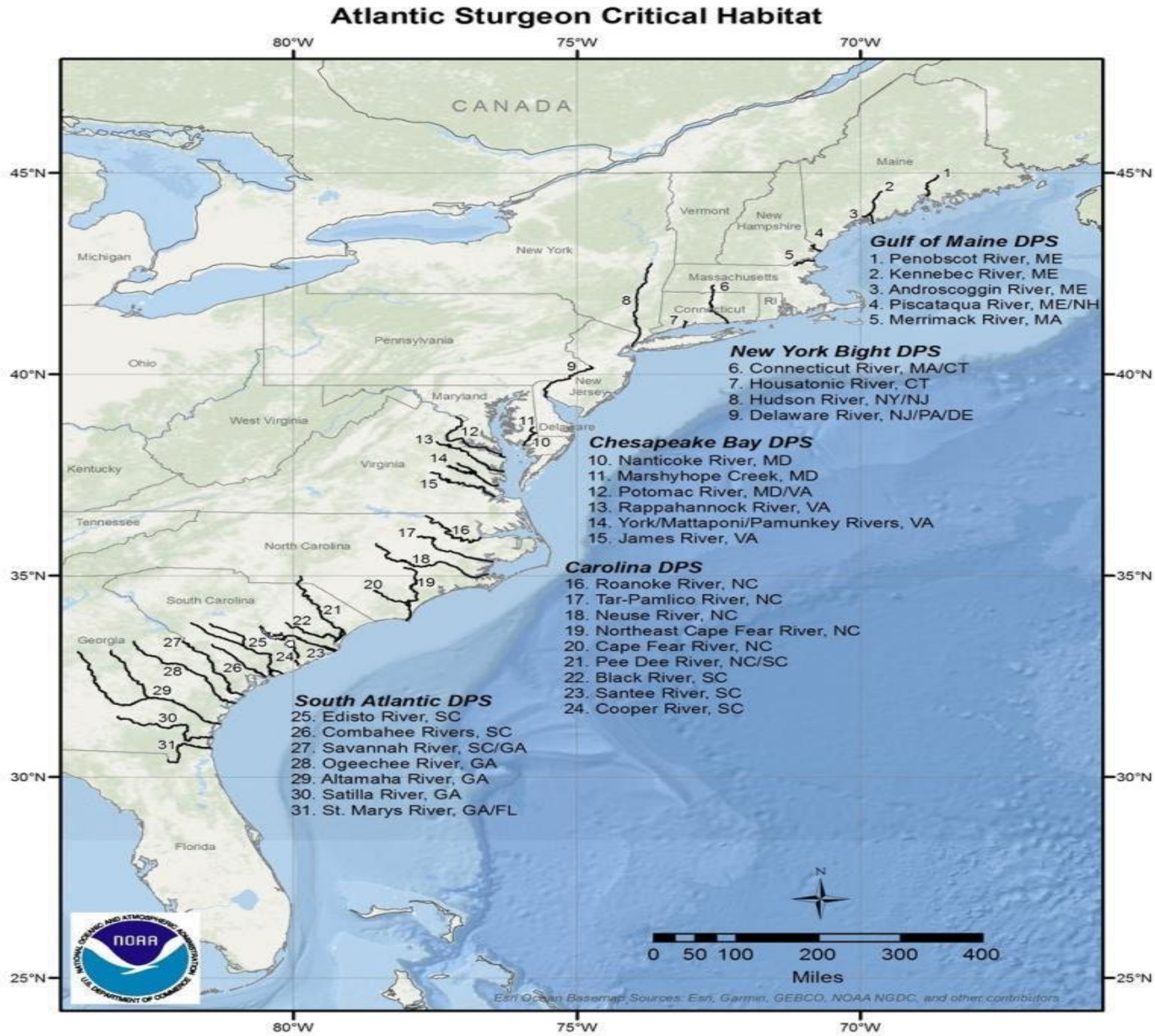


Figure 9. Map representing critical habitat for the conservation of endangered and threatened Atlantic sturgeon from Maine to Florida.

NMFS determined the physical features essential to the conservation of the Carolina DPS of Atlantic sturgeon that may require special management considerations or protection, which support the identified conservation objectives, are:

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

(2) Transitional salinity zones inclusive of waters with a gradual downstream gradient of 0.5- up to 30 ppt and soft substrate (*e.g.*, sand, mud) between the river mouths 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 mouths and spawning sites necessary to support:

(i) Unimpeded movement of adults to and from spawning sites; (Moser 2000) Seasonal and physiologically-dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary; and (Brundage III 2008) Staging, resting, or holding of subadults or spawning condition adults. Water depths in main river channels must also be deep enough (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 quality conditions, especially in the bottom meter of the water column, between the river mouths and spawning sites with temperature and oxygen values that support:

(i) Spawning; (Moser 2000) Annual and inter-annual adult, subadult, larval, and juvenile survival; and (Brundage III 2008) Larval, juvenile, and subadult growth, development, and recruitment. Appropriate temperature and oxygen values will vary interdependently, and depending on salinity in a particular habitat. For example, 6.0 mg/L DO or greater likely supports juvenile rearing habitat, whereas DO less than 5.0 mg/L for longer than 30 days is less likely to support rearing when water temperature is greater than 25°C. In temperatures greater than 26°C, DO greater than 4.3 mg/L is needed to protect survival and growth. Temperatures of 13 to 26°C likely to support spawning habitat.

The extent of habitat damage from gill net fishing can vary depending on several factors, including the type of habitat, the frequency and intensity of fishing activity, and the specific fishing practices used. The stressors affecting habitat expected from gill net fishing in North Carolina estuarine fishery are the presence of gill nets as a possible passage barrier and benthic disturbance when anchored or pulled.

From 2014–2020, 80% of gill net trips reported to the TTP were set gill nets, and there were an average of 30,317.1 annual estuarine anchored gill net trips. This data indicates the extent of gill net usage in North Carolina is extensive: more than 60 million yards (~35,000mi) of gill nets are set in coastal estuarine waters.

The NC estuarine fishery is limited in its activities to areas downstream of where sturgeon spawning is believed to occur. Therefore, the habitat described in PBF 1 is not affected by the

NC estuarine gill net fishery. Likewise, gill nets will have no effect on salinity or water quality conditions. Therefore, there will be no effect to PBF 2 or 4 from any activity covered under this opinion.

Spawning can only be successful if adult Atlantic sturgeon are able to safely and efficiently move from downstream areas into upstream spawning habitats. In addition, juvenile Atlantic sturgeon must be able to safely and efficiently travel from the upstream spawning areas downstream to nursery and foraging habitat. Passage barriers can be caused by: locks, dams, thermal plumes, turbidity, sound, reservoirs, gear, etc. Similarly, water depth is also very important. Under the fishery, gill nets are not allowed to completely block the flow of a river. Furthermore, nets are checked regularly to prevent the target catch from spoiling and moved regularly to increase capture probabilities following successful harvest periods. Because of these three factors, effects of gill nets on passage availability is expected to occur, but be temporary in nature. Therefore, we would anticipate that Atlantic sturgeon passage may be temporarily and incompletely blocked by nets associated with the commercial fishery. The temporary and incomplete nature of the migratory pathway obstruction will be insignificant to the function of PBF 3. The effects of gill nets on critical habitat therefore may affect, but are not likely to adversely affect designation critical habitat of Carolina DPS Atlantic sturgeon.

5.1.2 Critical Habitat Proposed for the North Atlantic DPS green sea turtle

On September 2, 1998, NMFS designated critical habitat for green sea turtles (63 FR 46694), which include coastal waters surrounding Culebra Island, Puerto Rico. This designated critical habitat for green sea turtles is outside the action area. However, NMFS has proposed critical habitat for six DPSs of green sea turtles (88 FR 46527; July 19, 2023). The proposed marine critical habitat includes nearshore waters (from the mean high water line to 20 m depth) off the coasts of Florida, North Carolina, Texas, Puerto Rico, U.S. Virgin Islands, California (which also includes nearshore areas from the mean high water line to 10 km offshore; (see Figure 10), Hawai‘i, American Samoa, Guam, and the Commonwealth of Northern Mariana Islands. Proposed marine critical habitat also includes Sargassum habitat (from 10 m depth to the outer boundary of the U.S. Exclusive Economic Zone) in the Gulf of Mexico and Atlantic Ocean (Figure 15). The proposed critical habitat for green sea turtles does occur within the action area.

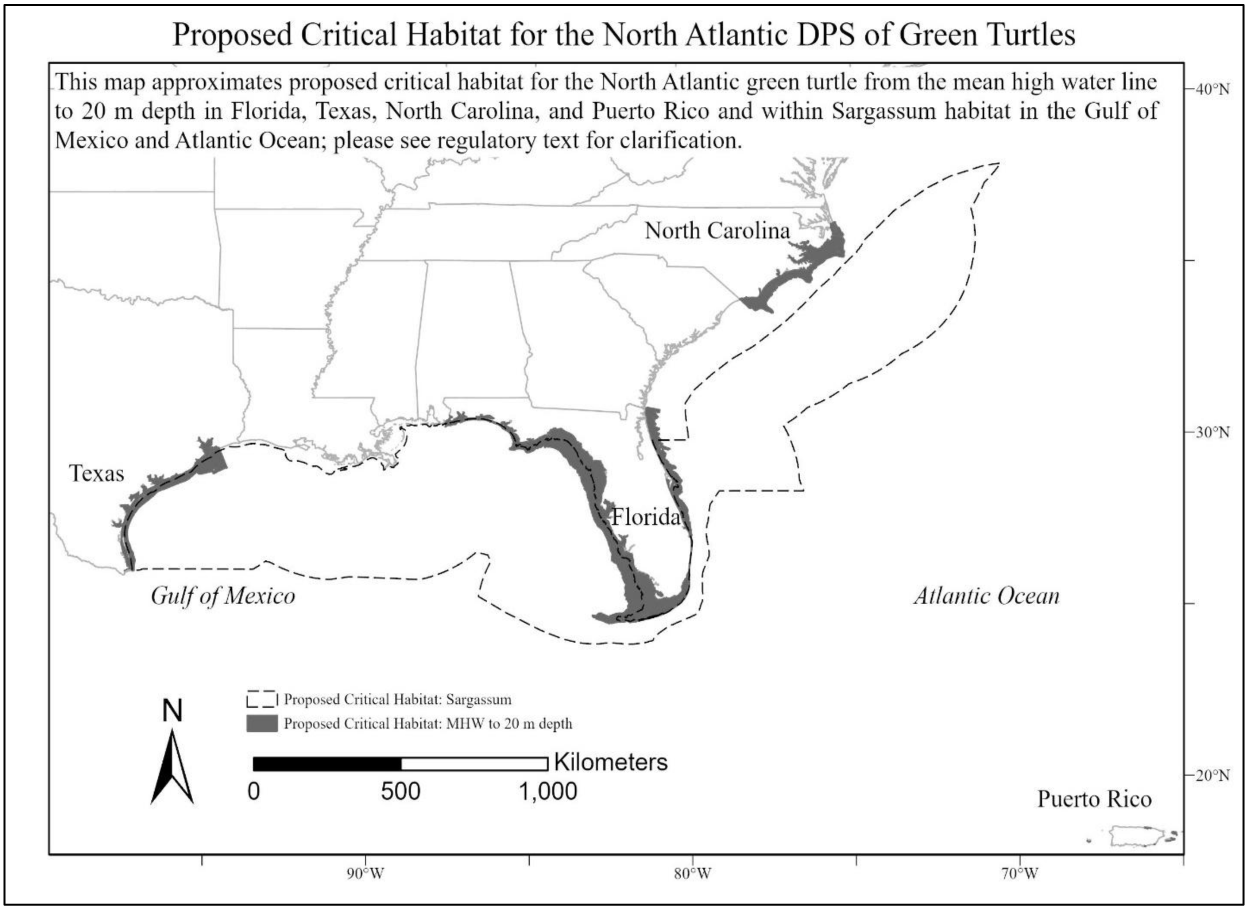


Figure 10. Proposed Critical Habitat for the North Atlantic DPS of green turtles

The PBFs for North Atlantic DPS green sea turtle proposed critical habitat are:

(1) Reproductive (North Atlantic, South Atlantic, Central North Pacific, Central South Pacific, and Central West Pacific DPSs). From the mean high water line to 20 m depth, sufficiently dark and unobstructed nearshore waters adjacent to nesting beaches designated as critical habitat by U.S. Fish and Wildlife Service (USFWS), to allow for the transit, mating, and internesting of reproductive individuals and the transit of post-hatchlings.

(2) Migratory (North Atlantic and East Pacific DPSs). From the mean high water line to 20 m depth (North Atlantic DPS) or 10 km offshore (East Pacific DPS), sufficiently unobstructed waters that allow for unrestricted transit of reproductive individuals between benthic foraging/resting and reproductive areas.

(3) Benthic foraging/resting (North Atlantic, South Atlantic, East Pacific, Central North Pacific, Central South Pacific, and Central West Pacific DPSs). From the mean high water line to 20 m depth, underwater refugia and food resources (i.e., seagrasses, macroalgae, and/or invertebrates) of sufficient condition, distribution, diversity,

abundance, and density necessary to support survival, development, growth, and/or reproduction.

(4) Surface-pelagic foraging/resting (North Atlantic DPS). Convergence zones, frontal zones, surface-water downwelling areas, the margins of major boundary currents, and other areas that result in concentrated components of the Sargassum-dominated drift community, as well as the currents which carry turtles to Sargassum-dominated drift communities, which provide sufficient food resources and refugia to support the survival, growth, and development of post-hatchlings and surface-pelagic juveniles, and which are located in sufficient water depth (at least 10 m) to ensure offshore transport via ocean currents to areas which meet forage and refugia requirements.

The proposed critical habitat will range from the South Carolina border to but not including Albemarle and Currituck Sounds, all nearshore areas from the mean high water line to 20 m depth. These areas contain benthic foraging/resting essential features.

Seagrass and other submerged aquatic vegetation are found throughout nearshore waters of North Carolina (Figure 11). Juvenile green turtles forage on seagrass beds in the waters of Core, Pamlico and Bogue Sounds (Bass 2006; Epperly 2007b; Epperly 1995b; McClellan 2009b). Juveniles also forage in Back Sound and the Cape Fear, New, and White Oak River estuaries from April through November (Avens 2003; Snoddy 2009; Snoddy 2010) or December (Williard 2017).

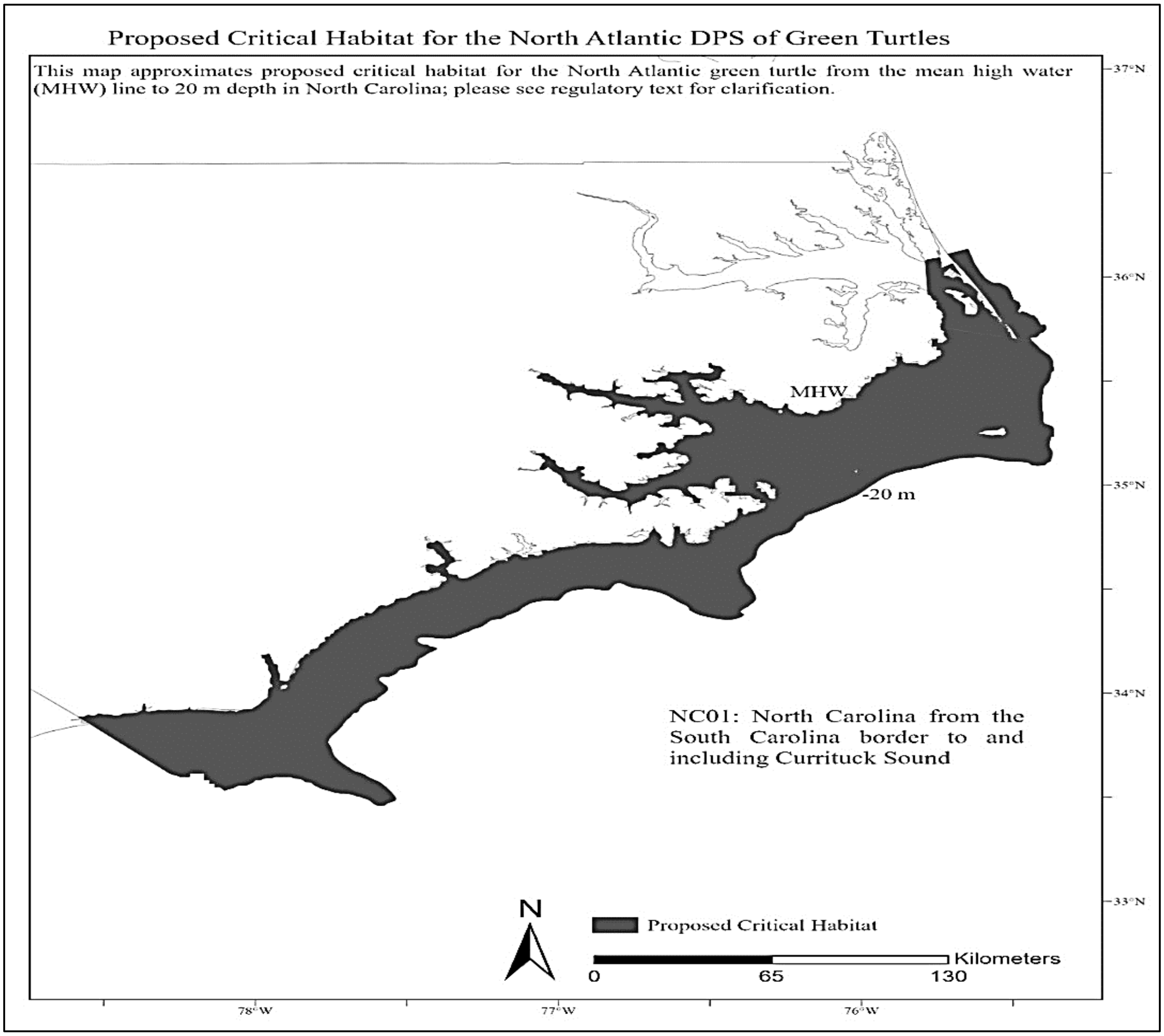


Figure 11. North Carolina Proposed Critical Habitat for NA DPS green turtle.

Geological and biological features are generally less susceptible to impacts from fixed gears (such as gill nets) when compared to other (e.g., mobile or towed) fishing gear types (Grabowski 2014; Kaiser 2014). Gill nets may affect benthic habitats due to gear set or dragged on the bottom, mostly during gear retrieval. Anchors attaching the net to the bottom, the ground line or lead line (attached to the lower part of the net to keep it on the bottom), or the net itself may be dragged through the sediment, snag bottom features, or disturb benthic organisms when retrieved from the water or moved through the water by tides (Grieve 2014; Kaiser 2014). Dragging of gear during retrieval is incidental, and not the intent or goal, of gill net fishing. The bottom surface affected is small for both anchors and ground lines (Grieve 2014). Gill nets do not penetrate the seafloor, so they would be expected to have impacts only on the surface of the benthos and surface-dwelling or emergent animals, plants, and algae (Grieve 2014; Kaiser 2014).

The gill nets used by the NC commercial gill net fishery would not be expected to have any effect on surface or pelagic foraging. Nets would only be expected to come in contact with the benthic habitat if strong currents pushed them down into the sediment or they come in contact with branched structures (e.g., coral). While Shester (2011) have shown gill nets can remove or damage kelp and gorgonian corals, they note that "significant damage or removal to seagrasses would be less plausible." Because the forage resources for green sea turtles in North Carolina are sea grasses, the effect of gill nets on benthic habitat is expected to be superficial (limited or no penetration of gear into the sediment) and limited to a small area affected by anchors, weights, or lines, such that their impact would not be meaningfully measured and thus insignificant.

As discussed for Atlantic sturgeon, the presence of gill nets could impede migration or access to nesting habitat. Gill nets will not affect the water clarity. Under the fishery, gill nets are checked regularly to prevent the target catch from spoiling and moved regularly to increase capture probabilities following successful harvest periods. Because of these factors, effects of gill nets on movement and access to nesting beaches is expected to occur, but be temporary in nature. The temporary and incomplete nature of the movement obstruction will be insignificant to the function of PBFs 1 and 2. Therefore, we expect that the proposed action may affect, but is not likely to adversely affect NA DPS green sea turtle proposed critical habitat.

6 Status of Species and Critical Habitat Likely to be Adversely Affected

This section examines the status of each species that may be affected by the proposed action. The status includes a discussion of the threats each ESA-listed species faces, a description of the populations that comprise the species, their population dynamics, and recovery needs. The species status section helps to inform the description of the species' current "reproduction, numbers, or distribution," which are the criteria identified in the definition of "jeopardize the continued existence of" in 50 CFR §402.02.

This section also examines the condition of designated and proposed critical habitat areas a whole (such as various watersheds and coastal and marine environments that make up the designated area), and discusses the condition and current function of designated and proposed critical habitat, including the essential physical and biological features essential to the conservation of the species (PBFs) that contribute to that conservation value of the critical habitat.

The following subsections are synopses of the best available information on the status of the species and designated and proposed critical habitat that are likely to be affected by one or more components of the action. The biology and ecology of these species as well as their status and trends inform the effects analysis for this document.

6.1 Atlantic Sturgeon

6.1.1 Species Description and Distribution

Five separate DPSs of Atlantic sturgeon were listed under the ESA by NMFS effective April 6, 2012 (77 FR 5880 and 5914, February 6, 2012). The New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs were listed as endangered and the Gulf of Maine DPS was listed as threatened. Atlantic sturgeon are long-lived, late-maturing, estuarine-dependent, anadromous fish distributed along the eastern coast of North America, as shown in Figure 12 (Waldman 1998). Historically, sightings have been reported from Hamilton Inlet, Labrador, Canada, south to the St. Johns River, Florida (Murawski 1977; Smith 1997). While adult Atlantic sturgeon from all DPSs mix extensively in marine waters, Atlantic sturgeon return to their natal rivers to spawn approximately 96% of the time (Kazyak 2021b). Genetic studies show that fewer than two adults per generation spawn in rivers other than their natal river (Waldman 2002; Wirgin 2000). Young sturgeon spend the first few years of life in their natal river estuary before moving out to sea (Waldman 2002). The 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).

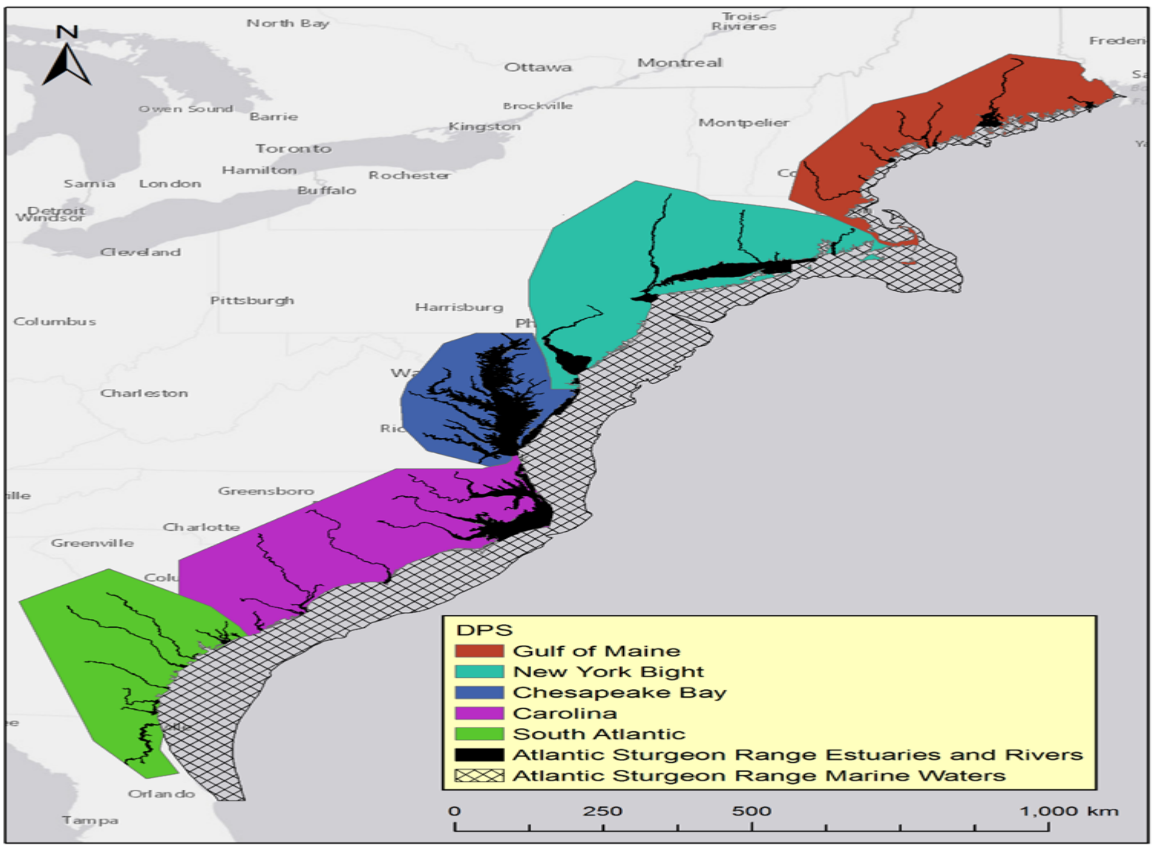


Figure 12. Geographic range of Atlantic Sturgeon DPSs

6.1.2 DPS-Specific Information

6.1.2.1 *Gulf of Maine DPS*

The GOM DPS of Atlantic sturgeon was listed as threatened on February 6, 2012. The GOM DPS historically supported at least four spawning subpopulations; however, today it is suspected that only two extant subpopulations exist (Penobscot and Kennebec rivers) (ASSRT 2007). 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. Although surveys have not been conducted to document Atlantic sturgeon presence, subadults may use the estuaries of the smaller coastal drainages (i.e., St. Croix, Machias and Saco rivers) during the summer months (ASSRT 2007; MSPO 1993).

The Kennebec River is the primary spawning and nursery area for GOM Atlantic sturgeon. Ripe female Atlantic sturgeon with enlarged, fully mature eggs ready to be fertilized have been found in the Kennebec River from mid-July through early August (MSPO 1993). Historical records indicate that the major spawning area for Atlantic sturgeon in the Kennebec River was above head-of-tide between Augusta and Waterville. Prior to any commercial fishing, the Kennebec supported approximately 10,000-15,000 spawning adults (ASSRT 2007; MSPO 1993). The construction of the Edwards Dam at river kilometer (rkm) 64 in 1837 was believed to have caused the commercial sturgeon catch to decline over 50 percent (MSPO 1993). Severe pollution in the river from the 1930's through the early 1970's is believed to have been a major factor in the continued decline of the sturgeon population in the Kennebec. In 2007, the ASSRT concluded that, due to stressors related to poor water quality, dredging, and commercial bycatch, there was a moderate risk (i.e., < 50 percent chance) of the Kennebec subpopulation of Atlantic sturgeon becoming endangered within the next 20 years.

An open population estimate of marine-oriented Atlantic sturgeon (sub-adult and adult) foraging in the Saco River from May to November is between 1,400 and 6,800 individuals annually (Flanigan 2021). The Kennebec River effective population size and 95% confidence limits (CL) were estimated at 67.0 (52.0-89.1) and 79.4 (60.3-111.7) by Waldman (2019); n = 62) and White (2021b); n = 48). Effective population size is essentially an estimate of the number of breeding individuals in a population required to maintain the amount of genetic variability observed within samples from that population. Furthermore, two larval Atlantic sturgeon were captured just above the Kennebec River estuary between 24 and 25 °C in mid-July, confirming successful reproduction in this location (Wippelhauser 2017). It is thought the Penobscot may have historically supported a spawning population, but it is possibly extirpated (ASMFC 2017a). Wippelhauser (2017) suggests Atlantic sturgeon use the upper Kennebec River, the Kennebec River estuary, and the Androscoggin River estuary for reproduction. It is unknown whether the Merrimack River supports a reproductive population of Atlantic sturgeon (ASMFC 2017a). And while the Androscoggin represents an additional known spawning location for this DPS, non-spawning individuals were observed to use the Penobscot, Androscoggin, Saco, Merrimack, St. John, and Minas Passage (Altenritter 2017; Novak 2017; Wippelhauser 2017). Survival rates of all ages is estimated to be approximately 74% annually (95% confidence limits, 15-99%; ASMFC 2017a). The ASSRT concluded that the Penobscot subpopulation also had a moderate risk of becoming endangered due to its potentially small size (likely less than 300 spawning adults), increased dredging projects, and poor water quality (ASSRT 2007). Within the Penobscot, substrate has been severely degraded by upstream mills, and water quality has been negatively affected by the presence of coal deposits and mercury hot spots. The potential for commercial bycatch was also viewed as a moderate threat to this subpopulation due to its small size.

6.1.2.2 *New York Bight DPS*

The New York Bight DPS was listed as endangered under the ESA on February 6, 2012. The New York Bight, ranging from Cape Cod to the Delmarva Peninsula. The Connecticut, Hudson, and Delaware Rivers all support reproductive populations while the Taunton River population appears to be extirpated. A recent assessment of relatedness of these populations to others along the coast reveals, as was the case at the time of listing, that the Hudson and Delaware populations appear to be a separate group from other populations but also different from one another (White 2021a). The Connecticut River was not included in that study. A recent study using acoustic telemetry to estimate spawning duration and return intervals shows that Hudson River adults return much more frequently than previously thought; females every 1.66 years and males every 1.28 years (Breece 2021). This is in agreement with recent studies conducted in the York River (Hager 2020), both suggesting females, in particular, spawn more often than previously thought. In the Hudson River, males were on spawning grounds on average from May 27 through July 11 and females from June 8 through June 29. The average male is also more likely to travel further upriver than the average female (Breece 2021).

There are a number of abundance estimates for each river. The Hudson River most likely supports the largest population of Atlantic sturgeon in the United States. Effective population estimates for the Hudson River are 156 (95% CL, 138.3-176.1; n = 459; Waldman (2019) and 145.1 (82.5-299.4; n = 307; White (2021a). Kazyak (2020) produced an abundance estimate of the 2014 adult spawning run size of 466 individuals (95% CL, 310-745). While this spawning run size is nearly identical to that estimated by Kahnle (2007), monitoring of relative abundance of juveniles from 2004 through 2019 has shown production may have doubled during those 16 years (Pendleton 2021).

In the Delaware River, the effective population size has been estimated to be 40 (95% CL, 34.7-46.2; n = 108) and 60.4 (42-85.6; n = 488) by Waldman (2019) and White (2021a), respectively. The significant difference between estimates is likely due to sample size. Therefore, White (2021a) estimate is likely most accurate. Additionally, a recent close-kin mark-recapture estimate was produced for the Delaware River and suggests there are fewer than 250 adults (census) in the Delaware River population (White 2021a).

In the Connecticut River, despite only limited collection of juvenile sturgeon (n = 47), there is an estimate of effective population size of two (95% CL, 2-2.7; Waldman 2019). This would suggest there has been a single spawning event in the Connecticut River that produced all of the juvenile fish collected or the spawning adults were so closely related as to be indistinguishable from a single pair. Either way, it is clear there is limited genetic diversity in this population and, unless these adults continue returning to the Connecticut River, it could take approximately 20 years to learn whether these juveniles have survived in sufficient numbers to sustain this new population.

Recent survival estimates do not suggest much of an improvement since the last estimates made during the commercial fishery (Boreman 1997; Kahnle 1998). Melnychuk (2017) provided an updated estimate of survival of Hudson River Atlantic sturgeon of approximately 88.22%, while for similar life stages over a longer time frame, ASMFC (2017b) estimated survival of the entire New York Bight to be 91% (95% confidence limits, 71-99%).

The range of Atlantic sturgeon can be measured from north to south or inshore to offshore. While there has been no change to the range along the East Coast, there are detection data of acoustic transmitters much further offshore than had previously been documented.

To understand movement along the coast, White (2021b) assessed the river of origin of Atlantic sturgeon harvested during the commercial fishery. This was a duplication of a study done by Waldman (1996), but showed fish harvested in the Hudson River were from many locations other than the Hudson. The makeup of the harvested fish in the 1990s was 82.3% Hudson, 7.3% Delaware, 4.7% James River spring run, 2.4% St. Lawrence, 2.1% Kennebec, 1.3% Pee Dee spring run, rather than 98% Hudson as had been estimated during the fishery. The reasons for the difference are likely a more thorough baseline consisting of 18 known populations rather than only nine (White 2021a) and the use of microsatellite DNA rather than mitochondrial. However, Wirgin (2018) sampling 148 sub-adult sturgeon in the Hudson River estuary and relying on microsatellite DNA, found 142 of those were of Hudson River origin with additional contributions from the Kennebec (2), Delaware (2), Ogeechee (1), and James (1) Rivers. This may suggest adults are more likely to enter estuaries than sub-adults.

In terms of nearshore habitat use, Breece (2018) showed habitat selection is driven by depth, time of year, sea surface temperature, and light absorption by seawater, while sex and natal river do not seem to be important predictors of habitat selection. Therefore, regardless of the makeup of the mixed populations in these estuarine areas, the drivers of where the fish are located affect all sexes and populations similarly. Inshore and offshore movement is highly dependent on photoperiod and temperature, with fish residing offshore from November to January and inshore from June to September (Ingram 2019). Fish gradually move inshore from February to May but rapidly move offshore during October (Ingram 2018; Ingram 2019). In the Delaware Bay, when fish have moved inshore for the spring and summer months, Breece (2018) showed Atlantic sturgeon prefer shallow water and warmer bottom temperatures primarily in the eastern portion of the bay during residency but that this preference changes to deep, cool water and the western edge of the bay during migration.

Kazyak (2021a) studied the offshore composition of sturgeon between Cape Hatteras and Cape Cod (mid-Atlantic, which comprises the New York Bight, Chesapeake Bay, and part of the Carolina DPSs) and found that 37.5% and 30.7% of all bycaught fish in this region were from the New York Bight and Carolina DPSs, respectively. This was primarily driven by 27.3% of fish from the Albemarle complex and 26.2% from the Hudson River. Estuarine bycatch in this area was primarily from Albemarle Complex, with many of the samples being obtained in waters of North Carolina, and most offshore fish were from the Hudson and James Rivers.

6.1.2.3 *Chesapeake Bay DPS*

The Chesapeake Bay DPS was listed as endangered under the ESA on February 6, 2012. Historically, Atlantic sturgeon were common throughout the Chesapeake Bay and its tributaries (Kahnle et al. 1998, Wharton 1957, Bushnoe et al. 2005). Based on U.S. Fish Commission landings data, approximately 20,000 adult female Atlantic sturgeon inhabited the Chesapeake

Bay and its tributaries prior to development of a commercial fishery in 1890 (Secor 2002a). Chesapeake Bay rivers once supported at least six historical spawning subpopulations (ASSRT 2007), but today reproducing populations are only known to occur in the James and York Rivers. However, the presence of telemetry tagged Atlantic sturgeon in freshwater portions of Chesapeake Bay tributaries during the summer/fall spawning season (late July to mid-October) suggests that spawning may also occur in the Rappahannock, Potomac, Nanticoke, and Pocomoke Rivers.

There are only three known spawning populations for this DPS in the James, York, and Nanticoke Rivers. Edwards (2020) noted an adult male Atlantic sturgeon was detected at the saltwater interface of the Patuxent River, which may indicate potential spawning. However, Kahn (2019a) noted that telemetry detections are not a meaningful indicator of whether a male is spawning. Because males are often in spawning condition during non-spawning situations Van Eenennaam (1996), even if this individual had been captured and observed in spawning condition, that would not have been enough to suggest spawning was occurring in the Patuxent River.

The James River supports the largest population of Atlantic sturgeon within the DPS. Balazik (2012) reported empirical evidence that James River Atlantic sturgeon spawn in the fall. As noted above, a more recent study also indicates that Atlantic sturgeon also spawn in the spring in the James River (i.e., dual spawning races)(Balazik 2015). Genetic analysis of tissue samples suggest effective populations in the James River range from around 40 to 100 (O'Leary 2014). The ASSRT concluded that the James River had a moderately high risk (> 50 percent chance) of becoming endangered in the next 20 years, due to anticipated impacts from commercial bycatch. Dredging and ship strikes were also identified as threats (i.e., moderate risk) that contribute to the risk of extinction for the James subpopulation of Atlantic sturgeon.

The York River has a much smaller population, with annual spawning abundance estimates for 2013 of 75 (Kahn 2014). The effective population size of the York River population ranges from 6 to 12 individuals, the smallest effective population size for any Atlantic sturgeon subpopulation along the Atlantic Coast. The total York River adult Atlantic sturgeon abundance is estimated at 289 individuals. The highest ranked stressor for the York River was commercial bycatch, which received a moderate risk rank (ASSRT 2007).

Monitoring in the York River reveals that males return to spawn every 1.13 years and females every 2.19 years (Hager 2020). Males in the Nanticoke River system return to spawn every 1.68 years (calculated from Table 2 in Secor et al. 2022) but there is insufficient information to estimate female return intervals. Hager (2020) shows spawning in the York River occurs on descending temperatures from 25.1 °C to 21.5 °C. This narrow temperature window is bounded by increased egg mortality at 25 °C and peak bioenergetic growth around 22 °C. Similarly, Secor (2022) shows adults present on Nanticoke River spawning grounds from 26.7 °C down to 17.8 °C with most fish leaving the system by 20 °C. Spawning in both systems appears to be driven by temperature and photoperiod with a peak of spawning around the autumn equinox (Hager 2020; Secor 2022). Sex ratios when spawning range from approximately 64 to 75% male in the

York River, though the overall population appears to be approximately 51% male (95% CL, 43-58%; (Kahn 2019b).

A recent assessment of relatedness of all Atlantic sturgeon populations showed that, when all populations along the coast are grouped, the James River (spring and fall runs) is most closely related to rivers in the northeast, while the York River is most closely related to rivers in the southeast (White 2021a). The York River population was distinct when compared to those southeastern rivers; the James River, meanwhile, when compared to northeastern rivers, remains closely related to a group of rivers in Canada and Maine but is differentiated from the Hudson and Delaware Rivers. At this point in the analysis, Program COLONY (a computer program to estimate likelihood of genealogical relationships from genotype data), which was used to estimate closeness of relationships, could have identified three clusters (James spring and fall, Hudson and Delaware, and Maine/Canada), but did not. When compared only with rivers from Maine and Canada (White 2021a), the James River spring and fall runs both appear to be unique but can be further separated from each other when compared to one another (Balazik 2017; White 2021a). This analysis shows that the York River population (and Nanticoke River population, which appear to form an upper Chesapeake Bay metapopulation [J. Kahn, NMFS, unpublished data]) is significantly different from the two James River populations at the most basic level of comparison.

Considerable advances have been made in understanding the abundance of each of these populations. There are no estimates of abundance for any life stage in the James River. The York River has estimates of adult abundance on spawning runs from 2014 through 2019 (Table 3). Census estimates of adult Atlantic sturgeon on spawning runs in the Nanticoke River in 2020 and 2021 are 36 (25-55) and Coleman (2024) estimated the Nanticoke River adult spawning run abundance is up to approximately 70 individuals. Effective population size of the James River (as a single spawning population) was estimated from 116 samples to be 32 (28.8-35.5; Waldman (2019) and White (2021a) assessed the James River spring (n = 45) and fall (n = 131) spawning adults separately and identified effective population sizes of 24.7 (21-29.4) and 85.5 (61.1-127.5), respectively. The lone effective population estimate for the York River (n = 203) is 9.3 (6.9-11.8; (White 2021a) and for the Nanticoke River (n = 32) is 12.2 (6.7-21.9; (Secor 2022).

Table 3. Estimated abundance of spawning runs in the Pamunkey River, the primary spawning tributary of the York River, derived from a model relying on capture probability (Kahn et al. 2021) and a mark recapture heterogeneity model (Kahn et al. 2019)

Year	Male*	Female*	Spawning abundance*	95% CL*	Jackknife model**	95% CL†
2014	117	41	158	127-189	152	115-215
2015	125	68	192	154-230	182	145-243
2016	112	38	149	120-179	219	166-298
2017	150	68	218	175-260	215	167-292

2018	92	30	122	98-145	154	112-222
2019	153	86	239	192-286	330	257-434

*estimates from Kahn (2021), **estimates from (Kahn 2019b); jackknife is a statistical cross-validation technique using resampling, useful for variance estimation

Several recent survival estimates have been produced. At the DPS level, the Chesapeake Bay DPS is estimated to have an apparent annual survival of approximately 88% (95% CL, 46-99%; ASMFC 2017). A recent estimate for adult York River Atlantic sturgeon by Kahn (2023) shows much higher survival than other estimates with an annual apparent survival of 99.2% (97.9-99.7%). Kahn (2023) estimate was higher because it accounted for different detection probabilities between sexes and identified tag loss rates of 12.8% through concurrent mark recapture research.

Oceanic distribution of the Chesapeake Bay DPS is best known from the analysis by Kazyak (2021a). This is the same information as presented for the New York Bight DPS because both populations occupy waters between Cape Hatteras and Cape Cod. Rothermel (2020), like Ingram (2019), noted an inshore movement in the spring and offshore movement in the fall and winter. And, like Breece (2018) observed, Atlantic sturgeon appear to prefer warmer, shallower water while residing offshore.

A recovery outline was produced for Atlantic sturgeon (NMFS 1998). The goal for recovery is to have reproductive populations across their historic range of sufficient size and diversity to support reproduction and recovery from mortality events. The invasive blue catfish has become a more notable threat to native fish in the Chesapeake Bay region. A recent analysis of stomach contents reveals that 22 of 560 fish sampled (4%) comprising 27 species consumed Atlantic sturgeon during the fall spawning period (Bunch 2021). The primary consumers of Atlantic sturgeon were striped bass (1 of 8 guts, 12.5%), carp (6 of 52 guts, 11.5%), and blue catfish (8 of 131 guts, 6%). No hard parts were present and the assumption is that the Atlantic sturgeon DNA was either from eggs or larvae that were quickly digested (Bunch 2021).

6.1.2.4 *Carolina DPS*

The Carolina DPS was listed as endangered under the ESA on February 6, 2012. The Carolina DPS ranges from the Albemarle Sound to the Santee-Cooper River and consists of seven extant subpopulations; one subpopulation (Sampit) is believed to be extirpated. The Carolina DPS is likely the least studied. Spawning likely occurs in the Roanoke, Tar/Pamlico, Neuse, Cape Fear, Pee Dee, Santee, and Cooper Rivers. Census abundance is not available for any system. The effective population size of juveniles collected in the Albemarle Sound is approximately 19 (95% CL, 16.5-20.6; n = 88; Waldman et al. 2019) to 29.5 (24.2-36.3; n = 71; White et al. 2021a). There is also a new effective population size estimate for the Pee Dee River spring (n = 66) and fall (n = 50) spawning runs, amounting to 13.5 (11.9-15.3) and 82 (60.3-122.1), respectively (White 2021a; White 2021b). Also, updating Hightower (2015), the ASMFC (2017a) produced an updated survival estimate for the entire Carolina DPS, suggesting Atlantic sturgeon survival rates are approximately 78% (95% CL, 39-99%).

Relatedness of known spawning populations was also assessed for the Carolina DPS, both in terms of its relationships to other populations outside of the DPS and within. Once the York River is isolated as being unique and different from all other southeastern populations, those populations then break into two groups with a bit of overlap. One group is the Albemarle Complex, Pee Dee spring run, Pee Dee fall run, Edisto spring run, Ogeechee spring run, and Satilla river populations while the other group is the Albemarle Complex, Pee Dee fall run, Edisto fall run, Savannah, Ogeechee fall run, and Altamaha populations (White 2021a). When compared amongst each other further, those groupings break out into the Albemarle Complex, Pee Dee spring run, and Pee Dee fall run separate from the rest of the southeastern rivers (White 2021a).

As mentioned in the discussion of the New York Bight DPS sturgeon distribution, the Carolina DPS made up 30.7% of detections between Cape Cod and Cape Hatteras. This DPS also makes up 6.2% of detections south of Cape Hatteras (Kazyak 2021a). From Cape Cod to Florida, Carolina DPS fish were most likely to be encountered in nearshore waters. Rulifson (2020), relying on acoustic telemetry, showed that, similar to what has been documented for New York Bight and Chesapeake Bay DPS fish, Carolina DPS sturgeon move inshore and offshore seasonally. The greatest number of detections along the North Carolina Atlantic Coast occur from November to April (Rulifson 2020). The Stock Assessment estimated the mean survival rates of 78%, 33%, and 72% for all acoustically tagged fish, acoustically tagged adults, and acoustically tagged juveniles from the Carolina DPS, respectively. The ASMFC also concluded it was relatively likely (75% probability) that mortality for the Carolina DPS exceeds the mortality threshold used for the Stock Assessment (ASMFC 2017a).

6.1.2.5 *South Atlantic DPS*

The South Atlantic DPS was listed as endangered under the ESA on February 6, 2012. This DPS historically supported eight spawning subpopulations but currently supports five extant spawning subpopulations (ASSRT 2007). At the time of listing only six spawning subpopulations were believed to have existed: the Combahee River; Edisto River; Savannah River; Ogeechee River; Altamaha River (including the Oconee and Ocmulgee tributaries); and Satilla River. Of these subpopulations, the Altamaha and Ashepoo, Combahee, and Edisto (ACE) Basin support the largest number of spawning adults, and are considered the second and third largest Atlantic sturgeon subpopulations within the United States, respectively

The Edisto and Ogeechee Rivers appear to have a spring and a fall run (White 2021a). When exploring the possibility of spring and fall spawning migrations, without any knowledge of the reproductive condition of the individuals, Vine (2019)identified temperature as a primary driver of upriver movement in both the spring and fall. In the spring, Atlantic sturgeon moved upriver as temperatures increased between 11 and 15 °C and in the fall, as temperatures were descending, between 29 and 24 °C (Vine 2019). For Atlantic sturgeon, discharge did not influence upriver movement (Vine 2019).

In 2017, the Atlantic States Marine Fisheries Commission (ASMFC) completed an Atlantic Sturgeon Benchmark Stock Assessment ASMFC (2017a). The purpose of the assessment was to evaluate the status of Atlantic sturgeon along the U.S. Atlantic coast (ASMFC 2017a). The assessment considered the status of each DPS individually, as well as all five DPSs collectively as a single unit. The assessment determined the South Atlantic DPS abundance is "depleted" relative to historical levels. The assessment concluded there was not enough information available to assess the abundance of the DPS since the implementation of the 1998 fishing moratorium. However, it did conclude there was 40% probability the South Atlantic DPS is still subjected to mortality levels higher than determined acceptable in the 2017 assessment. The assessment also estimated effective population sizes (N_e) when possible. Effective population size is generally considered to be the number of individuals that contribute offspring to the next generation. More specifically, based on genetic differences between animals in a given year, or over a given period of time, researchers can estimate the number of adults needed to produce that level of genetic diversity. For the South Atlantic DPS, the assessment reported N_e for the Edisto, Savannah, Ogeechee, and Altamaha rivers (Table 4). Additional estimates of N_e have been conducted since the completion of the assessment, including for additional river systems; Table 4 reports those estimates. White (2021b) cautions that, because the populations they considered were sampled at varying temporal scales and intensities and represented a mixture of single and mixed-cohort samples, the N_e estimates they report should be interpreted with reservation as they technically represent a value between true N_e and the effective number of breeders. They also state that, while their estimates are valuable for comparing the general magnitude of difference among populations, they should not be used to make inferences about long-term population viability (White 2021b).

Table 4. Available Estimates of Effective Population Sizes in the Rivers of the South Atlantic DPS

River	Effective Population Size (N_e) (95% CI)	Sample Size	Collection Years	Reference
Edisto	55.4 (36.8-90.6)	109	1996-2005	ASMFC (2017a)
	Fall Run – 48.0 (44.7-51.5)	1,154	1996-2004	Farrae (2017)
	Fall Run (82 (60.3-122.1)	373	1996, 1998, 2001-2003, 2005	White (2021b)
	Spring Run – 13.3 (12.1-14.6)	198	1998, 2003	Farrae (2017)
	Spring Run – 16.4 (12.8-20.6)	123	1998, 2003	White (2021b)
	60.0 (51.9-69.0)	145	1996, 1998, 2005	Waldman (2018)
Savannah	126.5 (88.1-205)	98	2000-2013	ASMFC (2017b)
	123 (103.1-149.4)	161	2013, 2014, 2017	Waldman (2018)
	154.5 (99.6-287.7)	134	2000, 2007, 2208, 2013, 2017, 2018	White (2021b)
Ogeechee	32.2 (26.9-38.8)	115	2003-2015	ASMFC (2017a)
	26 23.9–28.2	200	2007-2009, 2014-2017	Waldman (2018)
	23.9 (22.2-25.7)	197	2007-2009, 2014-2017	Fox (2019a)
	Spring Run – 31.1 (24.3-40.2)	92	2003, 2007, 2009, 2014, 2015, 2016	White (2021b)
	Fall Run – 56.5 (36.3-103.6)	55	2003, 2004, 2008, 2009, 2015, 2016	White (2021b)
	111.9 (67.5-216.3)	186	2005-2015	ASMFC (2017a)

River	Effective Population Size (N_e) (95% CI)	Sample Size	Collection Years	Reference
Altamaha	149 (128.7–174.3)	245	2005, 2011, 2014, 2016-2017	Waldman (2018)
	142.1 (124.2-164.0)	268	2005, 2011, 2014-2017	Fox (2019a)
	141.7 (73.4-399)	189	2005, 2010, 2011, 2018	White (2021b)
Satilla	21 (18.7–23.2)	68	2015-2016	Waldman (2018)
	11.4 (9.1-13.9)	74	2010, 2014, 2016	White (2021b)
St. Marys	1 (1.3–2.0)	14	2014-2015	Waldman (2018)

Generally, a minimum N_e of 100 individuals is considered the threshold required to limit the loss in total fitness from in-breeding depression to <10%; while an N_e greater than 1,000 is the recommended minimum to maintain evolutionary potential (ASMFC 2017a; Frankham 2014). Effective population size is useful for defining abundance levels where populations are at risk of loss of genetic fitness (ASMFC 2017a). While not inclusive of all the spawning rivers in the South Atlantic DPS, the population estimates reported in Table 4 suggest there is a risk for inbreeding depression ($N_e < 100$) in four of those rivers (Edisto, Ogeechee, Satilla, and St. Marys rivers) and loss of evolutionary potential ($N_e < 1000$) in all six. This information suggests there at least some inbreeding depression within the DPS and loss of evolutionary potential throughout all of it. However, White (2021b), stated that while historic comparisons are currently not available, all 18 populations surveyed showed reasonably high levels of contemporary genetic diversity and low inbreeding despite relatively recent and severe demographic bottleneck events.

A census estimate was produced for the upper 20 km of the Savannah River (river kilometers 281-301) to estimate the number of purported spawning adults in that stretch on a given day over 50 sampling occasions. The maximum estimate of daily abundance in those 20 km was 35 to 55 adults of unknown sex (Vine 2019). Effective population estimates were also produced for many rivers in the South Atlantic DPS. The Edisto River (n = 145) was estimated to have an effective population of 60 (95% CL, 51.9-69.0; (Waldman 2019), but was broken into two spawning populations by (White 2021b) following the identification of two distinct spawning groups (Farrae et al. 2017) for estimates of a spring run (n = 123) of 16.4 (12.8-20.6) and a fall run (n = 373) of 47.9 (25.3-88.8). The Savannah River was estimated to have an effective population size (n = 161) of approximately 123 (103.1-149.4) and also (n = 134) of approximately 154.5 (99.6-287.7) by White (2021b) and Waldman (2019), respectively. The Ogeechee River (n = 200) was estimated to have an effective population of 26 (23.9-28.2; Waldman et al. 2019), but was also broken into two spawning populations by White (2021b) for estimates of a spring run (n = 92) of 31.1 (24.3-40.2) and a fall run (n = 55) of 56.5 (36.3-103.6). The Altamaha River appears to support the largest Atlantic sturgeon population in the South Atlantic DPS, and one of the largest on the East Coast, with effective population estimates of 149 (128.7-174.3; n = 245; (Waldman 2019) and 141.7 (73.4-399; n = 189; (White 2021b). The effective population estimates for the Satilla River population are 21 (18.7-23.2; n = 68; Waldman et al. 2019) and 11.4 (9.1-13.9; n = 74; White et al. 2021a). Work in the St. Marys River on the Florida-Georgia border captured 25 fish including 14 river resident juveniles. Analysis of those individuals reveals an effective population size of 1 (1.3-2.0), but this is a known under-estimate because those individuals were from a single spawning event (Fox 2018; Waldman 2019). The St. Johns River in Florida does not appear to support an extant population (Fox 2018). Survival within the entire DPS was estimated to be approximately 86% (54-99%; (ASMFC 2017a).

The relatedness of the populations reveals three groups of related clusters within this DPS. The first cluster includes the Edisto spring run, the Ogeechee Spring run, and the Satilla River populations; the second includes the Edisto River fall run and Ogeechee River fall run; and the third includes the largest populations of the Savannah and Altamaha Rivers, but also the Ogeechee River fall run (White 2021b). As was seen with other rivers with dual spawning populations, the spring and fall runs are genetically differentiated.

Kazyak (2021a) presented the first comprehensive mixed stock analysis of Atlantic sturgeon in the Southeast and confirmed that while Atlantic sturgeon are making long-distance migrations, stock composition is best assessed at a regional level. The mixed stock analysis identified relatively little mixing of stocks in the Southeast. Of the 513 samples assigned to the "South" region (Cape Hatteras, NC to FL) the most common DPS was South Atlantic (91.2%, n=468) followed by Carolina DPS (6.2%; n=32), with only 2.6% (n=13) of the samples originating from other DPSs (Kazyak 2021a).

South of Cape Hatteras, Kazyak (2021a) showed that 91.2% of fisheries bycatch was from the South Atlantic DPS. In terms of population level distribution and susceptibility to commercial fisheries, 35.7% were from the Altamaha River, 21.4% from the Edisto River fall-run, 18.9% from the Savannah River, 7.2% from the Ogeechee River (both spring and fall), 5.5% Satilla, 3.7% Pee Dee (both spring and fall), and 2.0% Edisto spring-run. In the south, most offshore fish were from the Altamaha, followed by the Savannah (Kazyak et al. 2021). Within river movement studies also revealed that age-1 fish that were tagged in the summer remained in the rivers and overwintered before out-migrating between December and March (Fox 2019b). When observing the likelihood of becoming a coastally wandering sub-adult or remaining a river resident for another year, Fox (2019b)found that 36.7% returned as age 2 fish while 30.4% out-migrated as age 2. The St. Johns River, the furthest south in the South Atlantic DPS, has periodic use by sub-adults and adults, but is no longer spawning or rearing habitat.

The viability of the South Atlantic DPS depends on having multiple self-sustaining riverine spawning populations and maintaining suitable habitat to support the various life functions (spawning, feeding, and growth) of Atlantic sturgeon populations. Because a DPS is a group of populations, the stability, viability, and persistence of individual populations affects the persistence and viability of the larger DPS. The loss of any population within a DPS will result in (1) a long-term gap in the range of the DPS that is unlikely to be recolonized, (2) loss of reproducing individuals, (3) loss of genetic biodiversity, (4) potential loss of unique haplotypes, (5) potential loss of adaptive traits, (6) reduction in total number, and (7) potential for loss of population source of recruits. The loss of a population will negatively impact the persistence and viability of the DPS as a whole, as fewer than two individuals per generation spawn outside their natal rivers (King 2001; Waldman 2002; Wirgin 2000). The persistence of individual populations, and in turn the DPS, depends on successful spawning and rearing within the freshwater habitat, the immigration into marine habitats to grow, and then the return of adults to natal rivers to spawn.

6.1.3 Climate change effects to Atlantic sturgeon

Information regarding the vulnerability of Atlantic sturgeon to climate change suggests it poses a greater threat to the Carolina DPS than what was anticipated when the DPS was listed in 2012. Ocean temperature in the U.S. Northeast Shelf and surrounding Northwest Atlantic waters has increased faster than the global average over the last decade (Pershing 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 (Saba 2016). Global climate change affects all components of marine ecosystems, including human communities. Physical changes that are occurring and will continue to occur to these systems include sea-level rise, changes in sediment deposition; changes in ocean circulation; increased frequency, intensity and duration of extreme climate events; changing ocean chemistry; and warming ocean temperatures. A first-of-its-kind climate vulnerability assessment, conducted on 82 fish and invertebrate species in the Northeast U.S. Shelf, concluded that Atlantic sturgeon from all five DPSs were among the most vulnerable species to global climate change (Hare 2016).

Increased water temperatures as a result of climate change could mean a decrease in the amount of DO in surface waters. Atlantic and shortnose sturgeon rely on a variety of water quality parameters to successfully carry out their life functions. Low DO and the presence of contaminants modify the quality of Atlantic sturgeon habitat and in some cases, restrict the extent of suitable habitat for life functions. Secor (1995) noted a correlation between low abundances of sturgeon during this century and decreasing water quality caused by increased nutrient loading and increased spatial and temporal frequency of hypoxic (low oxygen) conditions. Of particular concern is the high occurrence of low DO coupled with high temperatures in the river systems throughout the range of the Carolina DPS in the Southeast. Sturgeon are more highly sensitive to low DO than other fish species and low DO in combination with high temperature is particularly problematic for Atlantic sturgeon. Studies have shown that juvenile Atlantic sturgeon experience lethal and sublethal (metabolic, growth, feeding) effects as DO drops and temperatures rise (Niklitschek 2005). Sturgeon are already susceptible to reduced water quality resulting from various factors: inputs of nutrients; contaminants from industrial activities and non-point sources; and interbasin transfers of water and climate change is likely exacerbating the challenges to sturgeon. Still, more information is needed to better determine the full and entire suite of past and ongoing impacts of climate change on sturgeon in the action area.

6.1.4 Recovery

A recovery outline for Atlantic sturgeon was developed in 2018. This outline is meant to serve as an interim guidance document to direct recovery efforts, including recovery planning, for the endangered New York Bight, Chesapeake Bay, Carolina, and South Atlantic distinct population segments (DPS) of the Atlantic sturgeon and the threatened Gulf of Maine DPS (77 FR 5880 and 77 FR 5914; February 6, 2012) until a full recovery plan is developed and approved.

For the Gulf of Maine, New York Bight, and Chesapeake Bay DPSs, historical spawning habitat is accessible in nearly all current and known historical spawning rivers. This is not the case for the Carolina and South Atlantic DPSs of Atlantic sturgeon. Within the range occupied by the Carolina DPS, dams have restricted Atlantic sturgeon spawning and juvenile developmental habitat by blocking over 60% of the historical sturgeon habitat upstream of the dams in the Cape

Fear and Santee-Cooper River systems. Dams also prevent access to the vast majority of historical spawning habitat on the Savannah River in the South Atlantic DPS.

The recovery vision for the Atlantic sturgeon is to ensure sub-populations making up all five Atlantic sturgeon DPSs must be present across the historical range. These subpopulations must be of sufficient size and genetic diversity to support successful reproduction and recovery from mortality events. The recruitment of juveniles to the sub-adult and adult life stages must also increase and that increased recruitment must be maintained over many years. Recovery of these DPSs will require conservation of the riverine and marine habitats used for spawning, development, foraging, and growth by abating threats to ensure a high probability of survival into the future.

The ASMFC completed an Atlantic Sturgeon Benchmark Stock Assessment in 2017 that considered the status of each DPS individually, as well as all 5 DPSs collectively as a single unit (ASMFC 2017a). The assessment concluded all five DPSs of Atlantic sturgeon, as well as each individual DPS remain depleted relative to historic abundance. The assessment also concluded that the population of all five DPSs together appears to be recovering slowly since implementation of a complete moratorium in 1998. However, while the survival estimates produced by the stock assessment were based on telemetry data, the conclusions that abundance was increasing was not supported by any underlying data. There was a relatively high probability that mortality for animals of the Gulf of Maine DPS and the Carolina DPS exceeded the mortality threshold used for the assessment. Kazyak (2021a) classified North Carolina and, therefore, the action area in the MID region, individual-based assignment tests suggested a highly mixed assemblage of Atlantic sturgeon from all five DPSs which included 14 populations from across the U.S. and Canada (the only population not represented in the sample was the Saint Lawrence). Individual-based assignment testing suggested 37.5% of individuals assigned to populations in the New York Bight DPS and 30.7% of individuals to populations in the Carolina DPS. At the population-level, the Albemarle Complex (27.3%) and Hudson River (26.2%) populations were the most prevalent specimen sampled in this region. However, all DPSs were represented in the samples collected. Kazyak (2021a) also observed differences in the stock composition of individuals captured in riverine/estuarine habitats versus offshore ($P < 0.001$ at both the population- and DPS-level). Of the individuals captured in the MID region in riverine/estuarine environments, 60.9% assigned to the Carolina DPS. Conversely, only 6.0% of individuals captured offshore assigned to the Carolina DPS, and individuals from the New York Bight (54.0%) and Chesapeake Bay DPSs (21.6%) were more prevalent. Results from the mixture analysis were similar and also suggested that samples collected offshore likely represented individuals from more populations and DPSs than samples collected in riverine/estuarine environments.

The recovery priority numbers for the Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs is 1C based on the Listing and Recovery Priority Guidelines (84 FR 18243, April 30, 2019). This number is based on the following criteria: demographic risk, recovery potential, and conflict. Demographic risk is “High” because of its productivity (i.e., relatively few adults compared to historical levels and irregular spawning success), abundance (i.e., riverine populations vary significantly and abundance is generally low in the DPS’, overall), and spatial distribution (i.e., riverine populations and connectivity vary, creating inconsistent population coverage across the DPSs and potentially limited ability to repopulate extirpated river populations). Meeting any one of these risk conditions ranks the DPSs as at high demographic risk. The DPSs potential to recover is, however, also “High” because man-made threats that have a major impact on the species’ ability to persist have been identified (e.g., bycatch in federally-managed fisheries, dams blocking access to spawning habitat, dredging, vessel strikes), the DPS’ response to those threats are well understood, management or protective actions to address major threats are primarily under U.S. jurisdiction or authority, and management or protective actions are technically feasible even if they require further testing (e.g., gear modifications to minimize dredge or fishing gear interactions). The DPSs are in conflict with construction and other developmental projects such as port deepening projects. Therefore, based on the Listing and Recovery Priority Guidelines (84 FR 18243, April 30, 2019), the recovery priority number for the Atlantic sturgeon DPSs is 1C, and is unchanged since listing and the last status review of Atlantic sturgeon.

6.2 Shortnose sturgeon

Detailed information on the status of shortnose sturgeon, including information on population structuring, taxonomy and life history, distribution and abundance, and threats throughout their range, can be found in the most recent Biological Assessment of Shortnose Sturgeon (SSSRT 2010), and the Recovery Plan (SSRT 1998).

6.2.1 Species Description and Distribution

Shortnose sturgeon was first listed under the Endangered Species Preservation Act on October 15, 1966 (32 FR 4001). When the ESA was signed into law in 1973, replacing the Endangered Species Preservation Act, shortnose sturgeon remained listed as endangered. Shortnose sturgeon occur along the Atlantic coast of North America from the Saint John River in Canada to the Saint Johns River in Florida (Figure 13).

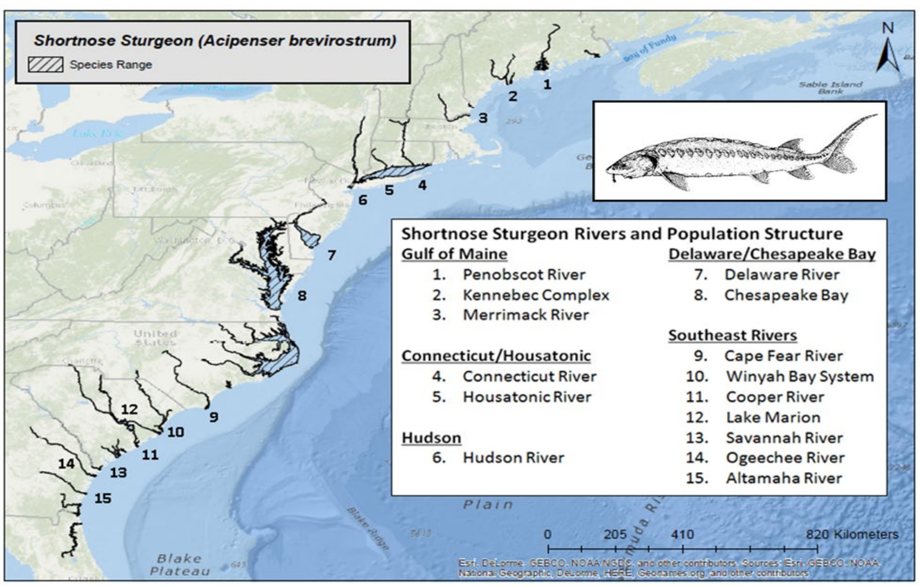
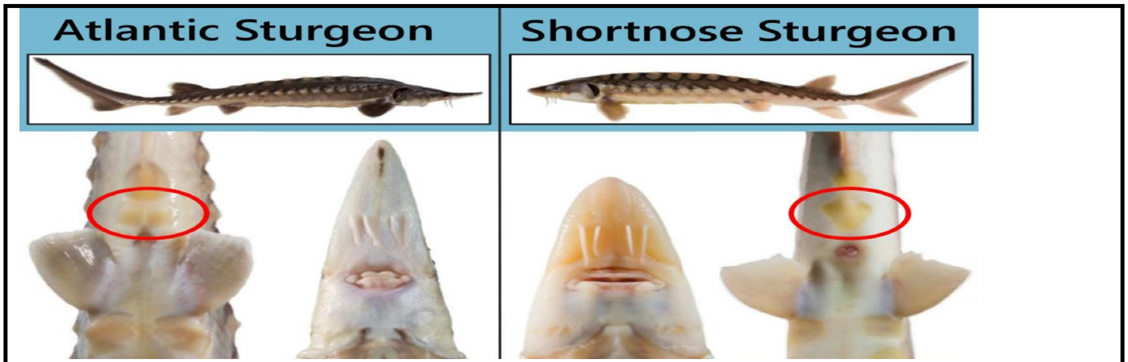


Figure 13. Geographic range of Shortnose Sturgeon



Characteristic	Atlantic Sturgeon *Acipenser oxyrinchus*	Shortnose Sturgeon *Acipenser brevirostrum*
Maximum length	> 9 feet	4 feet
Snout	Longer and more sharply pointed*	Shorter and blunter
Mouth	Mouth Width inside lips < 55% of bony interorbital width	Width inside lips > 62% of bony interorbital width
Bony plates	2-6 bony plates (at least pupil size) along base of anal fin	No row of bony plates along the base of anal fin
Habitat/Range	Anadromous; spawn in freshwater but primarily lead a marine existence	Anadromous; spawn at or above head-of-tide in most rivers. Aside from seasonal migrations to estuarine waters, rarely occurs in the marine environment
***Snout length and sharpness is less pronounced in older individuals**		

Figure 14. Shortnose Sturgeon and Atlantic Sturgeon comparison

6.2.2 General Status

Currently, shortnose sturgeon can be found in 41 bays and rivers along the U.S. East coast, but their distribution across this range is broken up, with a large gap of about 250 miles (400 km) separating the northern and mid-Atlantic metapopulations from the southern metapopulation (King 2014). Shortnose sturgeon spawning has been documented in several rivers across its range (including but not limited to: Kennebec River, Connecticut River, Hudson River, Delaware River, Pee Dee River, Savannah, Ogeechee, and Altamaha rivers; status for many other rivers remain unknown. Populations in the Kennebec, Hudson, Delaware, and Altamaha Rivers are relatively large and stable (Table 5). Populations in other rivers are smaller if they are still extant, with a large gap in their range through the mid-Atlantic region where little to no reproduction occurs from the Chesapeake Bay through Pamlico Sound. The Connecticut River population appears stable, though is adversely impacted by the presence of a series of dams separating optimal spawning habitat from optimal foraging habitat.

Table 5. Abundance estimates for shortnose sturgeon from all monitored rivers along the East Coast of the United States

River	Abundance	Citations
Kennebec	9,436	Wippelhauser (2015)
Androscoggin	3,000	Squiers (1993)
Merrimack	3,786	Santec Consulting Services 2023
Connecticut	1,500-1,800	Savoy (2003)
Hudson	61,000	Bain (2000)
Delaware	12,000	Brundage (2003)
Cape Fear	Unknown*	(SSSRT 2010)
Cooper	200	Cooke (2004)
Savannah	1,400-2,400	Bahr (2017)
Ogeechee	400	Peterson (2008)
Altamaha	6320	Peterson (2008)
Satilla	100	Peterson (2008)

*The current distribution and abundance of shortnose sturgeon in the Cape Fear River Estuary is unknown. No specimens have been encountered since 1997.(SSSRT 2010)

6.2.3 Critical Habitat

Critical habitat for shortnose sturgeon has not been designated.

6.2.4 Recovery

The long-term recovery objective for the shortnose sturgeon is to recover all populations to levels of abundance at which they no longer require protection under the ESA. Downlisting can be considered when all populations 1) are large enough to prevent extinction and 2) the loss of any one population will have minimal effect to the genetic diversity of the species.

This minimum abundance for each population segment has not yet been determined. Therefore, establishing endangered and threatened population size thresholds is a priority. To achieve and preserve minimum population sizes for each population segment, essential habitats must be identified and maintained, and mortality must be monitored and minimized. Accordingly, other key recovery tasks are to define essential habitat characteristics, assess mortality factors, and protect shortnose sturgeon through applicable Federal and state regulations.

6.3 Sea turtles

All sea turtle species occurring in the Atlantic Ocean are listed as either endangered or threatened under the ESA. Leatherback (endangered), hawksbill (endangered), Kemp's ridley (endangered), North and South Atlantic DPSs of green sea turtles (threatened) and Northwest Atlantic Ocean DPS of loggerhead sea turtles (threatened) are present in the action area and subject to capture in the NC fisheries. The species summaries in this section will focus on the Atlantic Ocean populations of these species, as these are the populations that may be affected by the proposed action. The following subsections are synopses of the best available information on the life history, distribution, population trends, current status, and threats of the six species and DPSs of sea turtles that are likely to be affected by one or more components of the action. A brief summary of the status of the species within U.S. Atlantic waters and in the action area is given below.

Sea turtles face numerous natural and man-made threats that shape their status and affect their ability to recover. Many of the threats are either the same or similar in nature for all listed sea turtle species including interactions with fisheries, construction and maintenance of navigation channels (dredging), coastal development, environmental contamination, climate change, and variety of other national and anthropogenic threats including predation, diseases, toxic blooms from algae and other microorganisms, and cold stunning. Additional detail about these threats is described in Section 7 Environmental Baseline and information specific to a particular species or DPS is discussed in the corresponding status sections where appropriate.

6.3.1 Climate change on Sea turtles

The IPCC (Shukla 2019) reports the following consequences of climate change on sea turtles with high confidence. Loss of sandy beaches, due to sea level rise and storm events, reduces available nesting habitat (Fuentes 2010 Katselidis et al. 2014, Patino-Martinez et al. 2014, Pike et al. 2015, Marshall et al. 2017). Storms, waves, and sea level rise are likely to increase erosion and sediment loss. Changes in beach morphology, dune scarping, vegetation loss, and reduction in beach area are likely to reduce availability of sea turtle nesting sites, and potential for landward migration of the beach profile is limited due to human development. Temperature directly affects important sea turtle life history traits, including: hatchling size, sex, viability, and performance (Hays 2003 Santos et al. 2017). One of the greatest concerns is the effect of temperature on hatchling emergence rates and sex ratios (Patrício 2017). Changes in ocean temperature indirectly impact sea turtles by altering the abundance and distribution of their prey (Sydeman 2015 Briscoe et al. 2017). Additionally, sea turtles require habitat associated with bathymetric and mesoscale features that aggregate their prey, and the persistence and location of these features are linked to variations in climate (Bjorndal 2017). The IPCC Shukla (2019) states with high confidence that climate change is likely to alter foraging success, juvenile recruitment, breeding phenology, growth rates, and population stability.

Climate change is expected to continue and may impact ESA-listed species and their habitat in the action area. The likely rate of change associated with climate impacts is on a century scale, which makes the ability to discern changes in the abundance, distribution, or behavior of listed species as a result of climate change impacts challenging in the short term.

6.3.2 Green sea turtle (North Atlantic and South Atlantic DPSs)

The green sea turtle was listed as threatened under the ESA on July 28, 1978, except for the Florida and Pacific coast of Mexico breeding populations, which were listed as endangered. On September 2, 1998, critical habitat for green sea turtles was designated in coastal waters surrounding Culebra Island, Puerto Rico (63 FR 46693). On April 6, 2016, NMFS and USFWS issued a final rule to list 11 DPSs of the green sea turtle (Figure 15). Three DPSs were listed as endangered and eight DPSs were listed as threatened (81 FR 20057). This rule superseded the 1978 final listing rule for green sea turtles and applied the existing protective regulations to the

DPSs. For the purposes of this analysis, only the North Atlantic DPS (NA DPS) and South Atlantic DPS (SA DPS) will be considered, as they are the only two DPSs with individuals occurring in the mid-Atlantic waters of the U.S. Only NA DPS nest in continental U.S., while both DPSs occur in the marine environment. Adults from the NA DPS and juveniles from both the NA and SA DPS occur in waters off the continental U.S. Within the continental U.S., individuals from both the NA and SA DPSs occupy foraging grounds. The listing of green turtle DPSs under the ESA in 2016 triggered the requirement to designate critical habitat to the maximum extent prudent and determinable (16 U.S.C. 1533(a)(3)(A)). Critical habitat cannot be designated within foreign countries or in areas outside the jurisdiction of the United States (50 CFR §424.12(g)). Therefore, we are required to designate critical habitat for those DPSs occurring in areas under U.S. jurisdiction, specifically the North Atlantic, South Atlantic, East Pacific, Central North Pacific, Central South Pacific, and Central West Pacific DPSs.

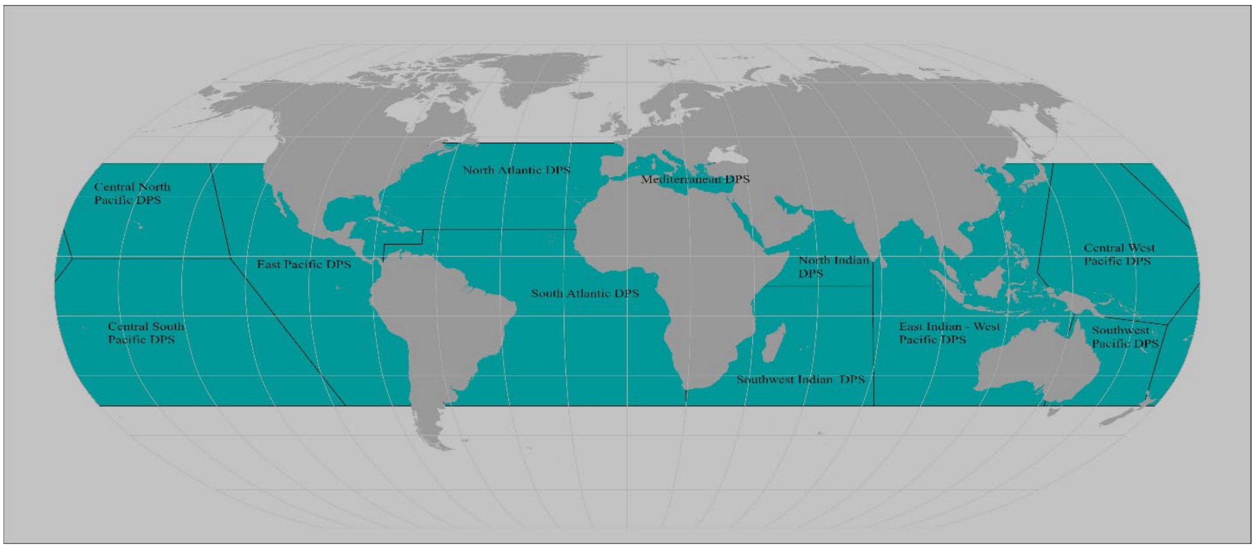


Figure 15 Map showing locations of the 11 distinct population segments of green sea turtles worldwide.

6.3.2.1 *Species Description and Distribution*

The green sea turtle has a circumglobal distribution, occurring throughout nearshore tropical, subtropical and, to a lesser extent, temperate waters. Adult turtles exhibit site fidelity and migrate hundreds to thousands of kilometers from nesting beaches to foraging areas. With the exception of post-hatchlings, green turtles live in coastal foraging grounds including open coastline and protected bays and lagoons. Oceanic habitats are used by oceanic-stage juveniles (post-hatchlings), migrating adults, and in some cases foraging juveniles and adults. Post-hatchlings feed close to the surface on a variety of marine algae and other life associated with drift lines and debris. Juvenile and adult green turtles feed primarily on seagrasses and algae, although they also consume jellyfish, sponges, and other invertebrate prey. Green sea turtles nest on sandy beaches of mainland shores, barrier islands, coral islands, and volcanic islands in more than 80 countries worldwide (Hirth 1997).

<u>North Atlantic DPS Distribution</u>: Green sea turtles from the NA DPS range from the boundary of South and Central America (7.5°N, 77°W) in the south, throughout the Caribbean, the Gulf of

Mexico, and the U.S. Atlantic coast to New Brunswick, Canada (48°N, 77°W) in the north. The range of the DPS then extends due east along latitudes 48°N and 19°N to the western coasts of Europe and Africa (Figure 13). In U.S. Atlantic and Gulf of Mexico waters, green sea turtles are distributed in inshore and nearshore waters from Texas to Massachusetts.

South Atlantic DPS Distribution: The range of the green sea turtle SA DPS begins at the border of Panama and Colombia at 7.5°N, 77°W, heads due north to 14°N, 77°W, then east to 14°N, 65.1°W, then north to 19°N, 65.1°W, and along 19°N latitude to Mauritania in Africa. The range extends along the coast of Africa to South Africa, with the southern border being 40°S latitude (Figure 13). The in-water range of the SA DPS is widespread and extends from the south Atlantic to North Atlantic Ocean.

6.3.2.2 *Genetic Diversity*

North Atlantic DPS: The NA DPS has a globally unique haplotype, which was a factor in defining the discreteness of the population for the DPS. Evidence from mitochondrial DNA studies indicates that there are at least four independent nesting subpopulations in Florida, Cuba, Mexico, and Costa Rica (Seminoff 2015). More recent genetic analysis indicates that designating a new western Gulf of Mexico management unit might be appropriate (Shamblin 2015).

South Atlantic DPS: Individuals from nesting sites in Brazil, Ascension Island, and western Africa have a shared haplotype found in high frequencies. Green turtles from rookeries in the eastern Caribbean however, are dominated by a different haplotype.

Within U.S. waters individuals from both the NA and SA DPSs can be found on foraging grounds. Genetic analyses of juvenile green sea turtles captured in inshore estuarine pound nets in NC indicated that 93% are from the NA DPS and 7% are from the SA DPS (Bass 2006).

6.3.2.3 *Life History Information*

Estimates of age at first reproduction for female green sea turtles range widely depending on population from 15-50 years (Avens 2013; Seminoff 2015). Females lay an average of three nests per season with an average of 100 eggs per nest and have a remigration interval of two to five years (Hirth 1997). Nesting occurs primarily on beaches with intact dune structure, native vegetation and appropriate incubation temperatures during summer months. After emerging from the nest, post-hatchling begin an oceanic juvenile phase. Oceanic-stage juvenile green turtles originating from nesting beaches in the Northwest Atlantic appear to use oceanic developmental habitats and move with the predominant ocean gyres for several years before returning to their neritic foraging and nesting habitats (Bolten 2003; Musick 2017; Tucker 1998). Most green turtles exhibit particularly slow growth rates, which has been described as a consequence of their largely herbivorous (*i.e.*, low net energy) diet (Bjorndal 1983). Growth rates of juveniles vary substantially among populations, ranging from <1 cm/year to >5 cm/year (Eguchi 2012).

6.3.2.4 *Status and Population Dynamics*

6.3.2.5 *North Atlantic DPS*

Compared to other DPSs, the NA DPS exhibits the highest nester abundance, with approximately 167,424 females at 73 nesting sites, and available data indicate an increasing trend in nesting.

(Seminoff 2015). The largest nesting site in the NA DPS is in Tortuguero, Costa Rica, which hosts 79% of nesting females for the DPS (Seminoff 2015). There are no reliable estimates of population growth rate for the DPS as a whole, but estimates have been developed at a localized level. In the continental US, green sea turtle nesting occurs along the Atlantic coast, primarily along the central and southeast coast of Florida. Modeling by Chaloupka et al. (Chaloupka 2008) using data sets of 25 years or more show the Florida nesting stock at the Archie Carr National Wildlife Refuge growing at an annual rate of 13.9%, and the Tortuguero, Costa Rica, population growing at 4.9%. According to data collected from Florida's index nesting beach survey from 1989-2021, green sea turtle nest counts across Florida have increased dramatically, from a low of 267 in the early 1990s to a high of 40,911 in 2019. Green sea turtle nesting is also documented annually on beaches of NC, South Carolina, and Georgia, though nesting is found in low quantities (up to tens of nests: nesting databases maintained on www.seaturtle.org).

6.3.2.6 *South Atlantic DPS*

The SA DPS has 51 nesting sites, with an estimated nester abundance of 63,332. More than half of the 51 identified nesting sites (37) did not have sufficient data to estimate the number of nesters or trends (Seminoff 2015). The largest nesting site is at Poilão, Guinea-Bissau, which hosts 46% of nesting females for the DPS (Seminoff 2015). Of the nesting sites where data are available, such as Ascension Island, Suriname, Brazil, Venezuela, Equatorial Guinea, and Guinea-Bissau, there is some evidence that population abundance is stable or increasing. NMFS reported the population trend for the NA DPS to be mixed in the most recent Report to Congress (NMFS 2023c).

6.3.2.7 *Threats*

The principal cause of past declines and extirpations of green sea turtles has been the overexploitation of the species for food and other products. Although intentional take of green sea turtles and their eggs is not extensive within the southeastern U.S., green sea turtles that nest and forage in the region may spend large portions of their life cycle outside the region and outside U.S. jurisdiction, where exploitation is still a threat in some areas. In addition to general threats to all sea turtles, green sea turtles are particularly susceptible to mortality from Fibropapillomatosis (FP) disease. FP results in the growth of tumors on soft external tissues (flippers, neck, tail, etc.), the carapace, the eyes, the mouth, and internal organs (gastrointestinal tract, heart, lungs, etc.) of turtles (Aguirre 2002; Herbst 1994; Jacobson 1989) Presently, FP is cosmopolitan, but has been found to affect large numbers of animals in specific areas, including Hawaii and Florida. Green sea turtles are also susceptible to cold-stunning. As temperatures fall below 8°-10°C, turtles may lose their ability to swim and dive, often floating to the surface. The rate of cooling that precipitates cold-stunning appears to be the primary threat, rather than the water temperature itself (Milton 2003). Sea turtles that overwinter in inshore waters, or are unable to leave these waters prior to temperature decreases, are most susceptible to cold-stunning because temperature changes are most rapid in shallow water (Witherington 1989).

6.3.2.8 *Recovery Goals*

A recovery plan, with associated recovery criteria, has yet to be developed for the NA and SA DPSs. To identify the EFs essential to the conservation of the NA and SA DPSs, we referenced the Recovery Plan for the U.S. Population of the Atlantic Green Turtle (NMFS 1991), which includes the NA and SA DPSs within U.S. jurisdiction and identifies the following recovery criteria to delist the species (i.e., the goal of the plan):

- The level of nesting in Florida has increased to an average of 5,000 nests per year for at least 6 years
- At least 25% (105 km) of all available nesting beaches (420 km) is in public ownership and encompasses greater than 50% of the nesting activity
- A reduction in stage class mortality is reflected in higher counts of individuals on foraging grounds
- All priority one tasks have been successfully implemented

To achieve these criteria, the plan indicates a need to protect and manage nesting habitat from the following terrestrial threats: beach erosion, coastal development (including beach armoring, re-nourishment, and cleaning), artificial lighting, recreational beach use (including beach driving), non-native vegetation, nest predation, storm events, pollution (including beach oiling and marine debris that washes ashore), and poaching. Recovery also requires protection of marine habitat, as follows:

> "Available sea turtle habitat has been significantly reduced over the past century. Among the factors contributing to this loss of habitat are coastal development and industrialization, increased commercial and recreational vessel activities, river and estuarine pollution, channelization, offshore oil and gas development, and commercial fishing activities. If present trends continue the cumulative loss of suitable habitat could reduce the likelihood of recovery of the species" (NMFS 1991).

The plan identifies the following activities needed to protect marine habitat:

1. Identify important habitat, including foraging habitat and habitat requirements of specific age/size/sex classes. This includes the pelagic habitat of post-hatchling and small juvenile turtles (e.g., *Sargassum*-dominated drift communities).
2. Prevent degradation (due to contamination and/or loss of food sources) and improve water quality (resulting from industrial pollution, channel dredging and maintenance, harbor activities, farm runoff, sewage disposal, etc.) of important turtle habitat
3. Prevent destruction of habitat (e.g., coral reefs, seagrass beds, sponges, and other live bottom habitats) from fishing gears and vessel anchoring
4. Prevent destruction of marine habitat from oil and gas activities; of particular concern are impacts, of oil spills, drilling mud disposal, disposal of other toxic materials, pipeline networks associated with oil and gas fields, onshore production facilities, increased vessel traffic, domestic garbage disposal, and explosive removal of obsolete platforms
5. Prevent destruction of marine habitat from dredging activities

6. Restore and limit further development in important foraging habitats (e.g., seagrass beds, which are relatively fragile habitats requiring low energy and low turbidity waters).

6.3.3 Kemp's ridley sea turtle

The Kemp's ridley sea turtle was listed as endangered on December 2, 1970 (35 FR 8491), under the Endangered Species Conservation Act of 1969, a precursor to the ESA. When the ESA was signed into law in 1973, the Kemp's ridley remained listed as endangered.

6.3.3.1 *Species Description and Distribution*

Kemp's ridley range from the Gulf of Mexico to the northwest Atlantic Ocean, as far north as the Grand Banks (Márquez 2001; Watson 2001) and Nova Scotia (Bleakney 1955) as shown in Figure 16. Kemp's ridley habitat includes sandy and muddy areas in shallow, nearshore waters, although they can also be found in deeper offshore waters during early life stages and migration. These areas support their primary prey species, which consist of swimming crabs, but may also include fish, jellyfish, and an array of mollusks. Pelagic stage turtles rely on the array of prey items associated with floating Sargassum habitat. Kemp's ridley use relatively shallow corridors to migrate between these foraging areas to nesting beaches. Most nesting occurs in Tamaulipas, Mexico, however in the U.S., Kemp's ridley are known to nest from Texas to NC.

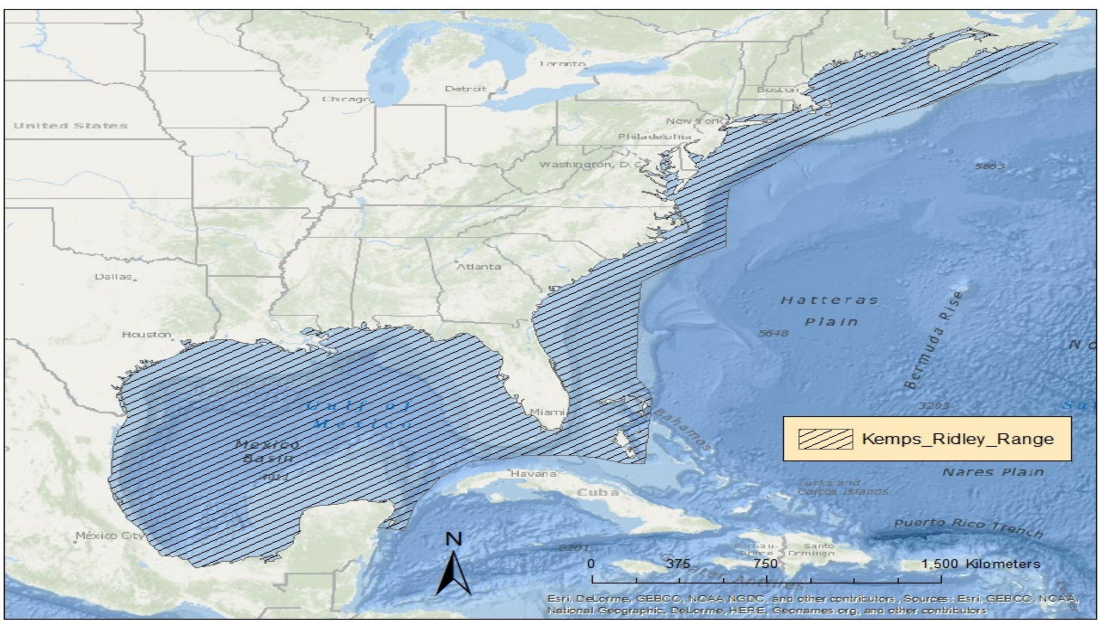


Figure 16. Map identifying the range of the endangered Kemp's ridley sea turtle

6.3.3.2 *Life History*

Estimates of age to sexual maturity for Kemp's ridley sea turtles ranges greatly from 5-18 years. (NMFS 2015) determined the best available point estimate of age to maturity for Kemp's ridley sea turtles was 12 years. The period between nesting seasons for each female is approximately 1.8 to 2.0 years (Marquez 1989; Rostal 2007; TEWG 2000). Nesting generally occurs from April to July. Females lay approximately 2.5 nests per season with each nest containing 95-112 eggs.

After hatching, pelagic post-hatchling and juveniles spend approximately 2 years in the ocean prior to recruiting to nearshore waters.

The nesting beach at Rancho Nuevo may produce a "natural" hatchling sex ratio that is female-biased, which can potentially increase egg production as those turtles reach sexual maturity (Coyne 2007; Wibbels 2007). There are an estimated 10,987 nests and 519,000 hatchlings released from three primary nesting beaches in Mexico (Phillips 2021a). The number of nests in Padre Island, Texas has increased over the past two decades (NMFS 2015).

6.3.3.3 *Status and Population Dynamics*

Of the species of sea turtles in the world, the Kemp's ridley has declined to the lowest abundance. When nesting aggregations at Rancho Nuevo were discovered in 1947, adult female populations were estimated to be in excess of 40,000 individuals (Hildebrand 1963). By the mid-1980s, however, nesting numbers from Rancho Nuevo and adjacent Mexican beaches were below 1,000, with a low of 702 nests in 1985. Nesting steadily increased through the 1990s, and then accelerated during the first decade of the twenty-first century (Figure 17). Following a significant, unexplained 1-year decline in 2010, Kemp's ridley nests in Mexico reached 21,797 in 2012 (Zoo 2013). From 2013 through 2014, there was a second significant decline in Mexico. More recent data in Mexico indicate similar fluctuations in the number of nests with periods of low and high nesting. Nesting in Texas has paralleled the trends observed in Mexico, however over the long term, nesting has increased in Texas from 1 reported nest in 1985 to over 200 in 2020. At this time, it is unclear whether the increases and decreases in nesting seen over the past decade represents a population oscillating around an equilibrium point or if nesting will increase or decrease in the future. Given these uncertainties, NMFS reported the population trend for Kemp's ridley sea turtle as unknown in the most recent Report to Congress (NMFS 2022e).

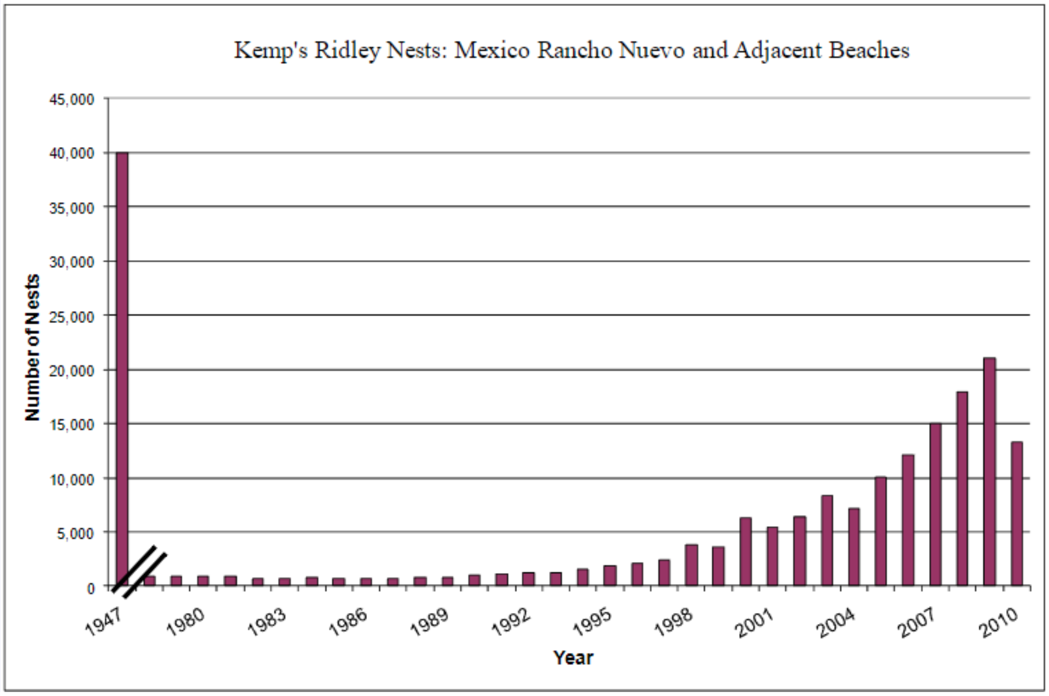


Figure 17 Number of Kemp's ridley nests in Mexico and south Texas.

6.3.3.4 *Threats*

The Kemp's ridley sea turtle was listed as endangered in response to a severe population decline, primarily the result of egg collection. Because the Kemp's ridley has one primary nesting beach, this species is particularly susceptible to habitat destruction by natural (e.g., hurricanes) and human caused events (NMFS 2015). Human caused threats include the potential for oil spills, especially in the Gulf of Mexico since it is an area of high-density offshore oil exploration and extraction. Kemp's ridley populations were impacted by the Deepwater Horizon oil spill in which pelagic/oceanic juvenile Kemp's ridley were the most common species encountered (McDonald 2017). Bycatch of Kemp's ridley in fisheries is a major threat to Kemp's ridley. Kemp's ridley are incidentally captured in fisheries using trawls, gill nets and hook and line occur throughout the northwest Atlantic Ocean and Gulf of Mexico and were reported to have the highest interaction with fisheries operating in these fisheries of any species (Finkbeiner 2011; Wallace 2013).

6.3.3.5 *Critical Habitat*

No critical habitat has been designated for Kemp's ridley sea turtles.

6.3.3.6 *Recovery*

In 1991, a recovery plan was developed to recover and protect Kemp's ridley turtle populations in the U.S. Caribbean, Atlantic Ocean, and Gulf of Mexico. Subsequently in 2011 a Bi-national (U.S. and Mexico) recovery plan for the Kemp's Ridley sea turtle was developed. The highest priority needs for Kemp's ridley recovery are to maintain and strengthen the conservation efforts that have proven successful. On the nesting beaches, this includes reinforcing habitat protection efforts, protecting nesting females, and maintaining or increasing hatchling production levels. In the water, successful conservation efforts include maintaining the use of TEDs in fisheries currently required to use them, expanding TED-use to all trawl fisheries of concern, and reducing mortality in gill net fisheries. Adequate enforcement in both the terrestrial and marine environment also is essential to meeting recovery goals. (NMFS 2011a)

6.3.4 Hawksbill sea turtle

The hawksbill sea turtle was listed as endangered throughout its entire range on June 2, 1970 (35 FR 8491) under the Endangered Species Conservation Act of 1969, a precursor to the ESA. When the ESA was signed into law in 1973, replacing the Endangered Species Preservation Act, the hawksbill remained listed as endangered.

Additional detailed information on the status of hawksbill sea turtles, including information on population structuring, taxonomy and life history, distribution and abundance, and threats throughout their range, can be found in the hawksbill 5-year review (USFWS 2013), the Recovery Plan (USFWS 1993).

6.3.4.1 *Species Description and Distribution*

Hawksbills have a circumglobal distribution throughout tropical and, to a lesser extent, subtropical waters of the Atlantic, Indian, and Pacific Oceans (Figure 18). In their oceanic phase, juvenile hawksbills can be found in *Sargassum* mats; post-oceanic hawksbills may occupy a range of habitats that include coral reefs or other hard bottom habitats, sea grass, algal beds, mangrove bays and creeks (Bjorndal 2009; Musick 2017). They are highly migratory and use a wide range of habitats during their lifetimes (Musick 2017; Plotkin 2002; Tucker 1998). Hawksbills nest on sandy beaches throughout the tropics and subtropics and are capable of migrating long distances between nesting beaches and foraging areas (USFWS 2013). Satellite tagged turtles have shown significant variation in movement and migration patterns. Distance traveled between nesting and foraging locations range from a few hundred to a few thousand kilometers (Horrocks 2011; Miller 1998).

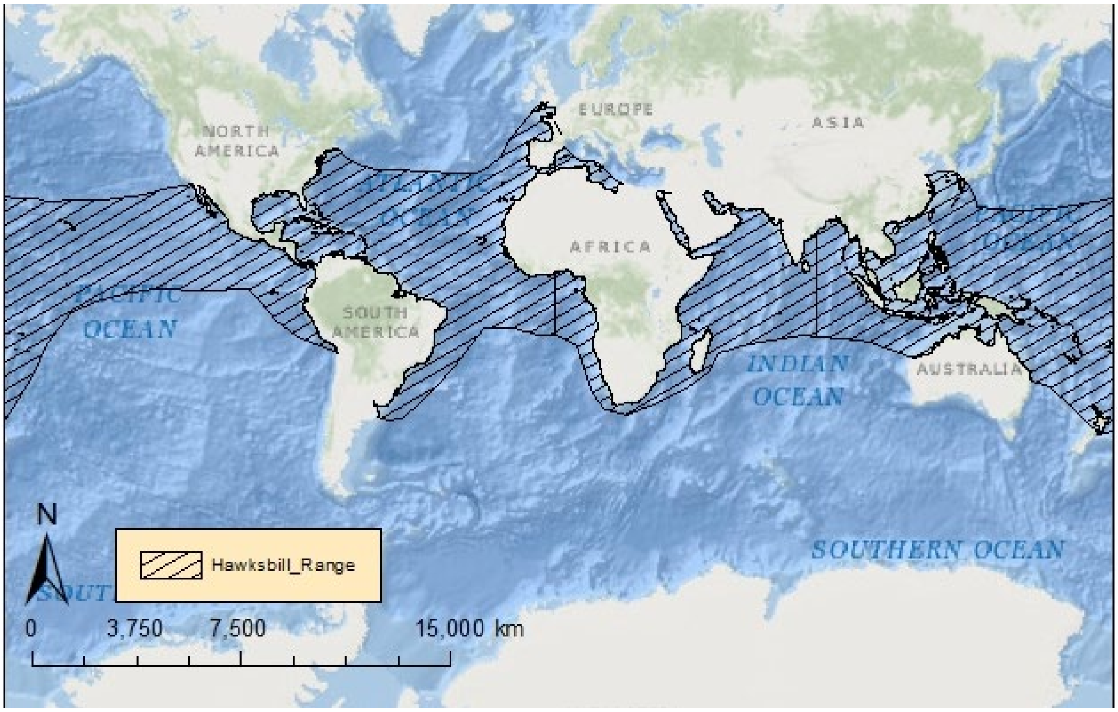


Figure 18. Map identifying the range of the endangered hawksbill turtle

6.3.4.2 *Life History Information*

Age to maturity for the species is also long, taking between 20 and 40 years, depending on the region (Miller 1998; Musick 2017). On average, female hawksbills return to nest on the beaches where they were born (natal beaches) every 2-5 years (remigration interval) (USFWS 2013), lay 3-5 nests per season (Mortimer 1999; Richardson 1999), and 130 eggs per nest (Witzell 1983). Hatchlings migrate to and remain in pelagic habitats until they reach approximately 22-25 cm in SCL and return to coastal foraging areas as juveniles.

6.3.4.3 *Status and Population Dynamics*

Very little long-term trend data exist for abundance of hawksbills at foraging sites, primarily because these data are logistically difficult and relatively expensive to obtain. Therefore, the primary information source for evaluating trends in global hawksbill populations is nesting beach data. Surveys at 88 nesting assemblages among 10 ocean regions worldwide indicate that 22,004-29,035 females nest annually (USFWS 2013). Among the 63 sites for which historic trends could be assessed, all 63 (100%) showed a decline during the long-term period of > 20 to 100 years. Among the 41 sites for which recent trend data are available, 10 (24%) are increasing, 3 (7%) are stable, and 28 (68%) are decreasing (USFWS 2013). Although greatly depleted from historic levels, nesting populations in the Atlantic Ocean in general are doing better than in the Indo-Pacific, where despite greater overall abundance, a greater proportion of the nesting sites are declining.

Along the east coast of the US, hawksbills are rarely observed north of Florida, however they have been observed as far north as Massachusetts. Nesting sites in the Atlantic Ocean basin occur in Florida, the insular Caribbean, Western Caribbean mainland, Southwestern Atlantic (Brazil), and Eastern Atlantic (USFWS 2013). Forty years of monitoring hawksbill sea turtles in the Gulf of Mexico indicates an increase in abundance (Lasala et al. 2023). Surveys at 33 nesting assemblages in the Atlantic Ocean indicate that 3,626-6,108 females nest annually (USFWS 2013). Of these sites, recent (<20 years) abundance data indicate 10 have increasing trends, 10 sites showing decreasing trends, and 13 sites lack enough information to assess trends.

6.3.4.4 *Threats*

The greatest threats to hawksbill sea turtles are overharvesting of turtles and eggs, degradation of nesting habitat, and fisheries interactions. Adult hawksbills are harvested for their meat and carapace, which is sold as tortoiseshell. Eggs are taken at high levels, especially in Southeast Asia where collection approaches 100%in some areas. In addition, lights on or adjacent to nesting beaches are often fatal to emerging hatchlings and alters the behavior of nesting adults. Due to their preference to feed on sponges associated with coral reefs, hawksbills are particularly sensitive to losses of coral reef habitat. Coral reefs are vulnerable to destruction and degradation caused by human activities (*e.g.*, nutrient pollution, sedimentation, contaminant spills, vessel groundings and anchoring, recreational uses) and are also highly sensitive to the effects of climate change (*e.g.*, higher incidences of disease and coral bleaching; (Crabbe 2008; Ramade 2005). Because continued loss of coral reef communities (especially in the greater Caribbean region) is expected to impact hawksbill foraging, it represents a major threat to the recovery of the species.

6.3.4.5 *Critical Habitat*

On June 24, 1982, USFWS designated critical habitat for hawksbill sea turtles in the terrestrial environment and nearshore waters of Isla Mona, Culebra Island, Cayo Norte and Island Culebrita, Puerto Rico (47 FR 27295). On September 2, 1998, NMFS designated critical habitat for hawksbill sea turtles in the coastal waters of Mona and Monito Islands, Puerto Rico (63 FR 46693). Designated critical habitat for hawksbill sea turtles is outside the action area.

6.3.4.6 *Recovery*

In 1993 a recovery plan was developed for Hawksbill turtles within U.S. jurisdiction in the Caribbean Sea, Atlantic. Ocean, and Gulf of Mexico. The U.S. populations of hawksbill turtles can be considered for delisting if, over a period of 25 years with a recovery goal by 2020, provided the following conditions are met:

> (1) The adult female population is increasing, as evidenced by a statistically significant trend in the annual number of nests on at least five index beaches, including Mona Island and BIRNM.
>
> (2) Habitat for at least 50% of the nesting activity that occurs in the USVI and Puerto Rico is protected in perpetuity.
>
> (3) Numbers of adults, subadults, and juveniles are increasing, as evidenced by a statistically significant trend on at least five key foraging areas within Puerto Rico, USVI, and Florida.

Actions Needed: Six major actions are needed to achieve recovery:

- Provide long-term protection to important nesting beaches.
- Ensure at least 75% hatching success rate on major nesting beaches.
- Determine distribution and seasonal movements of turtles in all life stages in the marine environment.
- Minimize threat from illegal exploitation.
- End international trade in hawksbill products.
- Ensure long-term protection of important foraging habitats.

6.3.5 Leatherback sea turtle

The leatherback sea turtle was listed as endangered throughout its entire range on June 2, 1970 (35 FR 8491) under the Endangered Species Conservation Act of 1969. When the ESA was signed into law in 1973, replacing the Endangered Species Preservation Act, the leatherback remained listed as endangered. In 2020 NMFS and USFWS published a Status Review and identified seven discrete populations (separated from each other as a result of physical and behavioral factors). NMFS concluded that the seven populations would meet the criteria for recognition as DPSs, however did not list them separately as DPSs as all would meet the definition of the endangered (85 FR 48332). For the purposes of this analysis, we will primarily focus on the Northwest Atlantic Ocean population as only individuals from this population occur in the mid-Atlantic waters of the U.S.

6.3.5.1 *Species Description and Distribution*

Leatherback turtles spend the majority of their lives at sea, where they develop, forage, migrate, and mate. The leatherback turtle has the widest distribution of any reptile, with a global range extending from 71°N to 47°S and migrate between highly productive temperate foraging areas and tropical and subtropical sandy nesting beaches (Figure 19). The Northwest Atlantic population includes leatherbacks originating from the Northwest Atlantic Ocean, south of 71°N, east of the Americas, and west of Europe and northern Africa (the southern boundary is a diagonal line between 5.377°S, 35.321°W and 16.063°N, 16.51°W) (NMFS 2020).

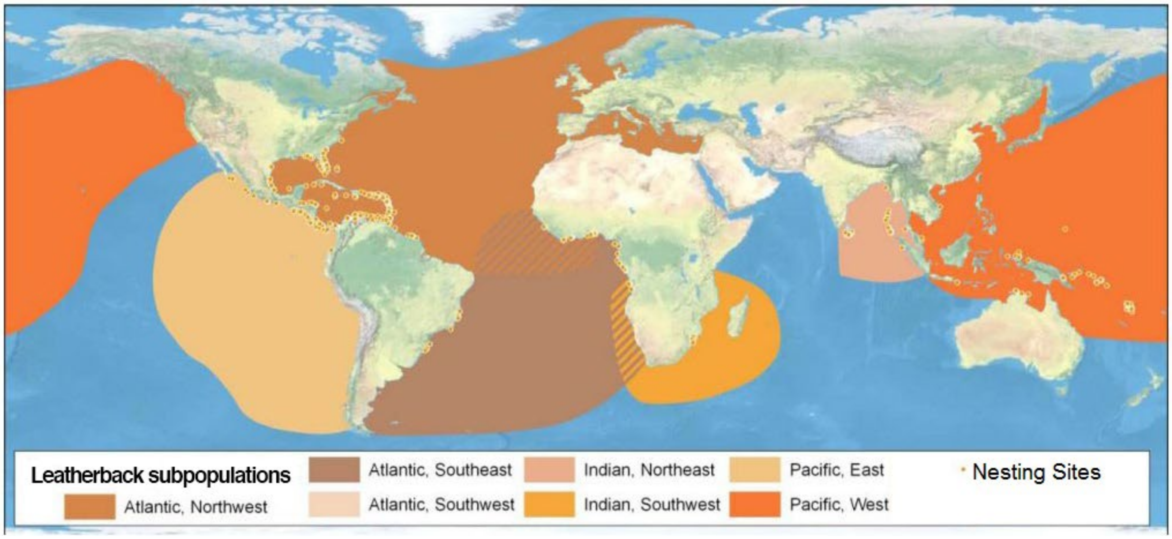


Figure 19. Map identifying the range of the endangered leatherback sea turtle, adapted from Wallace et al. 2010

6.3.5.2 *Life History Information*

Age at maturity has been difficult to ascertain, with estimates ranging from five to twenty-nine years (Avens 2009; Spotila 1996). Females lay up to seven clutches per season, with more than sixty-five eggs per clutch and eggs weighing greater than 80 grams (Reina 2002; Wallace 2007). The number of leatherback hatchlings that make it out of the nest on to the beach (i.e., emergent success) is approximately 50% worldwide (Eckert 2012). Females nest every one to seven years. Natal homing, at least within an ocean basin, results in reproductive isolation between five broad geographic regions: eastern and western Pacific, eastern and western Atlantic, and Indian Ocean. Leatherback sea turtles migrate long, transoceanic distances between their tropical nesting beaches and the highly productive temperate waters where they forage, primarily on jellyfish and tunicates. These gelatinous prey are relatively nutrient-poor, such that leatherbacks must consume large quantities to support their body weight. Leatherbacks weigh about 33% more on their foraging grounds than at nesting, indicating that they probably catabolize fat reserves to fuel migration and subsequent reproduction (James 2005; Wallace 2006). Sea turtles must meet an energy threshold before returning to nesting beaches. Therefore, their remigration intervals (the time between nesting) are dependent upon foraging success and duration (Hays 2000; Price 2004).

This separation is supported by data showing significant genetic discontinuity among the seven populations: Northwest Atlantic, Southwest Atlantic, Southeast Atlantic, Southwest Indian, Northeast Indian, West Pacific, East Pacific (NMFS 2020).

6.3.5.3 *Status and Population Dynamics*

The Northwest Atlantic population nesting female abundance at 55 sites is estimated to be 20,659, with the largest nesting site, Grand Riviere in Trinidad accounting for 29% of this abundance. NMFS and USFWS (NMFS 2020) estimated the index of nesting female abundance for 24 nesting sites in 10 nations within the Northwest Atlantic population. Nesting in the

Northwest Atlantic population is characterized by many small nesting beaches. Large nesting aggregations are rare; only about 10 leatherback nesting beaches in the Wider Caribbean Region (about 2% of the population's total nesting sites) host more than 1,000 crawls annually (Dow Piniak 2011). At beaches with the greatest known nesting female abundance, the Northwest Atlantic population is exhibiting a decreasing trend in nesting activity (NMFS 2020). The Northwest Atlantic Leatherback Working Group completed a region-wide trend analysis that also showed an overall decline in the population, reporting a 9.32% decline in nesting annually from 2008-2017 (Northwest Atlantic Leatherback Working Group 2018). In-water abundance studies of leatherbacks are rare. However, the relative abundance of turtles at a foraging area off Nova Scotia, Canada, from 2002 to 2015 was recently assessed (Archibald 2016). This study evaluated opportunistic sightings per unit effort and found a mean density of 9.8 turtles per 100 km^2, representing the highest in-water density of leatherback turtles reported to date. Archibald and James (Archibald 2016) concluded that the relative abundance of foraging leatherback turtles off Canada exhibited high inter-annual variability, but overall showed a stable trend from 2002 to 2015.

6.3.5.4 *Threats*

The primary threats to leatherback sea turtles include fisheries interactions (bycatch), harvest of nesting females, and egg harvesting. Because of these threats, once large rookeries are now functionally extinct, and there have been range-wide reductions in population abundance. Leatherbacks are also susceptible to marine debris ingestion than other sea turtle species due to their predominantly pelagic existence and the tendency of floating debris to concentrate in convergence zones that adults and juveniles use for feeding and migratory purposes (Chaloupka 1997; Shoop 1992). Ingestion of marine debris (plastic) is common in leatherback turtles and can block gastrointestinal tracts leading to death. Global climate change can be expected to have various impacts on all sea turtles, including leatherbacks. Climate change is likely to impact leatherbacks by altering nesting habitat, and changing the abundance and distribution of forage species, which will result in changes in leatherback foraging behavior and distribution and fitness and growth (NMFS 2020).

6.3.5.5 *Critical Habitat*

On March 23, 1979, NMFS designated critical habitat for leatherback sea turtles in the waters adjacent to Sandy Point, St. Croix, U.S.V.I. from the 183 m isobath to mean high tide level between 17° 42'12" N and 65°50'00" W (44 FR 17710). On January 26, 2012, NMFS revised the critical habitat designation for leatherback sea turtles to include coastal and open water areas along the U.S. West Coast (77 FR 4170). Designated critical habitat for leatherback sea turtles is outside the action area.

6.3.5.6 *Recovery*

In 1992 a recovery plan was been developed to recover and protect leatherback turtle populations found in U.S. waters. This plan is directed at recovery of leatherback populations occurring within the U.S. Caribbean, Atlantic and Gulf of Mexico. To help identify and guide the protection, conservation, and recovery of sea turtles, the ESA requires NOAA Fisheries and the

U.S. FWS to develop and implement recovery plans which provide a blueprint for conservation of the species and measurable criteria to gauge progress toward recovery.

The major recovery actions for leatherback turtles include:

- Protecting sea turtles on nesting beaches and in marine environments
- Protecting nesting and foraging habitats
- Reducing bycatch in commercial, artisanal, and recreational fisheries
- Reducing the effects of entanglement and ingestion of marine debris
- Reducing vessel strikes in coastal habitats
- Working with partners internationally to protect turtles in all life-stages
- Supporting research and conservation projects consistent with Recovery Plan priorities.

6.3.6 Loggerhead sea turtle (Northwest Atlantic Ocean DPS)

The loggerhead turtle was first listed as threatened under the ESA in 1978 (43 FR 32800). On September 22, 2011, the NMFS designated nine DPSs of loggerhead turtles, with the Northwest Atlantic Ocean DPS of loggerhead turtle listed as threatened. The NWA DPS is the only DPS that occurs within the action area and, therefore, it is the only one considered in this document. The Northwest Atlantic Ocean Distinct Population Segment (DPS) of the loggerhead sea turtle was listed as endangered under the ESA in 2011. In 2019, we initiated the 5-year review. The 5-year review is based on the best available data through August 2021 and published in 2023. We used information available in the 2023 Northwest Atlantic Ocean DPS Loggerhead 5-Year Review, found on the NMFS website.

6.3.6.1 *Species Description and Distribution*

Loggerhead turtles are circumglobal, and are found in continental shelf and estuarine environments throughout the temperate and tropical regions of the Atlantic, Indian, and Pacific Oceans (Figure 20). NWA DPS of loggerheads are found along eastern North America, Central America, and northern South America (Shoop 1989). Habitat use within these areas vary by life stage. Juveniles are omnivorous and forage on crabs, mollusks, jellyfish, and vegetation at or near the surface (Dodd 1988). Subadult and adult loggerheads are primarily found in coastal waters and eat benthic invertebrates such as mollusks and decapod crustaceans in hard bottom habitats. Nesting occurs on beaches within the southeast U.S. and the Wider Caribbean Region.

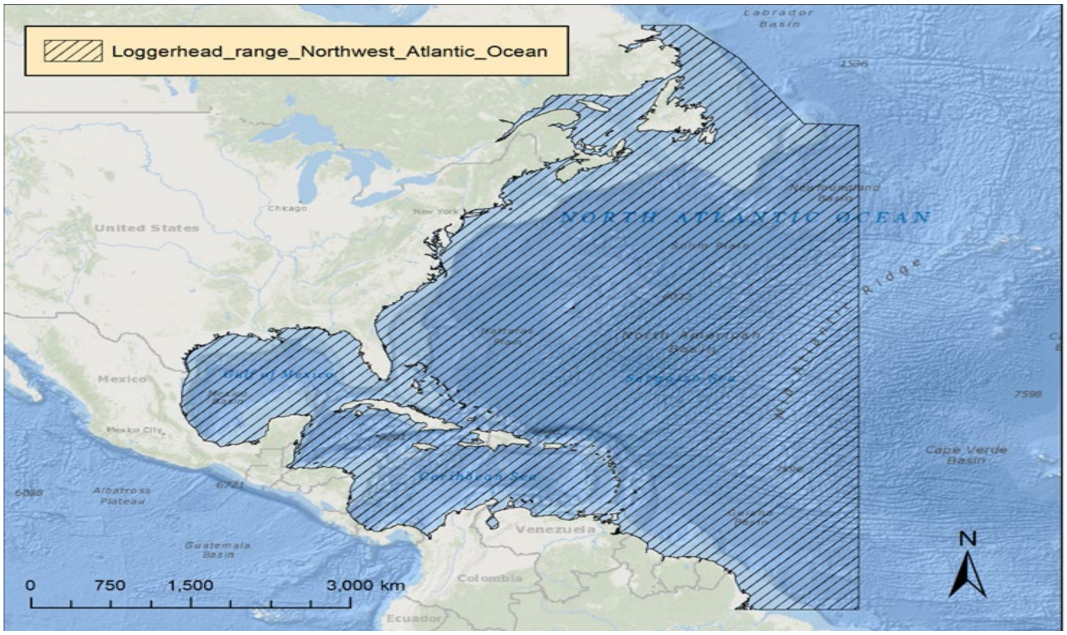


Figure 20. Map identifying the range of the Northwest Atlantic Ocean distinct population segment loggerhead sea turtle.

Within the NWA DPS, most loggerhead sea turtles nest from NC to Florida and along the Gulf of Mexico coast of Florida. The recovery plan identified five recovery units. The Northern Recovery Unit (NRU) includes nesting areas from the Florida/Georgia border north through southern Virginia. The recovery plan concluded that all recovery units are essential to the recovery of the species. Annual nest totals from beaches within the Northern Recovery Unit (NRU) averaged 5,215 nests from 1989-2008, a period of near-complete surveys of NRU nesting beaches (GADNR unpublished data, North Carolina Wildlife Resources Commission [NCWRC] unpublished data, SCDNR unpublished data), and represent approximately 1,272 nesting females per year, assuming 4.1 nests per female (Mrosovsky). The loggerhead nesting trend from daily beach surveys showed a significant decline of 1.3% annually from 1989-2008. Nest totals from aerial surveys conducted by SCDNR showed a 1.9% annual decline in nesting in South Carolina from 1980-2008. Overall, there are strong statistical data to suggest the NRU had experienced a long-term decline over that period of time. Data since that analysis (Table **6**) are showing improved nesting numbers and a departure from the declining trend. Georgia nesting rebounded in 2016 to show the first statistically significant increasing trend since comprehensive nesting surveys began in 1989 (Mark Dodd, GADNR press release on the Georgia Wildlife website). South Carolina and North Carolina nesting have also begun to shift away from the past declining trend. Loggerhead nesting in Georgia, South Carolina, and North Carolina all broke records in 2015 and then topped those records again in 2016. Nesting in 2017 and 2018 declined relative to 2016, back to levels seen in 2013 to 2015, but then bounced back in 2019, breaking records for each of the three states and the overall recovery unit.

Table 6 Total Number of NRU Loggerhead Nests recorded (GADNR, SCDNR, and NCWRC nesting datasets compiled at Seaturtle.org)

Year	Georgia	South Carolina	North Carolina	Totals
2008	1,649	4,500	841	**6,990**
2009	998	2,182	302	**3482**
2010	1,760	3,141	856	**5,757**
2011	1,992	4,015	950	**6,957**
2012	2,241	4,615	1,074	**7,930**
2013	2,289	5,193	1,260	**8,742**
2014	1,196	2,083	542	**3,821**
2015	2,319	5,104	1,254	**8,677**
2016	3,265	6,443	1,612	**11,320**
2017	2,155	5,232	1,195	**8,582**
2018	1,735	2,762	765	**5,262**
2019	3,945	8,774	2,291	**15,010**

6.3.6.2 *Life History Information*

Estimates of mean age of sexual maturity for female loggerheads sea turtles is 36 to 38 years (mean age predictions for minimum age are 22.5 to 25 years; Avens et al. 2015) with a 95% predictive interval of 29 to 49 years (Chasco 2020). Mean age at sexual maturity for males is 37 to 42 years (mean age predictions for minimum age are 26 to 28 years; (Avens 2015). Females nest one to seven times in a season, and clutch sizes range from 95 to 130 eggs. Females nest every 1 to 7 years and exhibit relatively strong nest-site fidelity (Shamblin 2017) with a mean remigration interval of 2.7 years (Shamblin 2021). Young juvenile loggerheads inhabit oceanic waters spanning the width of the North Atlantic Ocean and Mediterranean Sea after which juveniles typically return to the neritic waters of the Northwest Atlantic Ocean. Older juveniles undergo an ontogenetic, oceanic-to-neritic habitat shift, however, this transition is not obligate, permanent (*i.e.*, some return to oceanic habitats; (Phillips 2021a; Phillips 2021b) , nor fixed to a certain body size or age class (Winton 2018).

6.3.6.3 *Status and Population Dynamics*

An overall estimate of nesting females for the NWA DPS is not available because of reproductive parameter uncertainty: remigration intervals and clutch frequencies vary spatially and temporally, and data are insufficient for some Recovery Units. Adequate data are available from the NRU (Florida/Georgia border north through southern Virginia), and the State of

Florida, which represents 89% of nesting within the DPS (Ceriani 2017). Ceriani (2019) evaluated all known Florida nesting data from 1989 to 2018. Using the average annual number of loggerhead nests between 2014 and 2018, Ceriani (2019) estimated the total number of adults females nesting in Florida to be 51,319 (95% CI = 16,639-99,739). To avoid pitfalls of estimating nesting females based on estimates of emigration interval and clutch frequency, Shamblin (2021) used genetic analyses to estimate female abundance for the NRU, estimating 8,074 total nesting females from 2010 to 2015 (Shamblin 2021). The overall nesting trend of NWA DPS appears to be stable, neither increasing nor decreasing, for over two decades. The NRU has demonstrated a positive, statistically significant growth rate (1.3%; $p = 0.04$) over the previous 37 years (Lohe 2021).

In-water estimates of abundance include juvenile and adult life stages of both sexes but are difficult to perform on a wide scale. In the summer of 2010, NMFS' Northeast and Southeast Fisheries Science Centers estimated the abundance of juvenile and adult loggerhead sea turtles along the continental shelf between Cape Canaveral, Florida and the mouth of the Gulf of St. Lawrence, Canada. They provided a preliminary regional abundance estimate of 588,000 individuals (approximate inter-quartile range of 382,000-817,000) based on positively identified loggerhead sightings (NMFS 2011b). A separate, smaller aerial survey, conducted in the southern portion of the Mid-Atlantic Bight and Chesapeake Bay in 2011 and 2012, demonstrated uncorrected loggerhead sea turtle abundance ranging from a spring high of 27,508 to a fall low of 3,005 loggerheads (Barco 2018).

6.3.6.4 *Threats*

Destruction and modification of terrestrial and marine habitats threaten the NWA DPS of loggerhead turtles. On beaches, threats that interfere with successful nesting, egg incubation, hatchling emergence, and transit to the sea include erosion, erosion control, coastal development, artificial lighting, beach use, and beach debris (NMFS and USFWS 2023). In the marine environment, threats that interfere with foraging and movement include marine debris, oil spills and other pollutants, harmful algal blooms, and noise pollution (NMFS and USFWS 2023). Domestic and international fisheries bycatch impacts juvenile and adult loggerheads in pelagic and coastal waters throughout the range of the DPS (Bolten 2010; Finkbeiner 2011). Harmful algal blooms (HABs), also called "red tides," are a significant, nearly-annual threat to the DPS, especially to turtles inhabiting the waters off southwest Florida (Hart 2018).

6.3.6.5 *Critical Habitat*

In 2014, NMFS and the USFWS designated critical habitat for the NWA DPS of loggerhead turtle along the U.S. Atlantic and Gulf of Mexico coasts, from NC to Mississippi (79 FR 39856). The final rule designated five different units of critical habitat, each supporting an essential biological function of loggerhead turtles. These units include nearshore reproductive habitat, winter area, Sargassum, breeding areas, and migratory corridors. Designated critical habitat for loggerhead sea turtles is outside the action area.

6.3.6.6 *Recovery*

In July 2019, NMFS and USFWS reconvened the NW Atlantic Loggerhead Recovery Team to review progress toward recovery for the NW Atlantic Population of the Loggerhead Sea Turtle, 10 years after the publication of the Recovery Plan (2008).The Recovery Team concluded that the 2008 Recovery Plan continues to be the appropriate roadmap to recovery for the NW Atlantic Population of loggerheads. Although progress has been made, the Recovery Team is concerned that the Recovery Units (RUs) have not met most of the critical benchmarks to achieve the Demographic Recovery Criteria, that many of the Listing Factor Recovery Criteria are not yet being addressed, and that some critical Priority 1 Recovery Actions have not yet been implemented. In the Recovery Plan, to be considered for delisting, each recovery unit must have recovered to a viable level and each recovery unit must have increased for at least one generation. These rates of increase were dependent upon the level of vulnerability of each recovery unit. The minimum statistical level of detection (based on annual variability in nest counts over a generation time of 50 years) of 1% per year was used for the least vulnerable recovery unit (Peninsular Florida). A higher rate of increase of 3% per year was used for the most vulnerable recovery units (Dry Tortugas and Northern Gulf of Mexico). A rate of increase of 2% per year was used for the moderately vulnerable recovery unit (Northern).

The Recovery Criteria under each of the Five Listing Factors were individually assessed for progress toward recovery. Critical issues that have not yet been sufficiently addressed are:

- Beach armoring, shoreline stabilizations structures, and all other barriers to nesting continue to be a serious threat to loggerhead sea turtle recovery.
- A strategy has not been developed to assess, evaluate, and protect important marine habitats for feeding, migration, and internesting for loggerheads.
- Light management on nesting beaches is essential. Although more than 90% of loggerhead nesting in FL takes places on nesting beaches governed by lighting ordinances, not all nesting beaches in FL, AL, GA, SC, and NC have lighting ordinances or have lighting ordinances that do not adequately protect loggerheads from the adverse effects of artificial lighting. Across the southeast, implementation and enforcement of lighting ordinances are highly variable, due to funding and resource priorities.
- Consistent reporting is needed to quantify the annual percentage of total nests, nesting females and hatchlings disoriented or misoriented by artificial lighting to assess this threat and gauge progress toward reducing it across all recovery units.
- While progress has been made, bycatch of loggerheads in commercial fisheries remains a significant threat that is not yet fully addressed.
- Vessel strike mortality is a significant threat that has not yet been addressed.
- Marine debris ingestion and entanglement by loggerheads in US and international waters continues to threaten loggerheads and has not yet been addressed.
- Loggerhead sea turtle recovery is conservation dependent and no progress has been made to develop and implement specific and comprehensive Federal and State legislation to ensure long-term (including post-delisting) protection of loggerheads and their terrestrial and marine habitats, including protection from anthropogenic threats (e.g., fishery bycatch, beach nourishment, coastal armoring, dredging).

7 ENVIRONMENTAL BASELINE

The "environmental baseline" refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, 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 which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR §402.02).

7.1 Sturgeon

7.1.1 Atlantic Sturgeon within the Action Area

Atlantic sturgeon are considered in danger of extinction in NC and the NCDMF implemented a statewide moratorium on the possession of sturgeon in 1991 (MFC Rule 15A NCAC 03M.0508). The Carolina DPS habitats include rivers from the Albemarle Sound drainage that originate in southern Virginia, south to rivers of the Charleston Harbor area north of the Edisto River. There is evidence of spawning in the Roanoke, Tar-Pamlico, Cape Fear, Waccamaw, and Great Pee Dee rivers (ASSRT 2007).

The Pamlico Sound (Tar and Neuse Rivers) Atlantic sturgeon population is speculated to be small compared to other populations (Albemarle Sound, Cape Fear Estuary) in NC (ASSRT 2007; Oakley 2003). There is no documented spawning activity of Atlantic sturgeon in Wake or Johnston counties, with all records from the basin being further downriver.

Additionally, there is no documentation of spawning activity in the Neuse River; moderate numbers of juvenile Atlantic sturgeon (<50 cm TL) have been collected from the Neuse River (Grunwald 2008). Given that juveniles remain in their natal rivers, it is a logical assumption that the individuals captured in the river were spawned upstream. NMFS used this life history attribute, along with the presence of suitable spawning habitat features and lack of physical barriers, to justify designating critical habitat up to RKM 328 (Milburnie Dam). Most of the recent information for Atlantic sturgeon in North Carolina estuarine waters is from the Cape Fear River and the Albemarle Sound and its tributaries. Acoustically tagged subadult fish captured in the Cape Fear River made seasonal movements between freshwater habitats in the upper estuary to the river mouth at the ocean (Post 2014). Emigration out of the river and into the ocean starts in September and continues through January, with a peak in October when temperatures fall below 15 degrees (°) Celsius (C). Subadult fish return to the river system from offshore between February and May with peak immigration occurring in April when temperatures were greater than 10°C.

No directed research was conducted in North Carolina between 2014 and 2021, then directed research began again in 2021 with an emphasis on the Cape Fear River and the Roanoke River. (NMFS 2023a). The recent sampling has been conducted during both the fall and spring. Adult male Atlantic sturgeon in spawning condition were captured and tagged in the Cape Fear River during spring, but to date no adults have been captured in the Cape Fear River during the fall. Subadults have been captured and tagged during both the spring and fall. Several of these fish were recaptured between early summer and late fall, an indication of long residence times near the salt/freshwater interface. High inter-annual return rates of acoustically tagged subadults to the Cape Fear River demonstrates fish have fidelity to this system. This suggests the Cape Fear basin may be the natal system of these fish, or is at least a highly important foraging area (Post 2014).

7.1.2 Shortnose Sturgeon within the Action Area

Currently, there are no directed research programs focused solely on the habitat use in the sounds. However, directed research in the Albemarle Sound did occur around the time of listing (2011-2013). That research effort found the western Albemarle Sound was used by all life stages (i.e., YOY, juveniles, subadults, and adults) during at least some portion of the year (Post 2014). Telemetry data collected from juvenile and subadult Atlantic sturgeon acoustically tagged in Albemarle Sound revealed three general movement patterns: individuals remaining in western Albemarle Sound year round; individuals moving to eastern Albemarle Sound (near Oregon Inlet) in winter but back to western Albemarle Sound in summer; and individuals leaving Albemarle Sound to enter the Atlantic Ocean (Post 2014). These seasonal movements were consistent with the pattern of Atlantic sturgeon bycatch by fisheries-independent sampling occurring in Albemarle Sound from 1990-2015 (Hoos 2017). Aside from movements within Albemarle Sound, Post et al. (2014) also identified Oregon Inlet as a critical passageway for migrating adults and subadults as they make their way from the Albemarle Sound into the Atlantic Ocean and back. The same telemetry array used to detect the movement of fish tagged in the Albemarle Sound also detected fish from other river systems entering the sound from the Atlantic Ocean (Post 2014). The Stock Assessment estimated the mean survival rates of 78%, 33%, and 72% for all acoustically tagged fish, acoustically tagged adults, and acoustically tagged juveniles from the Carolina DPS, respectively. The ASMFC also concluded it was relatively likely (75% probability) that mortality for the Carolina DPS exceeds the mortality threshold used for the Stock Assessment (ASMFC 2017).

Few surveys have been conducted in the rivers and bays along the NC coast so the presence of a reproducing population of shortnose sturgeon is uncertain (SSSRT 2010). Shortnose sturgeon were historically present in the Roanoke, Chowan, and Cape Fear Rivers and the Winyah Bay System (SSSRT 2010). Most historical commercial sturgeon landings records were from Albemarle sound, however records did not differentiate between Atlantic and shortnose sturgeon (SSSRT 2010). Historical use of the New River, Neuse River, and Tar-Pamlico System are unknown, but there are relatively recent anecdotal reports from commercial fishers.

Cape Fear estuary likely serves as a migration or staging corridor for spawning, perhaps in Brunswick River. Evidence of a reproducing population in the Cape Fear River was provided by a gill net survey conducted in the early 1990s. Three gravid female shortnose were captured in the Brunswick River reach of the Cape Fear estuary during the months of January and February in 1989, 1990, 1991 and 1992 (Moser 1995). The survey used sonic tracking to document the distribution and movements of adult shortnose sturgeons and juvenile Atlantic sturgeons in the lower Cape Fear River. While only eight fish were captured during the study, the presence of gravid females and observations of rapid upstream migrations suggest it is possible shortnose sturgeon are spawning in this system (Moser 1995).

A majority of rivers in NC do not support shortnose sturgeon populations, despite historical records indicating their presence (VanDerwarker 2001). The current distribution and abundance of shortnose sturgeon in the Cape Fear River Estuary is unknown. No specimens have been encountered since 1997. (SSSRT 2010) Within NC, shortnose sturgeon only inhabit the Cape Fear River, the Waccamaw/Pee Dee/Black Rivers, and the Albemarle Sound. At the state level, shortnose sturgeon are listed as a priority species and as State Endangered.

7.2 Sea turtles

7.2.1 Green sea turtles within the Action Area

Green turtles were documented to commonly occur in North Carolina's inshore waters as early as 1884, prior to which the population had been sufficient to support a small-scale fishery both for individual fisher consumption and commercial sale (True 1893). These green turtles were reported to be small, suggesting that the majority of green turtles inhabiting these waters were juveniles. At the peak of the fishery, up to 100 green turtles were caught at one time, and turtles were "shipped by the barrel" for sale (Coker 1906). By the early 1920s, green turtles were rarely encountered; their scarcity was attributed to overfishing and egg collection from southern nesting beaches (Coker 1906).

Estuarine waters in NC provide important developmental and foraging habitats for juvenile green sea turtles, and nearshore coastal waters provide a required migratory pathway to and from these habitats (Braun McNeill 2018; Epperly 2007b; Snoddy 2010; Williard 2017). Green sea turtles also nest on NC beaches (Schwartz 1981; Shamblin 2018a), and recent genetic analyses indicated these green sea turtles may represent an incipient subpopulation (Shamblin 2018b). Green sea turtles are the second most common sea turtle species nesting in NC, however, they only account for approximately 2.5% of nests in NC (North Carolina Wildlife Resources Commission unpublished data, accessed from the SeaTurtle.org website). In contrast, sea turtle strandings from estuarine waters are dominated by green sea turtles. Between 2010 and 2020, more than 75% of strandings recovered from internal waters and shorelines were green sea turtles with strandings recovered every month across those years. The lengths for measured stranded greens indicate that they were predominantly juvenile turtles (mean Straight-line Carapace Lengths [SCL]: 28.3cm, range: 20.5-75.7cm) indicate that they were predominantly juvenile turtles (Avens 2013). The density of this species combined with their association with submerged aquatic vegetation (SAV) likely increase their co-occurrence with some anchored gill net fisheries, especially the fall flounder fishery (McClellan 2009a). However, data from fisheries bycatch studies and strandings indicate the relative abundance of green sea turtles in NC estuarine waters has increased over the last 20-30 years (Braun McNeill 2018; Byrd 2011; Epperly 2007b; Shamblin 2018b). Since then, stranding, cold-stunning, and incidental capture data show the high presence of benthic foraging/resting green turtles in waters off North Carolina (Figure 21). During rapid drops in water temperatures in fall and winter months, juvenile green turtles may be susceptible to cold-stunning (Niemuth 2020b). In early 2016, more than 1,800 hypothermic green turtles were found in eastern Pamlico and southern Core Sounds in a 4-week period, documenting the importance of these benthic foraging/resting areas (NCWRC unpublished data 2016).

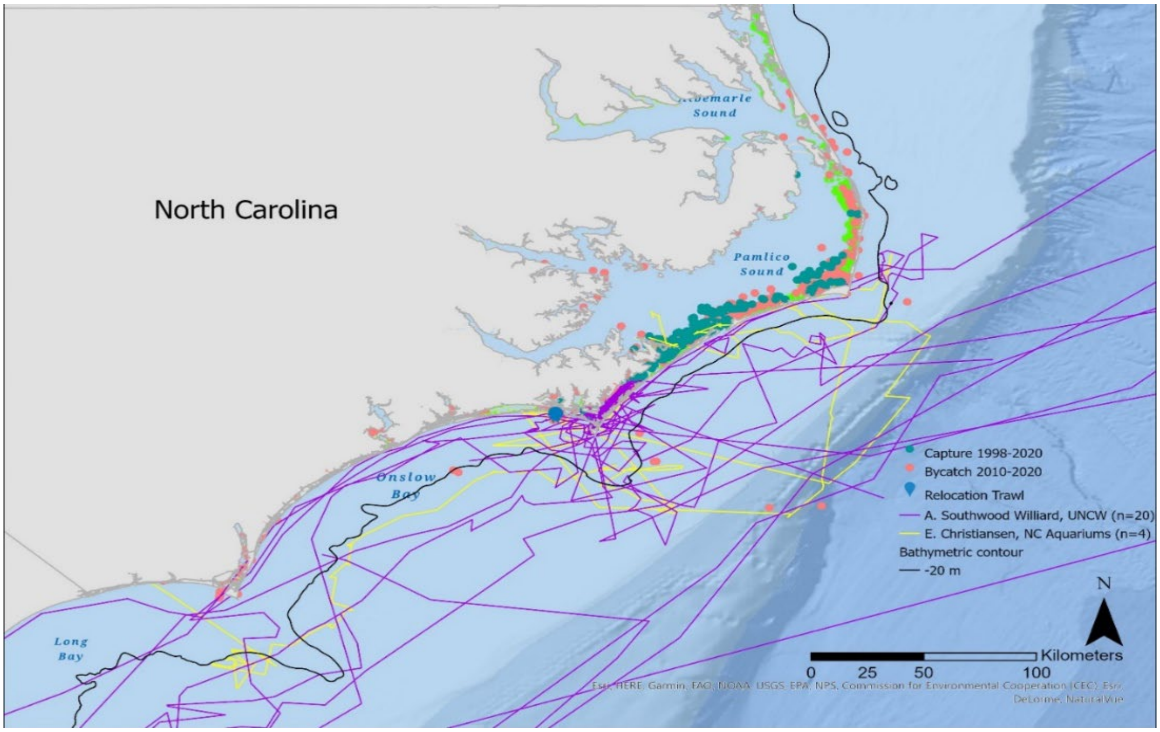


Figure 21. Benthic foraging and resting areas in North Carolina based on captures (NMFS 2023b) Green dots represent turtles captured during research studies; red dots represent incidentally captured turtles; blue markers represent areas where relocation trawls occurred. Purple lines represent 20 satellite-tracked turtles; yellow lines represent four satellite tracked turtles. Light green polygons represent seagrass cover; black line represents the 20 m isobaths.

The presence of foraging/resting green turtles in North Carolina is also supported by data on incidental captures collected by the NCDMF and the NMFS Beaufort Laboratory (n = 1,485), stranding records (n = 2,969), and necropsy data indicating that at least 43.5% of necropsied turtles (n = 485) had seagrass or other vegetation in their gut (NCWRC unpublished data 2015). Analyzing a subset of incidental captures (n = 757) indicates that most individuals are juveniles, with an average SCL of 32.4 cm, a minimum SCL of 20.6 cm, and a maximum SCL of 94.5 cm (SEFSC unpublished data 2022). Since then, direct capture for research studies, bycatch data, and satellite telemetry show that there is a large population of benthic foraging/resting green turtles in waters off North Carolina.

Generally, turtles occupied mean temperatures between 26 and 28 °C in water depths of generally less than one meter (but up to depths of four meters) and in areas close to the shoreline, near seagrass meadows (McClellan 2009a). During winter months when water temperatures fall below habitable levels, juveniles typically move out of shallow estuarine waters to deeper waters on the North Carolina shelf south of Cape Hatteras, migrate south along the continental shelf to waters off the coast of Florida, or migrate east to oceanic waters in the North Atlantic (Epperly 1995a; Read 2004; Southwood Williard 2017). Barden Inlet and the Cape Lookout Bight appear to be important transit routes, although other nearby inlets are also used by green sea turtles to move in and out of NC estuarine waters (McClellan 2009a; Southwood Williard 2017). During rapid drops in water temperatures in NC estuarine waters in fall and winter months, juvenile green sea turtles may be susceptible to cold-stunning (Niemuth 2020a). In early 2016, more than 1,800 hypothermic green sea turtles were documented in eastern Pamlico and southern Core Sounds in a 4-week period, documenting the importance of these foraging/resting areas (NCWRC unpublished data 2016).

All nearshore waters of North Carolina, from the mean high water line to 20 m depth, contain benthic foraging/resting essential features that may require special management considerations or protections. The area including Pamlico, Core, and Back Sound (*i.e.*, up to but not including Currituck and Albemarle Sounds) provides high conservation value to the NA DPS. This area supports a high density of green turtles (predominantly small juveniles) inhabiting extensive seagrass habitat during the majority of the year, as documented by numerous records of satellite tracking, directed captures for research, fishery bycatch, cold stuns-stunning, and strandings (Braun McNeill 2018; McClellan 2009a; Putman 2020); NCWRC unpublished data 2022).

7.2.2 Kemp's ridley sea turtles within the Action Area

Kemp's ridley sea turtles are listed on the North Carolina State Endangered Species Act as NC Endangered. Kemp's ridley nest in NC at low levels compared to green and loggerhead sea turtles, laying <10 nests per year (NCWRC unpublished data, accessed from the SeaTurtle.org website).

Among stranded animals recovered from internal waters and shorelines, Kemp's ridleys are the second most common species encountered with 693 documented between 2010 and 2020 (NCWRC unpublished data). Stranding of Kemp's ridley have been documented during every month of the year. The lengths for measured stranded Kemp's ridley indicate they were predominantly juveniles (SCL: 31.4cm, range: 18.6-61.5cm).

7.2.3 Hawksbill sea turtles within the Action Area

Reports of observations of hawksbill sea turtles in NC are also historically rare (Epperly 1995b). To date, two hawksbill sea turtle nests have been documented on NC beaches, both in 2015 (Finn 2016). These nests represent the northernmost records for the species and genetic analyses indicated this as a possible trans-Atlantic colonization event (Finn 2016). Twelve strandings of hawksbills have been recorded in NC since recording began in the mid-1980s. One hawksbill was documented as stranded from internal waters and shorelines between 2010 and 2020, and two hawksbill interactions were documented by the NCDMF Observer Program between 2000 and 2021 (Daniel 2013).

7.2.4 Leatherback sea turtles within the Action Area

Leatherback sea turtles have been documented in nearshore ocean waters of NC, particularly near Cape Lookout and Cape Hatteras (Avens 2009; Epperly 2007b; Keinath 1996; Shoop 1992). Nesting by leatherbacks is not common in NC, but nests are documented occasionally (NCWRC unpublished data, accessed from the SeaTurtle.org website). The occurrence of leatherbacks in inshore estuarine waters is thought to be uncommon to rare compared to green, loggerhead, and

Kemp's ridley sea turtles based on historical (Epperly 2007b) and recent stranding data. Of the 5,456 stranded animals recovered from NC internal waters and shorelines from 2010–2020, 12 were leatherbacks (NCWRC unpublished data, accessed from the SeaTurtle.org website). Based on carapace length measurements, most, if not all stranded leatherbacks were adults (Avens 2013). The NCDMF Observer Program has not documented a bycatch of a leatherback in inshore estuarine anchored gill net fisheries since the program began in 2000, however there is potential for this species to overlap spatially and temporally with these fisheries.

7.2.5 Loggerhead sea turtles within the Action Area

Areas of NC provide important habitat, such as beaches for nesting females and developing hatchlings, foraging hotspots in neritic waters for adults (Ceriani 2017), and developmental and foraging habitats in estuarine waters for juveniles (Avens 2003; Braun McNeill 2018; Chaloupka 1997). Approximately 97% of sea turtle nests in NC are laid by loggerheads (NCWRC unpublished data, accessed from the SeaTurtle.org website). From 2010 to 2020, 584 loggerheads strandings were recovered in every month across the time series (NCWRC unpublished data). The lengths for measured stranded loggerheads indicate that they were predominantly juvenile turtles (mean SCL: 65.6 cm, range: 42.4-96.8 cm; Avens, 2015).

Loggerhead turtles are occasionally observed in inshore estuarine gill net fisheries, with 8 interactions observed in ITP years 2013-2021. Although they do occur in shallow waters, telemetry data indicated that this species occurs often in the deep waters of Pamlico Sound and across a wider range of depths than green sea turtles (McClellan 2009a). This habitat use may decrease rates of incidental capture in the fall flounder anchored large-mesh gill net fishery, which operates primarily in shallow water, often <1 m deep (McClellan 2009b).

7.3 Fisheries

Bycatch occurs when fisheries interact with living marine resources (e.g., marine mammals, sea turtles, non-market fish species, corals, or seabirds) that are not the target species for commercial sale. Bycatch represents a global threat to many ESA-listed species. Populations of marine megafauna (e.g., turtles, mammals, sharks) can be particularly sensitive to the detrimental effects of bycatch due to life history parameters such as slow growth, late age at maturity, and low reproductive rates (Hall 2017). Highly migratory, transboundary species that spend large amounts of time in ocean jurisdictions lacking adequate bycatch mitigation measures, monitoring, or enforcement are often most vulnerable to this threat. While mitigation and minimization measures have reduced fisheries bycatch in the United States in recent years, large numbers of ESA-listed species are still routinely captured in federal and state commercial fisheries targeting other species.

7.3.1 Sturgeon

Recreational and commercial fishing activities in state waters have captured, injured, and killed sturgeon. Historically, one of the major contributors to declines in Atlantic sturgeon populations was direct commercial harvest of this fish. Atlantic sturgeon migrate extensively across estuarine and marine environments and frequently form mixed-stock aggregations in non-natal habitats, it can be difficult to determine how these threats impact specific populations and DPSs (Kazyak 2021a). In the past 10 years, it is estimated that 6,913 Atlantic sturgeon were captured in the NC inshore gill net fishery. 6,513 of those were released alive, 651 were injured and 400 were killed. Atlantic Sturgeon caught in anchored large-mesh (≥5 ISM; ≥12.7 CSM) were estimated at 4,474 live and 276 dead for a total of 4750. In anchored small-mesh (<5 ISM; <12.7 CSM) Atlantic Sturgeon captures were estimated at 2,163 total with 2,039 live and 124 dead (NCDMF 2023). Even when a fish is observed, captured and released alive, the rate of post-release mortality is unknown. Impacts from poaching are also unknown. A literature review found Atlantic sturgeon have been incidentally captured in seven of 12 gill net fisheries on the U.S. east coast, including sink nets, drift nets, and inshore gill nets (Zollett 2009). All 12 of these gill net fisheries co-occur in locations where Atlantic sturgeon researchers target Atlantic sturgeon with gill nets, suggesting the five fisheries without reported interactions are due to lack of reporting, not lack of interactions. Sink gill nets have been identified as a source of high mortality for Atlantic sturgeon (Stein 2004), and the majority of incidental captures occurred in sink gill nets.

Similarly, shortnose sturgeon have been taken incidentally in gill nets (NCDMF 2023). Shortnose sturgeon were considered to be extirpated from North Carolina waters, until an individual was found in the Brunswick River in 1987 (Ross 1988). Recent intensive gill-net studies establish the presence, though rare, of shortnose sturgeon in the lower Cape Fear River (Moser 1995). Despite intensive gill-net sampling (893 net-days), Moser (1995) only obtained five shortnose sturgeon in the lower Cape Fear River between 1989 and 1993. In 1998, the North Carolina Division of Marine Fisheries reported a capture of a shortnose sturgeon in western Albemarle Sound. The NCDMF Observer Program has also documented the presence of shortnose sturgeon in NC. In 2016, there were two incidental takes of shortnose sturgeon in estuarine anchored gill nets. One shortnose sturgeon (634 mm TL) was released alive from an anchored large-mesh gill net on April 7, 2016, in the upper Cape Fear River (Boyd 2017). Because of this take and tagging data of shortnose sturgeon in the area, the Director issued Proclamation M-5-2016 that closed the upper Cape Fear River to anchored gill nets effective April 10, 2016, and this gear is still prohibited in the area. The other observed shortnose sturgeon incidental take (861 mm TL) was released alive from an anchored large-mesh gill net on September 30, 2016, in the Chowan River (Boyd 2018). There was no other evidence that shortnose sturgeon were common in that area (the last confirmed report was from 1998); therefore, no additional restrictions were implemented for anchored gill nets.

Currently, only Georgia and North Carolina have completed an assessment with NMFS on the impacts of their state's fishery and bycatch in those states through the application and issuance of an ITP, which goes through the section 7 consultation process that exempts take of listed species and habitat to avoid is currently not violating the ESA.

7.3.2 Sea Turtles

From 1988 to 1992, commercial fishers in Core and Pamlico Sounds reported that juvenile green turtles comprised 4% to 16% of annual sea turtle bycatch (total n = 21; Epperly *et al.* 1995). Subsequent standardized fishery-dependent sampling conducted in Core and Pamlico Sounds from 1997 to 2009 demonstrated a significant increase in green turtle catch per unit effort (CPUE) of 4,250% and an increased proportion of green turtles in the species distribution from 19% to 42% (Braun McNeill 2018; Epperly 2007a). This increase in the number of green turtles captured corresponded with a significant decrease in size distribution, with the predominant SCL size class shifting from 30-35 cm to 25-30 cm (Braun McNeill 2018). Analysis of green turtle bycatch in the North Carolina inshore gill net fishery also indicated an increase in CPUE of more than 650% between 2001 and 2016 (Putman 2020). Incidental captures confirm that the benthic foraging/resting essential features extend westward into the Pamlico and Albemarle Sound estuaries and northward into the Cape Fear, New, and White Oak Rivers (Epperly 2007b); SEFSC unpublished data 2015). Seven juveniles that survived capture in gill nets in the lower Cape Fear River remained there (within a 3 km radius of the capture site) after release for up to 42 days (Snoddy 2010). Direct capture for research studies and satellite telemetry further demonstrate green turtles use of benthic habitats in North Carolina. Ten juveniles (27.9 to 42.5 cm SCL) captured in Core, Back, and Pamlico Sounds inhabited areas from Bogue Sound to Pamlico Sound. These turtles were strongly associated with seagrass habitat (most frequently at the edge of seagrass beds) and retreated into the beds when disturbed by natural and anthropogenic activities, including vessel and fishing activities (McClellan 2009a). In general, each turtle used a restricted area and showed little movement during the summer, followed by an increase in movement during the fall, consistent with an onset of migratory behavior (McClellan 2009a).

7.4 Vessel interactions

7.4.1 Sturgeon

Sturgeon (Atlantic and shortnose) are susceptible to vessel strikes from both recreational and commercial vessels. Recreational vessels result in injury, but the sturgeon can occasionally recover while strikes from commercial vessels with larger propellers are nearly always lethal. Very little is known about the effects of vessel strikes on individuals from the Carolina DPS. Large vessels have typically been 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 2010). Also, Miranda (2013) estimated that the large towboats on the Mississippi River, which have a propeller diameter of 2.5m, a draft of up to 3m , 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 ~19-33 in (~50-85 cm in length) with a similar life history to shortnose sturgeon, were being killed at a rate of 0.02 individuals per .6 mi or 1 kilometer traveled by the towboats. Historically, vessel strike strandings in the action area have been rare. However, NMFS Southeast Region began dispersing “Report Sturgeon” signage in NC in July 2018, with a particular focus on the Cape Fear River. Since those signs were deployed, 5 sturgeon strandings, showing evidence of a vessel strike, were reported from Cape Fear River. The increase in reporting may be due to the placement of signs asking citizens to report that were posted June 2018 and the designation of Atlantic sturgeon critical habitat (82 FR 39160, August 17, 2017). Additional reports of sturgeon strandings showing signs of vessel strikes have been reported in sturgeon rivers. There is no directed survey for sturgeon strandings and all records are opportunistically reported by the public or resource managers that happen to find an animal, usually on a beach or river bank. A number of the rivers in the Southeast where sturgeon are present are bounded by areas not easily accessible to the public. Thus, a number of sturgeon strandings/carcasses may go unreported simply because they are not detected.

7.4.2 Sea turtles

Sea turtles (green, Kemp's ridley, hawksbill, leatherback, and loggerhead) may be physically injured if struck by transiting vessels within the fishery. Sea turtles are susceptible to vessel collisions and propeller strikes because they regularly surface to breathe and may spend a considerable amount of time on or near the surface of the water. Vessel strikes represent a recognized threat to air breathing marine species including sea turtles and these injuries are commonly observed in stranded animals. Vessel strikes can lead to the injury, debilitation, harassment, and/or mortality of sea turtles (Dwyer 2003). Results from a study by Hazel (2007) suggest that green turtles cannot consistently avoid being struck by vessels moving at relatively moderate speeds (i.e., greater than four kilometers per hour).

High levels of vessel traffic in nearshore areas along the U.S. Atlantic and Gulf of Mexico coasts result in frequent injury and mortality of sea turtles. From 1997 to 2005, nearly 15% of all stranded loggerheads in this region were documented as having sustained some type of propeller or collision injury, although it is not known what proportion of these injuries were sustained ante-mortem versus post mortem. In one study from Virginia, Barco (2016) found that all 15 dead loggerhead turtles encountered with signs of acute vessel interaction were apparently normal and healthy prior to human-induced mortality. The incidence of propeller wounds of stranded turtles from the U.S. Atlantic and Gulf of Mexico doubled from about 10% in the late 1980s to about 20% in 2004. Singel (2007) reported a tripling of boat strike injuries in Florida from the 1980's to 2005. Over this time period, in Florida alone over 4,000 (~500 live; ~3500 dead) sea turtle strandings were documented with propeller wounds, which represents 30% of all sea turtle strandings for the state (Singel 2007). These studies suggest that the threat of vessel strikes to sea turtles may be increasing over time as vessel traffic continues to increase in the southeastern U.S. and throughout the world.

Vessels in the action area include Federal, private, and commercial vessels. Federal vessels include those maintained by the U.S. Navy, U.S. Coast Guard, NOAA, and U.S. Army Corps of Engineers. Private and commercial vessels also have the potential to interact with sea turtles. At this time, we are unaware of any sea turtles identified with a vessel strike injury that have been directly related to activities associated with the NC Gill net fishery activities included proposed action.

NMFS has implemented a series of regulations aimed at reducing potential for incidental mortality of sea turtles from commercial fisheries in the action area:

Sea Turtle Handling and Resuscitation Techniques

NMFS published a Final Rule (66 FR 67495, Publication Date December 31, 2001) detailing handling and resuscitation techniques for sea turtles that are incidentally caught during scientific research or fishing activities. Persons participating in fishing activities or scientific research are required to handle and resuscitate (as necessary) sea turtles as prescribed in the Final Rule. These measures help to prevent mortality of hardshell turtles caught in fishing or scientific research gear.

<u>Outreach and Education, Sea Turtle Rescue and Rehabilitation</u>

There is an extensive network of Sea Turtle Stranding and Salvage Network participants along the Atlantic coast who not only collect data on dead sea turtles, but also rescue and rehabilitate any live stranded sea turtles. A Final Rule (70 FR 42508, Publication Date July 25, 2005), allows any agent or employee of NMFS, the USFWS, the USCG, or any other federal land or water management agency, or any agent or employee of a state agency responsible for fish and wildlife, when acting in the course of his or her official duties, to take endangered sea turtles encountered in the marine environment if such taking is necessary to aid a sick, injured, or entangled endangered sea turtle, or dispose of a dead endangered sea turtle, or salvage a dead endangered sea turtle that may be useful for scientific or educational purposes. NMFS already affords the same protection to sea turtles listed as threatened under the ESA [50 CFR 223.206(b)].

7.5 Dams, Dredging and Disposal

Riverine, nearshore, and offshore areas are often dredged to support commercial shipping, recreational boating, construction of infrastructure, and marine mining. The Wilmington District of the U.S. Army Corps of Engineers performs construction and maintenance dredging, including for Wilmington Harbor, Morehead City Harbor, and shallow draft inlets. In 2020, NMFS issued a biological opinion to the US Army Corps of Engineers and Bureau of Ocean Energy Management, known as the *2020 South Atlantic Regional Biological Opinion for Dredging and Material Placement Activities in the Southeast United States*(SARBO 2020) for programs which include dredging in the action area. Maintenance dredging is currently modifying Atlantic sturgeon nursery habitat in the Savannah River and modeling indicates that the proposed deepening of the navigation channel will result in reduced dissolved oxygen (DO) and upriver movement of the salt wedge, restricting spawning habitat. Dredging is also modifying nursery and foraging habitat in the Saint Johns River. Dredging in spawning and nursery grounds modifies the quality of the habitat and is further restricting the extent of available habitat in the Cape Fear and Cooper Rivers, where Atlantic sturgeon habitat has already been modified and restricted by the presence of dams.

Dams and their operations are the cause of major instream flow alteration in the Southeast (USFWS et al. 2001). Hill (1996) identified the following impacts of altered flow to anadromous fishes by dams:

- altered DO concentrations and temperature;
- artificial destratification;
- water withdrawal;
- changed sediment load and channel morphology;
- accelerated eutrophication and change in nutrient cycling; and
- contamination of water and sediment.

Dams are used to impound water for water resource projects such as hydropower generation, irrigation, navigation, flood control, industrial and municipal water supply, and recreation. Dams can also have profound effects on anadromous species by fragmenting populations, impeding access to spawning and foraging habitat, and altering natural river hydrology and geomorphology, water temperature regimes, and sediment and debris transport processes (Pejchar 2001; Wheaton 2004). The loss of historic habitat ultimately affects anadromous fish in two ways: 1) it forces fish to spawn in sub-optimal habitats that can lead to reduced reproductive success and recruitment, and 2) it reduces the carrying capacity (physically) of these species and affects the overall health of the ecosystem (Patrick 2005). Physical injury and direct mortality occurs as fish pass through turbines, bypasses, and spillways. Indirect effects of passage through all routes may include disorientation, stress, delay in passage, exposure to high concentrations of dissolved gases, elevated water temperatures, and increased vulnerability to predation. Activities associated with dam maintenance, such as dredging and minor excavations along the shore, can release silt and other fine river sediments that can be deposited in nearby spawning habitat. Dams can also reduce habitat diversity by forming a series of homogeneous reservoirs; these changes generally favor different predators, competitors and prey, than were historically present in the system (Auer 1996).

7.5.1 Sturgeon

The detrimental effects of dams on populations of shortnose and Atlantic sturgeon are generally well documented (Cooke 2004; Kynard 1998). Perhaps the biggest impact dams have on sturgeon is the loss of upriver spawning and rearing habitat (see Table 7 for dams in NC).

Table 7. Summary of dam location, year built, sturgeon presence, and spawning activity and locations in NC Source: adapted from NMFS (2017).

River	First Dam (Year Built)	River Kilometer (rkm)	Historical Sturgeon Presence / Spawning	Current Sturgeon Presence / Spawning
Chowan River Basin	Emporia Dam, Meherrin (1918)	203	Yes / Unknown	Unknown / Unknown
Tar-Pamlico (Tar River)	Rocky Mount Mills Dam (1971)	199	Unknown / Unknown	Unknown / Unknown
Neuse	Milburnie Dam (1903)	341	Unknown / Unknown	Unknown / Unknown
Cape Fear	Lock and Dam #1 (1915)	97	Yes / Unknown	Yes / Unlikely
Winyah Bay/Pee Dee	Blewett Falls Dam (1912)	330	Yes / Unknown	Yes / Yes (Great Pee Dee River, rkm 206.5)

Migrations of sturgeon in rivers without barriers are wide-ranging with total distances exceeding 200 km or more, depending on the river system (Kynard 1997). Although some rivers have dams constructed at the fall line that have not impacted sturgeon spawning, in many other rivers dams have blocked sturgeon upriver passage, restricting spawning activities to areas below the impoundment and leaving sturgeon vulnerable to perturbations of natural river conditions at different life stages (Cooke 2004; Kynard 1997). Sturgeon spawning sites remain unknown for the majority of rivers in their range. Observations of sturgeon spawning immediately below dams, further suggests that they are unable to reach their preferred spawning habitat upriver. Overall, 91% of historic Atlantic sturgeon habitat seems to be accessible, but the quality of the remaining portions of habitat as spawning and nursery grounds is unknown, therefore estimates of percentages of availability do not necessarily equate to functionality (ASSRT 2007). Thus, dams may be one of the primary causes of the extirpation of sturgeon subpopulations on the east coast.

The suitability of riverine habitat for sturgeon spawning and rearing depends on annual fluctuations in water flow, which can be greatly altered or reduced by the presence and operation of dams (Cooke 2004; Jager 2001). Effects on spawning and rearing may be most dramatic in hydropower facilities that operate in peaking mode (Auer 1996; Secor 2002b). Daily peaking operations store water above the dam when demand is low and release water for electricity generation when demand is high, creating substantial daily fluctuations in flow and temperature regimes. Kieffer (2012) reported extreme flow fluctuations for hydroelectric power generation on the Connecticut River affected access to shortnose sturgeon spawning habitat, possibly deterred spawning at times, and left rearing shoals either completely scoured during high flows or dry and exposed during low flows.

Several dams within the Atlantic sturgeon historic range have been removed or naturally breached. Sturgeon appear unable to use some fishways (e.g., ladders) but have been transported in fish lifts (Kynard 1998). Data on the effects of the fish lift at the Holyoke Hydroelectric Project on the Connecticut River suggest that fish lifts that successfully attract other anadromous species (i.e., shad, salmon etc.) do a poor job of attracting sturgeon: attraction and lifting efficiencies for shortnose sturgeon at the Holyoke Project are estimated around 11% (ASSRT 2007). Despite decades of effort, fish passage infrastructure retrofitted at hydroelectric dams has largely failed to restore diadromous fish to historical spawning habitat (Brown 2013). While improvements to fish passage are often required when hydroelectric dams go through Federal Energy Regulatory Commission relicensing, the relicensing process occurs infrequently, with some licenses lasting up to 50 years. Over 95% of dams on the eastern seaboard are not hydroelectric facilities, and are thus not subject to continual relicensing or fish passage improvement measures (ASMFC 2008).

Dredging and filling operations impact important habitat features of Atlantic sturgeon as they disturb benthic fauna, eliminate deep holes, and alter rock substrates (Smith 1997). Dredging operations may also pose risks to anadromous fish species by destroying or adversely modifying benthic feeding areas, disrupting spawning migrations, and filling spawning habitat with re-suspended fine sediments. As benthic omnivores, sturgeon are particularly sensitive to modifications of the benthos that affect the quality, quantity and availability of prey species. Nellis (2007) documented that dredge spoil drifted 12 km downstream over a 10-year period in the Saint Lawrence River, and that those spoils have significantly less macrobenthic biomass compared to control sites. Hatin (2007) reported avoidance behavior by Atlantic sturgeon during dredging operations, and McQuinn (2007) found that Atlantic sturgeon were substrate dependent and avoided dredge spoil dumping grounds.. This is particularly relevant when the dredged sediment contains high concentrations of organic material, these sediments often have high oxygen demands, and will actively absorb DO from the water column, lowering the oxygen available for other aquatic life. Dredging these sediments can expose them to the water column where they can further degrade water quality beyond the changes in DO from dredging other types of sediments. During times when DO is low, sturgeon may seek refuge from stressful environmental conditions by "hunkering" down and aggregating in deep, cool holes (Collins 2002; Hastings 1987). Periods of low DO concentrations and high water temperature, can result in physiological stress (Campbell 2004; Niklitschek 2009a) and poor body condition (Flournoy 1992) for sturgeon. Stress symptoms may include immobility or reduced movement (Hilton 2016; Katopodis 2019; Wilkens 2015), increased ventilation rates, and decreased metabolism (Niklitschek 2009a). Low DO levels can reduce growth, feeding, and metabolic rates. Fish may swim to the surface in low oxygen conditions to receive more oxygen- rich water at the air-water interface (Secor 2001; SSSRT 2010). Hence, even a minor decrease in DO from dredging or dredge-related activities during these times can be harmful or fatal to sturgeon in rivers.

The 2020 South Atlantic Regional Biological Opinion for Dredging and Material Placement Activities in the Southeast United States (SARBO 2020), considered dredging and material placement activities under the jurisdiction of the United States Army Corps of Engineers (USACE) Civil Works and Regulatory Programs and dredging/sand mining in borrow sites in federal waters under the jurisdiction of the Bureau of Ocean Energy Management (BOEM) Marine Minerals Program in the Southeast United States from the North Carolina/Virginia Border through and including Key West, Florida and the Islands of Puerto Rico and the U.S. Virgin Islands. Activities considered under the SARBO (2020) Opinion include dredging (maintenance dredging, dredging/sand mining in borrow sites, and restoration dredging/muck dredging to improve water quality); dredge material placement (sand placement for beach nourishment, nearshore placement, placement in in ocean dredged material disposal site [ODMDS], upland placement, transportation of materials between dredging and material placement locations); geotechnical and geophysical (G&G) surveys, conducted by USACE, necessary to complete dredging and material placement projects; and monitoring for and handling of ESA-listed species encountered during projects covered under this Opinion. NMFS concluded that the programmatic actions listed above are not likely to jeopardize the continued existence of ESA listed species or result in adverse modification to designated critical habitats considered in that Opinion.

7.5.2 Sea turtles

Hydraulic dredging can directly harm large marine animals (e.g., sturgeon and sea turtles) by lethally entraining them through the dredge drag-arms and impeller pumps. Large animals that are entrained in hydraulic dredges rarely survive the encounter. Hopper dredges, in particular, are capable of moving relatively quickly compared to turtles which can be overtaken and entrained by the suction draghead of the advancing dredge. An estimated 609 incidental takes (lethal or sublethal interactions) of sea turtles were documented from hopper dredging activity in the southeastern U.S. from 1980 through 2006 (Dickerson 2007).

Reductions in dredge entrainment rates for sea turtles have been achieved through mitigation measures including gear modifications, operational changes, time-area restrictions, and the capture and relocation of turtles away from dredge sites (Dickerson 2007). Dickerson et al. (2007) studied the effectiveness of turtle relocation trawling in reducing the incidental take of sea turtles in hopper dredge operations. They found that relocation trawling can be an effective management option provided that a substantial amount of trawling effort is conducted either at the onset of dredging or early in the project. The construction and maintenance of Federal navigation channels have caused sea turtle mortalities. Hopper dredges can entrain and kill sea turtles. Dredging may also alter foraging habitat and relocation trawling associated with the project may injure or kill sea turtles and displace the turtles out of their preferred habitat. Whole sea turtles and sea turtle parts have been taken in hopper dredging operations from New York through Florida. Between 1980 and 2003, the last time a comprehensive report was prepared by the COE, 475 documented incidents of sea turtle interactions during dredging activities in 34 channels from New York to Texas were documented. Most sea turtle encounters with hopper dredges result in serious injuries or mortalities.

Due to beach erosion in some winters, dredged materials are commonly borrowed from offshore shoals to deposit onto beaches, generally for recreational purposes. Harbor and channel dredging can indirectly affect sea turtles by degrading habitat, such as altering benthic foraging areas, decreasing the number and abundance of prey species, and reducing water quality by increasing turbidity and releasing potential contaminants into the water column (Ramirez 2017).

7.6 Water Quality

Water quality in rivers and streams is affected by human activities conducted in the riparian zone, as well as those conducted more remotely in the upland portion of the watershed. Industrial activities can result in discharge of pollutants, changes in water temperature and levels of DO, and the addition of nutrients. In addition, forestry and agricultural practices can result in erosion, runoff of fertilizers, herbicides, insecticides or other chemicals, nutrient enrichment, and alteration of water flow. Coastal and riparian areas are also heavily impacted by real estate development and urbanization resulting in stormwater discharges, non-point source pollution, and erosion. The Clean Water Act regulates pollution discharges into waters of the United States from point sources; however, it does not regulate non-point source pollution.

Chemicals such as chlordane, DDE, DDT, dieldrin, PCBs, cadmium, mercury, and selenium settle to the river bottom and are later consumed by benthic feeders, such as macroinvertebrates, and then work their way higher into the food web (e.g., to sturgeon and salmon). Some of these chemicals have recently been documented to affect physiological processes and development of larval life stages, impede a fish’s ability to withstand stress, while simultaneously increasing the stress of the surrounding environment by reducing DO, altering pH, and altering other physical properties of the water body (Chambers et al. 2012).

Water quality along the East Coast varies by region and watershed. The EPA recently published its fifth edition of the National Coastal Condition Report, a "report card" summarizing the status of coastal environments as of 2010 (EPA 2015). The report analyzes water quality, sediment, coastal habitat, benthos, and fish contaminant indices to determine status on a range from good to fair to poor. A summary of the results for the Southeast (North Carolina to Florida) regions is shown below in Figure 22. More than half of the coastal areas in both regions along the Atlantic coast were rated as either poor or fair for phosphorous, chlorophyll, and overall water quality index. Ecological fish tissue quality also received low ratings, particularly in the Southeast region where over half of the coastal area was rated as "poor" for this criterion.

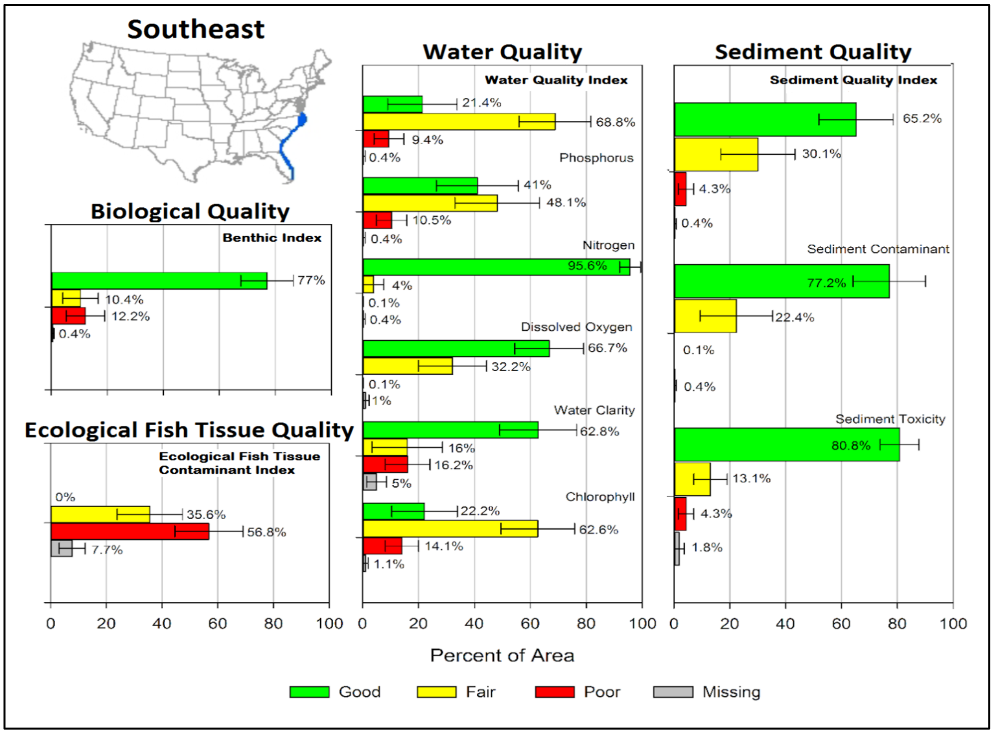


Figure 22. National Coastal Condition Assessment 2010 Report findings for the Southeast Region. Bars show the percentage of coastal area within a condition class for a given indicator. Error bars represent 95% confidence levels (EPA 2016).

The Clean Water Act requires states and territories to assess water quality every two years under 305(b) and identify waters that are impaired under 303(d) and in need of restoration. Multiple sturgeon waterways are impaired (Table 8). Impairments may be based on a single or multiple stressors within the system. One stressor may mask the effects of other stressors that are also adversely affecting aquatic life. Restoration is achieved by establishing the maximum amount of an impairing pollutant allowed in a waterbody, or Total Maximum Daily Load[1] (TMDL). These assessments are sent as an integrated report every even numbered year to EPA, which must

[1] A TMDL is the calculation of the maximum amount of a pollutant allowed to enter a waterbody so that the waterbody will meet and continue to meet water quality standards for that particular pollutant. A TMDL determines a pollutant reduction target and allocates load reductions necessary to the source(s) of the pollutant.

approve of each impaired waters' listing. As a result, many recent state assessments are not finalized until the following year or later.

Table 8. Impairments within Sturgeon Waters with Approved TMDLs

Basin/Impairment	Square Miles Impaired
Lumber	
Fecal Coliform	206
Neuse	
Benthos	11.6
Nitrogen	6063
Nitrogen, Phosphorus	771
PCB Fish Tissue Advisory, Fish Community	45.9
Roanoke	
Dioxin	304
Low Dissolved Oxygen	501
Tar	
Fecal Coliform	64
Nitrogen, Phosphorus	6148
White Oak	
Fecal Coliform	365
Nitrogen	17.4

The EPA approved North Carolina's most recent 303(d) list for freshwaters in April of 2022. The Cape Fear River basin remains impaired due to benthic and fish community imbalance and low DO. Four rivers and creeks within the basin, New Hope Creek, UT at Cross Creek Publicly Owned Treatment Works (POTW), Rocky River, and Little Cross Creek, were down listed. New Hope Creek and UT at Cross Creek POTW were reclassifies as from category 5 (exceeds criteria) to category 3a (data are insufficient to determine if a parameter is meeting or exceeding criteria) because new data indicated improvements in turbidity and DO levels, respectively. Rocky River was reclassified as category 1 (unimpaired) because data indicated DO levels were consistently within criteria limits. Little Cross Creek was delisted because the benthic community assessment used data collected from the wrong station. Two segments of the Cape Fear River Basin, UT to Stagg Creek and Neills Creek, were newly listed as a category 5 impairments for benthos and turbidity, respectively. TMDLs for nutrients are in development for the Middle Cape Fear River and approved TMDLs for cadmium in Little Troublesome Creek and for Selenium in South Buffalo Creek have been in place since 1997.

For the Neuse River, impairments include turbidity, chlorophyll a, impaired benthic biological criteria, and pH. Two creeks were down listed from a category 5 to category 3a (Pigeon House Branch) and to a category 1 (Little Creek) for new data regarding improvements in DO and benthic biological criteria. The larger Neuse River (from Falls Lake below normal pool elevation) was added as a new listing due to exceeding turbidity criteria. The Neuse River Estuary has had approved TMDLs since 2002 for total nitrogen.

Similarly, the Yadkin-Pee Dee River Basin remains heavily impaired by chlorophyll a, pH, zinc, turbidity, low impaired benthic biological criteria and fish community criteria, fecal coliform, copper, PCBs, arsenic, DO, and water temperature. The Pee Dee River was downlisted from a category 5 to 3a as a result of new data on pH showing improved pH levels. Several creeks were also added to the 303(d) list for exceeding the following criteria: turbidity, benthic community criteria, copper, zinc, PCBs, and chlorophyll a. TMDLs exist for various creeks within the Yadkin-Pee Dee River Basin and approved TMDLs for fecal coliform are in place for Roaring River (2011) and Rocky River (2002).

Listed impairments to the Roanoke River basin include poor benthic biological criteria and fish community criteria, turbidity, water temperature, copper dissolved chronic criteria, chlorophyll a, and DO. Two creeks within the basin were down listed from a category 5 to a category 3a (Country Line Creek) and to a category 1 (Nutbush Creek) for new data regarding improvements in benthic community criteria and chlorophyll a. Two additional creeks (Island Creek and Rattlesnake Creek) were added to the list of impaired waters for North Carolina due to impaired benthic biological criteria and fish community criteria. Approved TMDLs for Roanoke River were approved in 1996 for dioxin and DO as well as for the Tar River in 1995 for nutrient and DO.

The Tar-Pamlico River Basin remains impaired by pH, chlorophyll a, turbidity, DO, benthic biological criteria, zinc, copper, shellfish growth capabilities, enterococcus, and fish community criteria. Segments of the Pamlico River were down listed from a category 5 to category 3a for improved DO levels as a result of new data, and from a category 5 to a 1 for improvements towards enterococcus criteria also as a result of new data. One segment of the Pamlico River was added to the impaired list for exceeding chlorophyll a criteria in addition to two creeks for exceeding turbidity criteria (UT to Deep Creek) and DO criteria (Town Creek). TMDLs for the Tar River were approved in 1995 for nutrients and DO levels.

7.7 Municipal Separate Storm Sewer Systems

Municipal Separate Storm Sewer Systems (MS4s) are conveyances or a system of conveyances that are:

- owned by a state, city, town, village, or other public entity that discharges to Waters of the United States,
- designed or used to collect or convey stormwater (e.g., storm drains, pipes, ditches),
- not a combined sewer, and
- not part of a sewage treatment plant, or publicly owned treatment works

The Clean Water Act Section 402(p)(3)(B) states that permits for MS4 discharges may be issued on a system or jurisdiction-wide basis, and must effectively prohibit non-stormwater discharges into the sewer system. Stormwater discharges regulated under an MS4 permit represent a baseline stormwater impact to which other regulated discharges are added.

In North Carolina all MS4 dischargers are required to register for a permit. NPDES permits may be issued in one of two types: individual and general. General NPDES wastewater permits currently exist for non-contact cooling water discharges, petroleum-based groundwater remediation, sand dredging, seafood packaging, and domestic discharges from single-family residences (e.g., pesticides, conjunctive water uses). Individual permits are issued on a case-by-case basis for activities not covered under the general permits.[2] General permits, on the other hand, cover discharges with similar operations and types of discharges that are applicable statewide. The requirements of a general permit are defined and known by the permittee. In general, an individual permit will take longer to be issued than a general permit.

There are currently 122 permitted MS4 entities in North Carolina and there are currently 109 active NPDES MS4 permits. The North Carolina DEQ issues individual NPDES MS4 Permits for a five-year permit term and does not currently offer a general permit option.

7.8 Environmental Contamination

Environmental contaminants include atmospheric loading of pollutants, stormwater runoff from coastal development, groundwater discharges, and industrial development. Non-point sources from terrestrial activities have caused reductions in water quality leading to degradation of habitat for sturgeon and sea turtles. Chemical contamination may have effects on listed species' reproduction and survival. Multiple municipal, industrial, and household sources, as well as atmospheric transport, introduce various pollutants such as pesticides, hydrocarbons, organochlorides (*e.g.*, DDT, PCBs, and PFCs), and others that may cause adverse health effects to sea turtles (Camacho 2013; George 2017). Acute exposure to hydrocarbons from petroleum products released into the environment via oil spills and other discharges may directly injure individuals through skin contact with oils, inhalation at the water's surface and ingesting compounds while feeding. (Stacy 2017). Hydrocarbons also have the potential to impact prey populations, and therefore may affect listed species indirectly by reducing food availability in the action area. (Schuyler 2014b). Excessive turbidity due to coastal development and/or construction sites may also influence sea turtle or sturgeon foraging ability. The 2010 status review for shortnose sturgeon reviewed contaminant risks applicable to all sturgeon species. The life history characteristics of amphidromous sturgeon (i.e., long lifespan, extended residence in estuarine habitats, benthic foraging) predispose these species to long-term and repeated exposure to environmental contamination and potential bioaccumulation of heavy metals and other toxicants (Dadswell 1979; NMFS 1998). Chemicals and metals such as chlordane, dichlorodiphenyl dichloroethylene (DDE), DDT, dieldrin, PCBs, cadmium, mercury, and selenium settle to the river bottom and are later consumed by benthic feeders, such as macroinvertebrates, and then work their way higher into the food web, including to sturgeon. Some of these compounds may affect physiological processes and impede a fish's ability to withstand stress, while simultaneously increasing the stress of the surrounding environment by reducing dissolved oxygen, altering pH, and altering other physical properties of the water body. Pesticide exposure in fishes may affect anti-predator and homing behavior, reproductive function, physiological development, and swimming speed and distance (Beauvais 2000b; Moore 2001; Scholz 2000b; Waring 2004). Sensitivity to environmental contaminants also varies across

[2] Individual permits are further divided into two classes: major and minor. Major discharges are permitted to discharge one million gallons per day or greater. Minor discharges are permitted to discharge less than one million gallons per day.

life stage. Early-life-stages of fishes appear to be more susceptible to environmental and pollutant stress than older life stages (Rosenthal 1976b). The presence of a contaminant in the tissues of an organism indicates exposure, but does not always mean these tissues residues are causing adverse effects. Elevated levels of contaminants in fish have been associated with reproductive impairment (Billsson 1998a; Cameron 1992b; Giesy 1986; Hammerschmidt 2002a; Longwell 1992; Mac 1991; Matta 1997)), reduced larval survival (Berlin 1981; Giesy 1986), delayed maturity (Jørgensen 2004) and posterior malformations (Billsson 1998a).

As early as 1980, Cape Fear River's chemical burdens were starting to be identified by researchers. In 1980, the river had been contaminated with chemical compounds containing fluorine, originating at DuPont's Fayetteville Works plant, (which combined with Chemours) after this merge the detection of PFAS (also called PFOA) in the North Carolina waters is first documented. The Cape Fear River basin got contaminated with wastewater discharges from the chemical plant. Two years later, Chemours started replacing PFOA with a chemical called GenX. This was in compliance with the U.S. Environmental Protection Agency (EPA) PFOA Stewardship Program in 2009. Beginning in 2012, the chemical GenX along with other PFAS was detected in the water of the Cape Fear River. Sampling was completed in 2015 for the EPA's Unregulated Contaminant Monitoring Rule (UCMR3). According to the results released, PFAS is present in over 20 public water systems, 11 of which were detected in NC counties. Additional research is needed to explain the exposures south of the Chemours facility. Another areas of concern is the high levels of PFAS contamination in Deep and Haw Rivers. (EPA 2023). To understand the levels of polyfluoroalkyl substances (PFAS) in fish in the middle and lower Cape Fear River, the NC Department of Environmental Quality and NC Wildlife Resources Commission collected and tested fish from the species that are most frequently caught and consumed in North Carolina based on surveys by the NCWRC. PFAS were found in all species tested. Levels of PFOS were higher in Bluegill, Flathead Catfish, Largemouth Bass, Striped Bass and Redear. Levels were lower in American Shad, Blue Catfish and Channel Catfish. The PFOS concentrations were similar to those measured in fish from other states, based on recent data from EPA (2023). On July 13, 2023, the North Carolina Department of Health and Human Services adopted fish consumption advisories in the middle and lower portions of the Cape Fear River due to high levels of PFOS detected in many of the fish sampled.

7.8.1 Sturgeon

The life histories of sturgeon species (i.e., long lifespan, extended residence in estuarine habitats, benthic foraging) predispose them to long-term, repeated exposure to environmental contamination and potential bioaccumulation of heavy metals and other toxicants (Dadswell 1979). Heavy metals and organochlorine compounds accumulate in sturgeon tissue, but their long-term effects are not well studied (Ruelle 1993). Shortnose sturgeon collected from the Delaware and Kennebec Rivers had total toxicity equivalent concentrations of polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), Polychlorinated biphenyls (PCBs), DDE, aluminum, cadmium, and copper all above adverse effect concentration levels reported in the literature (Brundage III 2008). Dioxin and furans were detected in ovarian tissue from shortnose sturgeon caught in the Sampit River/Winyah Bay system (South Carolina). High levels of contaminants, including chlorinated hydrocarbons, in several other fish species are associated with reproductive impairment (Billsson 1998b; Cameron 1992a; Giesy 1986;

Hammerschmidt 2002b), reduced survival of larval fish (McCauley 2015; Willford 1981), delayed maturity and posterior malformations (Billsson 1998b). Pesticide exposure in fish may affect anti-predator and homing behavior, reproductive function, physiological maturity, swimming speed, and distance (Beauvais 2000a; Scholz 2000a; Waring 2004).

Sensitivity to environmental contaminants also varies by life stage. Early life stages of fish appear to be more susceptible to environmental and pollutant stress than older life stages (Rosenthal 1976a). Early life stage Atlantic and shortnose sturgeon are vulnerable to PCB and Tetrachlorodibenzo-p-dioxin (TCDD) toxicities of less than 0.1 parts per billion (Chambers 2012). Increased doses of PCBs and TCDD have been correlated with reduced physical development of Atlantic sturgeon larvae, including reductions in head size, body size, eye development and the quantity of yolk reserves (Chambers 2012). Juvenile shortnose sturgeon raised for 28 days in North Carolina's Roanoke River had a 9% survival rate compared to a 64% survival rate at non-riverine control sites (Cope 2011). The reduced survival rate could not be correlated with contaminants, but significant quantities of retene, a paper mill by-product with dioxin-like effects on early life stage fish, were detected in the river (Cope 2011).

Dwyer (2005) compared the relative sensitivities of common surrogate species used in contaminant studies to 17 ESA-listed species including Atlantic sturgeon. The study examined 96-hour acute water exposures using early life stages where mortality is an endpoint. Chemicals tested were carbaryl, copper, 4-nonphenol, pentachlorophenal and permethrin. Of the ESA-listed species, Atlantic sturgeon were ranked the most sensitive species tested for four of the five chemicals (Atlantic and shortnose sturgeon were found to be equally sensitive to permethrin). Additionally, a study examining the effects of coal tar, a byproduct of the process of destructive distillation of bituminous coal, indicated that components of coal tar are toxic to shortnose sturgeon embryos and larvae in whole sediment flow-through and coal tar elutriate static renewal (Kocan 1993).

7.8.2 Sea turtles

A variety of heavy metals have been found in sea turtles tissues in levels that increase with turtle size. These include arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, silver, and zinc, (Barbieri 2009; Fujihara 2003; García-Fernández 2009; Godley 1999; Storelli 2008). Cadmium has been found in leatherbacks at the highest concentration compared to any other marine vertebrate (Gordon 1998). Newly emerged hatchlings have higher concentrations than are present when laid, suggesting that metals may be accumulated during incubation from surrounding sands (Sahoo 1996). Arsenic has been found to be very high in green turtle eggs (Van de Merwe 2009). Sea turtle tissues have been found to contain organochlorines, including chlorobiphenyl, chlordane, lindane, endrin, endosulfan, dieldrin, perfluorooctane sulfonate, perfluorooctanoic acid, DDT, and PCB (Alava 2006; Gardner 2003; Keller 2005; Oros 2009; Storelli 2007). PCB concentrations are reportedly equivalent to those in some marine mammals, with liver and adipose levels of at least one congener being exceptionally high (Davenport 1990; Oros 2009). Levels of PCBs found in green sea turtle eggs are considered far higher than what is fit for human consumption (Van de Merwe 2009). Keller (2004) investigated the possible health effects of organochlorine contaminants, such as polychlorinated biphenyls (PCBs) and pesticides on loggerhead sea turtles. Although concentrations were relatively low compared with other species, they found significant correlations between organochlorine contaminants levels and health indicators for a wide variety of biologic functions, including immunity and homeostasis of proteins, carbohydrates, and ions.

Several studies have reported correlations between organochlorine concentration level and indicators of sea turtle health or fitness. Organochlorines have the potential to suppress the immune system of loggerhead sea turtles and may affect metabolic regulation (Keller 2006; Oros 2009). Accumulation of these contaminants can also lead to deficiencies in endocrine, developmental and reproductive health (Storelli 2007). Balazs (1991) suggested that environmental contaminants are a possible factor contributing to the development of the viral disease FP in sea turtles by reducing immune function. Day (2007) investigated mercury toxicity in loggerhead sea turtles by examining trends between blood mercury concentrations and various health parameters. They concluded that subtle negative impacts of mercury on sea turtle immune function are possible at concentrations observed in the wild.

7.9 Marine debris

Marine debris has become a widespread threat for a wide range of marine species that are increasingly exposed to it on a global scale. Plastic is the most abundant material type worldwide, accounting for more than 80% of all marine debris (Poeta 2017). The most common impacts of marine debris are associated with ingestion or entanglement and both types of interactions can cause the injury or death of animals of many different species. Ingestion occurs when debris items are intentionally or accidentally eaten (e.g. through predation on already contaminated organisms or by filter feeding activity, in the case of large filter feeding marine organisms, such as whales) and enter in the digestive tract. Ingested debris can damage digestive systems and plastic ingestion can also facilitate the transfer of lipophilic chemicals (especially POPs—persistent organic pollutants) into the animal's bodies. An estimated 640,000 tons of fishing gear is lost, abandoned, or discarded at sea each year throughout the world's oceans (Macfadyen 2009). These "ghost nets" drift in the ocean and can fish unattended for decades (ghost fishing), killing large numbers of marine animals through entanglement.

Marine debris is a significant concern for ESA-listed species, particularly sea turtles and marine mammals. The initial developmental stages of all turtle species are spent in the open sea. During this time both juvenile turtles and their buoyant food are drawn by advection into fronts (convergences, rips, and driftlines). The same process accumulates large volumes of marine debris, such as plastics and lost fishing gear, in ocean gyres (Carr 1987). An estimated four to twelve million metric tons of plastic enter the oceans annually (Jambeck 2015). It is thought that sea turtles eat plastic because it closely resembles jellyfish, a common natural prey item (Schuyler 2014b). Ingestion of plastic debris can block the digestive tract which can cause turtle mortality as well as sub-lethal effects including dietary dilution, reduced fitness, and absorption of toxic compounds (Laist 1999; Lutcavage 1997). Santos (2015) found that a surprisingly small amount of plastic debris was sufficient to block the digestive tract and cause death. They reported that 10.7% of green turtles in Brazilian waters were killed by plastic ingestion, while 39.4% had ingested enough plastic to have killed them. These results suggest that debris ingestion is a potentially important source of turtle mortality, one that may be masked by other causes of death. Gulko and Eckert (2003) estimated that between one-third and one-half of all sea turtles ingest plastic at some point in their lives. A more recent study by Schuyler et al. (2015) estimates that 52% of sea turtles globally have ingested plastic debris. Schuyler (2016) synthesized the factors influencing debris ingestion by turtles into a global risk model, taking into account the area where turtles are likely to live, their life history stage, the distribution of debris, the time scale, and the distance from stranding location. They found that oceanic life stage turtles are at the highest risk of debris ingestion. Based on this model, olive ridley turtles are the most at-risk species; green, loggerhead, and leatherback turtles were also found to be at a high and increasing risk from plastic ingestion (Schuyler 2014a). The regions of highest risk to global turtle populations are off the east coasts of the U.S., Australia, and South Africa; the East Indian Ocean, and Southeast Asia. In addition to ingestion risks, sea turtles can also become entangled in marine debris such as fishing nets, monofilament line, and fish-aggregating devices (Dagorn) (Laist 1999; Lutcavage 1997; NRC 1990). Turtles are particularly vulnerable to ghost nets due to their tendency to use floating objects for shelter and as foraging stations (Dagorn 2013; Kiessling 2003).

7.10 Climate Change in North Carolina

The following is a comprehensive summary of baseline climate change conditions in NC as reported in the 2022 NOAA National Centers for Environmental Information, State Climate Summaries (Kunkel). Temperatures in NC have increased steadily with winter average temperatures generally above average since 1990 and summer average temperatures the warmest on record for the last 16 years (2005–2020). Although NC has not experienced an increase in the frequency of very hot days the last 11 years (2010–2020), it has experienced the largest number of very warm nights. There is no overall trend over time in annual precipitation. Since 1900, global average sea level has risen by about 7–8 inches. This has caused an increase in tidal floods associated with nuisance-level impacts. Nuisance floods are events in which water levels exceed the local threshold (set by NOAA's National Weather Service) for minor impacts. These events can damage infrastructure, cause road closures, and overwhelm storm drains. As sea level has risen along the NC coastline, the number of days exceeding the nuisance-level threshold has also increased, with the greatest number (14) occurring at Wilmington in 2018. A large portion of NC's coastline is extremely vulnerable to sea level rise due to its low elevation and to geological factors that are causing the land to sink in the northern Coastal Plain.

A storm at hurricane intensity reaches NC about once every 3 years; however, storms at less than hurricane intensity can also have major impacts. The late 1990s through the early 2000s and the late 2010s through 2020 were notably active hurricane periods. In 1999, Hurricane Floyd dropped 15 to 20 inches of rain in the eastern part of the state, which was still recovering from flooding caused by Hurricane Dennis several weeks earlier. Beginning on September 6, 2004, the remnants of Hurricane Frances dropped 6 to 10 inches of rain across much of western NC over a 3-day period. Less than 2 weeks later, the remnants of Hurricane Ivan struck the same area, dropping 10 inches of rain and causing hundreds of landslides in the mountains. During October 7–9, 2016, Hurricane Matthew dumped torrential rain that caused major flooding in eastern NC, with many locations receiving more than 10 inches and a few locations more than 18 inches. In September 2018, the most intense rainfall event on record occurred as Hurricane Florence dropped 20 to 36 inches in eastern NC, causing widespread destruction and losses exceeding $20 billion, more than the combined losses from Floyd and Matthew. In addition to damage from high winds and flooding, hurricane strikes can produce tornadoes. Rainbands associated with Hurricane Frances spawned multiple tornadoes in the central and eastern portions of the state.

There is a large and growing body of literature on past, present, and future impacts of global climate change, exacerbated and accelerated by human activities. Some of the likely effects commonly mentioned are sea level rise, increased frequency of severe weather events, and change in air and water temperatures. NOAA's climate information portal provides basic background information on these and other measured or anticipated effects (see the Climate.gov website).

7.11 Predation

7.11.1 Sturgeon

Very little is known about natural predators of Atlantic sturgeon. However, Gadomski (2005) and Bunch (2021) have shown that catfish (*Ictalurus spp*.) and other species do prey on juvenile sturgeon, and concerns have been raised regarding the potential for increased predation on juvenile Atlantic sturgeon by introduced blue and flathead catfish (Brown 2005).Other documented predators of sturgeon species, in general, include sea lampreys (*Petromyzon marinus*), gar (*Lepisosteidae spp*.), striped bass (*Morone saxatilis*), common carp (*Cyprinus carpio*), northern pikeminnow (*Ptychocheilus oregonensis*), channel catfish *(Ictalurus punctatus*), smallmouth bass (*Micropterus dolomieu*), walleye (*Sander vitreus*), fallfish (*Semotilus corporalis*), grey seal (*Halichoerus grypus*), and sea lion (*Zalophus spp.)*(Gadomski 2005). However the extent is unknown.

7.11.2 Sea turtles

Predation by various land predators is a threat to developing nests and emerging hatchlings. The primary natural predators of sea turtle nests are mammals, including raccoons (*Procyon lotor)*, dogs (*Canis lupus familiaris*), pigs (*Sus domesticus*), skunks (*Mephitis mephitis*), and badgers (*Taxidea taxus*). Emergent hatchlings are preyed upon by these mammals, as well as ghost crabs (*Ocypode quadrata*), laughing gulls (*Leucophaeus atricilla*), and the exotic South American fire ant (*Solenopsis invicta*). In addition to natural predation, direct harvest of eggs and adults from beaches in foreign countries continues to be a problem for various sea turtle species in certain parts of their range (Dow Piniak 2011).

8 EFFECTS OF THE ACTION

Effects of the action are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action but are not part of the action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (50 CFR §402.02).

This section of the opinion considers the stressor of bycatch in commercial gill nets where exposure is the interaction with the net and the response is the probable outcome, including live releases and mortalities.

During ITP years 2013–2021, there were 9,305 observed commercial anchored gill net trips. Of the 9,305 trips, 9,167 of them included gear that were exclusively either large-mesh (n = 7,396) or small-mesh (n = 1,771) nets. The remaining 138 of them included gear that had nets of both mesh-size categories. The 138 trips, therefore, were split into two proportional trips in each case for an overall total of 7,478.7 observed large-mesh trips and 1,826.3 observed small-mesh trips. From 2013 to 2021, there were 196,979 estuarine anchored gill-net trips. This is an average of 21,886 per year. (NCDMF 2023). Given the number of trips recorded and the number of observed trips this gives the fishery a 4.7% observed trip rate or ~1 of 21 trips is observed.

This data was used as the amount of fishing to calculate interaction rates. The following protected species interactions were documented on observed commercial anchored gill net trips: Atlantic sturgeon (n = 359), shortnose sturgeon (n = 2), unidentified sturgeon (n = 2), green sea turtles (n = 247), Kemp's ridley sea turtles (n = 42), loggerhead sea turtles (n = 8), and unidentified sea turtles (n = 11).

8.1 Sturgeon

8.1.1 Exposure Analysis

8.1.1.1 *Atlantic sturgeon exposure*

This section of the opinion estimates the number of Atlantic sturgeon that will interact with North Carolina's inshore gill net fisheries. Exposure varies depending on whether it is a large mesh or small mesh fishery. Since 2010, NCDMF has monitored these fisheries, providing considerable information (fishery effort, observer coverage, and bycatch rates identified above) on which to determine the number of sturgeon-net interactions that are reasonably certain to occur. The above documented levels of fishing effort, anticipated future fishing effort, proportion of observer coverage, and incidents of bycatch were used as model parameters to calculate interaction rates for the next 10 years. This is a reasonable approach because fishing effort has been declining over the past decade and we are anticipating fishing effort consistent with that observed since the southern flounder gill net fishery was closed in 2018. Furthermore, as a protection against modeling errors resulting from limited observe coverage that may result in more bycatch than anticipated by this modeling, NCDMF is continuing the observer program at the same levels to inform managers whether bycatch rates are changing causing effects of the action to be different than considered here. In other words, while this exposure analysis relies on the best available scientific and commercial data, extrapolations relying on that data and its underlying variability represent what is reasonably certain to occur but also will be monitored to know if observed bycatch rates are higher than calculated here. Estimates of bycatch produced here are made by mesh size, season, and MU.

The modeled estimates of bycatch were derived from observed trips and observed captures from 2013 through 2021. In those years, 80.68% of observed trips (7,396/9,167) were of large mesh fisheries. However, 88.64% of observed bycatch occurred in large mesh fisheries). While nearly 10,000 trips were observed over those 9 years, when broken into MU, by mesh size, and by season, only 361 Atlantic or shortnose sturgeon bycatch events were observed (Table 10). Because of the relative rarity of bycatch events, the data becomes very limited and less useful for analyzing in narrow categories. Therefore, we pooled all of the data to produce our models and estimates. Once we had estimates, we applied the 88.64% occurrence rate of bycatch in large mesh gill nets to estimate anticipated bycatch events by mesh size.

Table 9. Observed bycatch events of Sturgeon 2013-2021 in NC commercial estuarine anchored gill nets

Year	Atlantic Sturgeon		Shortnose sturgeon	
	Large mesh	Small mesh	Large mesh	Small mesh
2013	35	10	0	0
2014	27	2	0	0
2015	66	12	0	0
2016	61	5	1	0
2017	104	3	1	0
2018	27	0	0	0
2019	15	4	0	0
2020	7	0	0	0
2021	17	1	0	0
Total	359	37	2	0

The number of probable interactions in future large mesh and small mesh fisheries can be estimated using data from 2013-2021 (Table 11) and an estimate of how future planned regulations will affect the amount of fishing effort over the next 10 years. The observed levels of exposure from 2020 and 2021 are expected to continue at similar fishing rates through the 10-year length of the permit. For those two years, the ZIP GLM model was able to estimate bycatch levels, the average of which rounds up to 231 Atlantic sturgeon captured each year. Of these, 205 bycatch events are likely to occur in large mesh gill nets. These values were, and will continue to be, strongly dependent on fishing effort. Fishing effort is expected to either remain somewhat consistent with the 2020 and 2021 levels or to continue declining.

Table 10 Reported fishery effort by year along with calculated levels of live and dead bycatch of Atlantic sturgeon during the previous ITP.

Year	Fishery net hours	Calculated live bycatch	Lower 95% CL	Upper 95% CL	Calculated lethal bycatch	Lower 95% CL	Upper 95% CL
2013	27,694	1,445	790	2,100	93	50	136
2014	25,307	1,173	478	1,868	75	30	120
2015	20,980	939	628	1,250	58	38	78
2016	18,010	872	578	1,166	55	36	74
2017	19,552	1,058	716	1,400	67	44	90
2018	18,929	342	109	575	24	8	40
2019	16,735	257	102	412	15	5	25

2020	11,752	141	36	246	7	0	14
2021	12,453	294	91	497	18	5	31

Those 231 individuals captured each year (2,310 individuals over the duration of the ITP) will not all be natal to the Carolina DPS of Atlantic sturgeon. Determination of DPS for each Atlantic sturgeon bycatch event is not possible in real time because each DPS is morphologically indifferentiable and the New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs are commonly found in NC waters. However, lengths of individuals can be used to guide the likely DPS assignments. Individuals <500 mm TL and ≥1,500 mm TL are assumed to belong to the DPS where they were collected (ASMFC 2017) because individuals of these sizes are generally regarded as juveniles natal to those locations but not large enough to leave the river or adults that are most likely returning to their natal rivers to reproduce. Of the 319 incidentally captured Atlantic sturgeon that were measured during ITP years 2013–2021, 34 (12.2%) were <500 mm TL, 3 (0.9%) were ≥1,500 mm TL, and 86.8% were in between those length categories. Thus, 13.1% of bycatch could be assigned to the Carolina DPS without further evaluation, but the correct DPS for the remaining portion of bycatch is unknown. Assigning DPS based on the subadult (characterized as a migratory juvenile) lengths can be inferred from a recent genetic analysis reported by Kazyak (2021a) for Atlantic sturgeon sampled along the US Atlantic coast. In their paper, samples were divided between river/estuarine waters and coastal ocean waters, and among regions "North," "Mid," and "South" for analysis. Samples from NC were split between the "Mid" region (from Cape Hatteras and Pamlico River north to Massachusetts) and the "south" region (from around Cape Hatteras and Neuse River south to the Florida-Georgia line). The proportional assignment predictions of DPS were applied to the 277 remaining exposures anticipated (86.8% of the total). Because most observed bycatch in NC come from the area included in the "mid" region, the proportional assignments from this region were deemed the most appropriate. The mean, minimum, and maximum proportion of each DPS anticipated by combining probable natal fish with mixed population proportions from Kazyak et al. (2021) are presented in Table 12.

Table 11. Proportion of each Atlantic sturgeon DPS likely represented as bycatch in the NC inshore gill net fisheries

DPS	Mean	Lower 95% CL	Upper 95% CL
New York Bight	0.135	0.110	0.159
Chesapeake Bay	0.019	0.011	0.042
Carolina	0.644	0.581	0.662
South Atlantic	0.087	0.071	0.138

In order to anticipate the amount of exposures to each DPS that are reasonably certain to occur, we rely on the upper 95% confidence limits of the estimates in Table 11 above. This is because we are dealing with uncertainty in the data and confidence limits are used to frame the extents of what could be the true proportion observed in the data. Therefore, we consider that up to 14.6% of the bycatch could be from the New York Bight DPS because that is the upper limit of what is statistically reasonably certain to occur. Because we considered that the upper 95% confidence limits of each effected DPS, the cumulative numbers for affected DPSs will exceed 231, but the amount of anticipated bycatch is unchanged and the differences in upper extent of effects to any particular DPS will fluctuate given the random bycatch events from within a group of Atlantic sturgeon of mixed genetic origin.

8.1.1.2 *Shortnose sturgeon exposure*

The NCDMF Observer Program has only documented two observed bycatch events (both released alive) of shortnose sturgeon since the program began in 2000. The lower Cape Fear River Program conducted by University of NC-Willmington, is a large-scale water quality and environmental assessment program encompassing the Cape Fear River Estuary and a large portion of the lower Cape Fear watershed, the program included a fin fish monitoring component from 1995 through 2003, which was a collaborative endeavor between UNC-W and NCDMF; no shortnose sturgeon were captured in the lower Cape Fear River or estuary. Due to the vagility seen in shortnose sturgeon (Fernandes 2010) shortnose sturgeon interactions are reasonably certain to occur, though they will be infrequent. Best available information suggests that individual rivers and estuaries along the North Carolina coast do not currently support reproducing populations of shortnose sturgeon. Between 2000 and 2013, no shortnose were observed either as monitoring of the fishery or during fishery independent gill net surveys. Then between 2013 and 2021, two were observed (one in 2016 and the other in 2017). That trend may indicate an increasing presence of shortnose sturgeon in the action area and if that rate of increase continues during this permit cycle, we would anticipate that up to four shortnose sturgeon are reasonably certain to be captured as bycatch during the 10-year permit.

8.1.2 Response Analysis

Given the potential for exposure to stressors associated with the proposed action discussed above, in this section, we describe the range of responses ESA-listed species may display as a result of exposure to those stressors. Our assessment considers the potential lethal, sub-lethal (or physiological), or behavioral responses that might reduce the fitness of individuals. We discuss the response of a species in terms of *take* under the ESA. *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” (16 U.S.C. §1532(19)). NMFS defines *harass* as 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 (NMFS Policy Directive 02-110-19). *Harm* is defined as an act that actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding or sheltering (50 CFR §222.102).

The NCDMF Observer Program data from ITP years 2013 through 2021 indicated that the majority (94%) of Atlantic sturgeon bycatch in anchored inshore gill nets were released alive.

The 6% observed mortality rate is approximately what was anticipated in the previous Conservation Plan and biological opinion. Because of the underlying data supporting the previous analysis and the additional observations of response to bycatch during the last Conservation Plan, we continue to anticipate that 6% of all sturgeon bycatch will be lethal. Therefore, of the 231 sturgeon expected to be captured as bycatch each year, 218 of those would be expected to be released alive and 13 would be killed. For a 2-year rolling average, this would be 436 Atlantic sturgeon released alive and 26 killed.

However, entanglement in nets could result in injury and mortality, reduced fecundity, and delayed or aborted spawning migrations of sturgeon (Moser 1995). It is important to note that the number and proportion of sturgeon considered to have been released alive on observed trips is not the same as the number of sturgeon that ultimately survive interaction with fishing gear on observer trips. And even when the individuals survive, injuries may lead to slower growth, lower fecundity, or more energy used during movement. In addition, observers are recording status at time of capture; the data thus do not provide information regarding post-release mortality. There is limited information available to characterize post-release mortality for sturgeon caught in gill net gear. Fox (2013) conducted field trials of an experimental low-profile gill net design in conjunction with an examination of Atlantic sturgeon behavior in the presence of sink gill nets and an examination of post release mortality of incidentally landed Atlantic sturgeon. A total of 20 fishing trips were taken under the project by participating vessels, during which paired gill nets were deployed. Two to three strings each of a control industry standard gill net and experimental low profile gill net were deployed at each location. A total of 31 Atlantic sturgeon were incidentally caught over the course of this project, 18 of which were dead upon the net being hauled. The 13 remaining sturgeon were fitted with a p-sat transmitter and released alive. Of these, only four transmitters were recovered, and Fox (2013) speculated that one (25%) of these individuals suffered a mortality post-release. A greater sample size is needed to make any strong conclusions about post-release mortality experienced by Atlantic sturgeon caught in gill net gear (NMFS 2022a). Because of the small sample size and the uncertainty as to whether the one individual was a post-release mortality, we consider an estimate of 25% to be an over-estimate of true post-release mortality.

Bahn (2012) discussed post-release mortality without mentioning any injuries; therefore, NMFS assumes there were likely no injuries observed because they would have been important in the post-release mortality discussion. Each individual sturgeon will react differently to changes in environmental conditions such as water quality, salinity, and stress associated with incidental capture (Altinok 1998; Gunderson 1998; Jenkins 1993; Niklitschek 2009b; Secor 1995; Secor 2001; Secor 2002c; Secor 2002b; Sulak 1998; Waldman 2002) . The number of anticipated sturgeon injured as bycatch is between the number observed in Collins (1996) a 20% nonlethal injury rate for sturgeon captured in anchored commercial shad nets in South Carolina and the 0% reported during monitoring of the Altamaha River in Bahn (2012). Based on that, and the post-release mortality estimates above, it is likely that no more than 10% of the sturgeon bycatch released alive will be harmed as a result of the capture. Injuries to sturgeon can be relatively minor, such as gill abrasions or cuts from the nets or more severe, such as loss of scutes, loss of pectoral fins, or internal trauma. More severe injuries can lead to post-release mortality or when individuals survive, their long-term growth may be affected. For instance, common injuries from bycatch are damage to pectoral fins because of the way they entangle in a net and fish with injured pectoral fins expend more energy swimming, requiring more food consumption to reach their maximum sizes. Because sturgeon fecundity is directly related to the size of the individuals (Mitchell et al. 2020), any injuries that affect a sturgeon's growth, also affect their cumulative reproductive capacity throughout their lives by affecting both raw numbers of eggs produced per reproductive event and frequency of reproductive events. As noted above, 218 Atlantic sturgeon are expected to be released alive each year. Therefore, 22 of those are likely to be harmed by the capture process Table 12 .

Table 12. Anticipated annual Atlantic sturgeon take resulting from the NC inshore gill net fishery during the permit term 2024-2033) broken out by total bycatch and of those, killed, harmed, and no delayed effects. The upper 95% confidence limits for the proportion of each DPS that will be subjected to those anticipated types of take are shown in the last 4 columns.

Mesh	Total Bycatch	Dead	Harmed	No Delayed Effects	NYB	CB	Car	SA
Large	205	11	20	176	15.9%	4.2%	66.2%	13.8%
Small	26	2	2	20	15.9%	4.2%	66.2%	13.8%

Spawning Atlantic sturgeon are not likely to be intercepted by the fishery because of the size gill nets used, the timing, and the location of the nets. Additionally, research by Fox (2019c) has shown that tagging and telemetry is a feasible approach to developing post-release mortality estimates for sturgeon, thus the PIT tagging of incidentally caught sturgeon and the maintenance of the telemetry arrays in the action area will provide data needed.

8.1.3 Summary Analysis

Combining the exposure analysis and response analysis provides an estimate of the amounts and types of take that are reasonably certain to occur (Table 13). The modeling done for Atlantic sturgeon anticipates that approximately 231 Atlantic sturgeon will be caught each year from 2024-2034. Of those bycatch events 205 will be in large mesh gill nets. Both mesh sizes combined would expect the capture and live release of 218 Atlantic sturgeon. Thirteen mortalities are expected each year, as well as 22 sturgeon harmed (either injured in nets or delayed mortalities).

Table 13. Anticipated Atlantic sturgeon take in small and large mesh gill nets under the proposed NC inshore gill net commercial fishery.

	Disposition	Derivation source	2-year cycle	10-year total take
Large and small mesh combined	Live	Anticipated (modeled)	436	2,180
	Dead	Anticipated (proportional)	26	130
	Post-release harm (subset of live releases)	Anticipated (proportional)	44	220
	Dead (observed)	Observed	6 dead	

When considering those total amounts of annual take, there is uncertainty from which DPS affected sturgeon will be. Using the upper 95% confidence limits from Kazyak et al. (2021), we anticipate no more than 37 Atlantic sturgeon could be captured from the New York Bight DPS, 10 from the Chesapeake Bay DPS, 153 from the Carolina DPS, and 32 from the South Atlantic DPS. While 13 Atlantic sturgeon are likely to be killed each year, no more than 2 New York Bight DPS Atlantic sturgeon will be killed, no more than 1 Chesapeake Bay DPS Atlantic sturgeon will be killed, no more than 9 Carolina DPS Atlantic sturgeon will be killed, and no more than 2 South Atlantic DPS Atlantic sturgeon will be killed (Table 14).

Table 14 Identification of the amount or extent of take that is reasonably certain to occur along with the maximum proportions (upper 95% confidence limits) of each DPS affected. The numbers should not total the actual anticipated amount of take because they rep represent the upper proportions of each DPS for the jeopardy analysis.

DPS	Total Captured	Alive, no injury	Alive, post-release harm	Killed
Atlantic sturgeon (amount of take reasonably certain to occur)	462	392	44	26
New York Bight DPS	74	60	7	5
Chesapeake Bay DPS	20	17	2	1
Carolina DPS	306	260	30	18
South Atlantic DPS	64	54	6	4

Shortnose and Atlantic sturgeon are sympatric throughout much of their range and co-occur in many rivers along the East coast of North America. Although their use of fresh, brackish, and marine habitats differs slightly. Both species spawn in freshwater habitats and distribution of YOY shortnose and Atlantic sturgeon partially overlap at the freshwater/brackish water interface; shortnose sturgeon primarily occupy freshwater and Atlantic sturgeon primarily occupy brackish regions of estuaries. Because encounters are so rare, and mortality rates of Atlantic sturgeon have been observed to be roughly 6%, we expect shortnose sturgeon likely have a similar response to being captured in gill nets. If the trend of increasing use of North Carolina waters continues over the next 10 years, it is likely that as many as 4 shortnose sturgeon could be captured. The two shortnose sturgeon that were captured during the last 10-year ITP cycle were released alive. It's likely the shortnose sturgeon under the next 10-year cycle will also be released alive, but it is possible they could die.

Shortnose Sturgeon	Disposition	Total take over 10 year permit
	Live or Dead	4

8.2 Sea turtles

8.2.1 Exposure analysis

The NC internal coastal (inshore estuarine) anchored large and small-mesh gill net fisheries nets has caused and is likely to continue to cause entanglement of sea turtles. Sea turtles are vulnerable to entanglement and drowning in gill nets, especially when gear is unattended. Sea turtles are particularly prone to entanglement because of their body configuration and behavior. Sea turtles can be wedged (i.e., held by a mesh or meshes around the body) or become entangled when their mouth, maxillae, scutes, snout, or other projections become entangled in netting.

This section of the opinion estimates the number of Sea turtles that will interact with North Carolina's inshore gill net fisheries. The probability of exposure varies depending on whether it is a large mesh or small mesh fishery. Since 2010, NCDMF has monitored these fisheries, providing considerable information on which to determine the number of sea turtle-net interactions that are reasonably certain to occur. As with sturgeon, because using the limited observed capture data to make inferences about narrow categories (mesh size x season x MU), we pooled the available data to estimate the probability of exposure. Unlike sturgeon, there was not even enough data to estimate differences between large and small mesh gear, so it is presented as total estimates of bycatch for each species. We therefore used the results of the modeling to anticipate the amount of bycatch that is reasonably certain to occur.

8.2.1.1 *Green Sea Turtles*

The proposed action is expected to result in both live captures (non-lethal take) and mortalities (lethal take) of green sea turtles. Exposure would occur when the operation of the inshore gill net fishery results in bycatch of green sea turtles. Green sea turtles are vulnerable to incidental capture in the North Carolina commercial inshore gill net fishery because they are commonly found foraging in the same area and seasons where fishing occurs.

Of the 247 observed green sea turtles interactions between 2013 and 2021, 187 of them were alive and 60 (60/247 = 24.3%) were dead (Table 15). Most green sea turtles were observed in

MU B during the fall in large-mesh anchored gill nets; very few green sea turtles have been observed as bycatch during the winter (n = 2). The number of green sea turtles observed on any one trip ranged from zero to six individuals. The majority (98%) of observed trips had no observed interactions with green sea turtles. For the two most recent years with data available (2020-21), there were an average of 12,103 reported fishing trips. During those trips from 2013-2021, observers recorded trips observed, captures, and with that data we were able to estimate the total amount of bycatch (Table 15)

Table 15. Number of incidental takes observed in commercial estuarine anchored gill nets by the NCDMF Observer Program listed by species, disposition (alive, dead, and total), and ITP year (2013–2021: September 2012–August 2021)

	2013	2014	2015	2016	2017	2018	2019	2020	2021
Trips Observed	918	912	1,523	1,203	1,504	1,240	1,019	443	543
Fishery Effort (trips)	27,694	25,307	20,980	18,010	19,552	18,929	16,735	11,752	12,453
Observed Alive	13	11	30	34	23	29	14	21	12
Observed Dead	2	4	13	9	12	9	3	5	3
Total Observed	15	15	43	43	35	38	17	26	15
Estimated Alive	216	214	333	394	287	404	210	386	155
Estimated Dead	66	66	105	119	91	126	64	122	48
Estimated Total	282	280	438	513	378	530	274	508	203

The number of probable interactions in future large mesh and small mesh fisheries can be estimated using data from 2013-2021 and an estimate of how future planned regulations will affect the amount of fishing effort over the next 10 years. The observed levels of fishing effort from 2020 and 2021 are expected to continue through the proposed ITP permit period 2024-2033 and therefore, the exposure rates for the next 10 years should be consistent with the average bycatch observed in 2020 and 2021. The estimated exposure of green sea turtles from both Atlantic DPSs is pooled to include both large and small mesh fisheries.

Based on calculated levels of sea turtle bycatch during the past ITP, and specifically at the lower efforts observed in 2020 and 2021, less green sea turtle bycatch is anticipated during the next ITP. The average annual bycatch predicted each year in the next 10 is 356 bycaught turtles. To account for variability, a 2-year average of bycatch would not exceed 712 individual green sea turtles captured.

It is difficult to identify the impact of NC inshore anchored gill net fisheries on green sea turtle populations due to the uncertainty of abundance for each DPS in NC waters. Within U.S. waters, individuals from both the NA and SA DPS of green sea turtles can be found on foraging grounds. While there are currently no in-depth studies available to determine the percent of NA and SA DPS individuals in any given location, a study on the foraging grounds off Hutchinson Island, Florida (Atlantic Ocean-side), found that approximately 5% of the turtles sampled came from the Aves Island/Suriname nesting assemblage, which is part of the SA DPS (Bass 2000). This information suggests that the vast majority of the anticipated captures in the Atlantic Ocean are likely to come from the NA DPS. However, it is possible that animals from the SA DPS could be captured by NC anchored gill net fishery. Based on reported frequency of genetic assignment of bycatch in the previous ITP and estimates of genetic composition of foraging aggregations from Bass (2006), green sea turtles from the North Atlantic DPS represent approximately 93% of the green sea turtles in the action area and green sea turtles from the South Atlantic DPS represent approximately. 7% of green sea turtles in the action area

8.2.1.2 *Kemp's Ridley Sea Turtles*

Although Kemp's ridley do occur in shallow waters, telemetry data indicate that this species occurs often in the deep waters of Pamlico Sound which may decrease rates of interactions with the anchored large-mesh gill net fishery, which operates primarily in shallow water, often less than 1 m deep (McClellan 2009a). Of the 42 observed Kemp's ridley sea turtles, 34 of them were released alive (see Table 16). All Kemp's ridley sea turtles were observed in anchored large-mesh gill nets, and most were observed during the fall and summer in MUs B and E. No Kemp's ridley sea turtles were observed in ITP year 2020, anchored small-mesh gill nets, winter, or MU D1. The number of Kemp's ridley sea turtles observed on any one trip ranged from zero to three individuals. The majority (99%) of observed trips had no observed interactions with Kemp's ridley sea turtles, suggesting zero inflation in the data.

Table 16 Observed Kemp's ridley sea turtle interactions with commercial gill nets during the 2013-2021 ITP

		2013	2014	2015	2016	2017	2018	2019	2020	2021	
Kemp's Ridley Sea Turtle	Alive	2	1	5	7	8	5	5	0	1	34
	Dead	2	0	1	2	1	2	0	0	0	8
	Total	4	1	6	9	9	7	5	0	1	42
	Prop. Dead	50%	0%	17%	22%	11%	29%	0%	0%	0%	19%

There were so few interactions with Kemp's ridley sea turtles that even though it was possible to model an estimated number of interactions (17 live, 4 dead) each year, because 99% of the underlying data was 'no interaction', the variability from the previous years overwhelms to final 2 years of data. It is likely that the number of probable interactions in future large mesh and small mesh fisheries will exceed the modeled data for 2020 and 2021 based on data from the entire period of 2013-2021. Modeling results by ITP year are shown in Table 17.

Table 17. Predicted numbers of bycatch events broken out by live and dead Kemp's Ridley Sea Turtles

ITP Year	Live	Dead
2013	79	18
2014	61	14
2015	51	10
2016	33	7
2017	61	15
2018	55	13
2019	56	13
2020	17	4
2021	17	4
Mean	47.8	10.9
SD	21.1	4.96

Because there was only a single observed interaction in years 2020 and 2021, we believe it is more appropriate to consider an interaction rate equal to the average of the entire time period from 2013 to 2021. The likely reason for low observations in this time was due to Covid-19 pandemic and reduced observer coverage during that time. If we apply the observation data from years with more data, that would result in an average live capture rate of 5 Kemp's ridley sea turtles per year and an average of 2 dead Kemp's ridley sea turtles per year. To allow for some interannual variability, this likely means we can anticipate observing 10 live captures and 4 dead captures in large mesh gill nets every 2 years. Likewise, the lack of data for small mesh captures (no observations at all in 2020 or 2021), can be compensated for similarly by using small mesh gill net catch data over the entirety of the previous ITP. That would lead us to anticipate 2 observed captures (live or dead) every year or 4 live or dead every 2 years.

8.2.1.3 *Other Sea Turtles (Loggerhead, Leatherback, Hawksbill)*

Observer data from the current sea turtle ITP years 2013 through 2021 indicate that the majority of 100% of loggerhead sea turtles were released alive. Based on the identified and unidentified sea turtles from the past permit cycle, it is reasonably certain that other sea turtles besides green and Kemp's ridley will be captured. Hawksbill and leatherback sea turtles are likely the rarest encountered. Because of that, we anticipate no more than 2 of either are likely to be encountered during the entire permit period. Northwest Atlantic Ocean DPS loggerhead sea turtles are more common than the other two species. While only 8 were observed during the previous ITP, it is very likely that 2 could be observed in any given year, in either small or large mesh gill nets. While our previous estimate over-estimated the likelihood of interacting with loggerhead sea turtles, the values observed in the previous ITP likely under-estimate their presence. Because of that, we anticipate as many as 2 loggerhead sea turtles are likely to be captured each year, or 4 during any given 2-year period.

8.2.2 Response analysis

8.2.2.1 *Sea turtles*

Observer data from ITP years 2013 through 2021 indicated that the majority of sea turtle takes in estuarine anchored gill nets were released alive: 76% of green sea turtles, 81% of Kemp's ridley, and 100% of loggerhead turtles. However, it is expected that some proportion of the sea turtles that are released alive after capture in a gill net will succumb to post-release mortality due to the physiological effects of the capture, or they will experience a decreased ability to forage or migrate, which may make the more susceptible to re-capture within a short period of time.

The main risk to sea turtles from capture in gill net gear is forced submergence. Sea turtles can dive for prolonged periods and to great depths voluntarily because of their low metabolic rates, efficient blood oxygen transport mechanisms, and moderate tolerance to hypoxia (Lutcavage et al. 1997). Although sea turtles can stay submerged for 20-180 minutes during voluntary dives, forced submergence due to net entanglement can be lethal (Lutz and Bentley 1985). Turtles caught in a net will struggle in attempts to escape and surface for air, and oxygen stores will be rapidly depleted. It has been found that the physiological damage incurred due to net entanglement may affect the turtle's behavior and reduce its chances of survival post-release, and it has been suggested that a sea turtle's recovery from lactic acid build up can take over 15 hours, depending on the length of time submerged and level of acidosis (Milton and Lutz 2003).

However, sea turtles released alive from gill nets may later succumb to injuries sustained at the time of capture or from netting otherwise still attached when they are released (known as post-release or post- interaction mortality), resulting in permanent impacts. Post-interaction mortality results from delayed effects of physiological disturbances or traumatic injuries caused by capture (Phillips 2015; Stacy 2016). Some may suffer impaired swimming or foraging abilities, altered migratory behavior, and altered breeding or reproductive patterns. These behavioral changes may make sea turtles more susceptible to recapture within a short period of time. Numerous factors affect the survival rate of entangled sea turtles: activity level and condition of the sea turtle (i.e., disease and hormonal status); and how much netting, if any, was attached to the sea turtle at release.

Sea turtle mortality as a result of the fishery operating will result in loss of reproductive potential of each individual killed. According to the work of Crouse (1987), if the reproductive value of an egg is 1, then the reproductive value of a subadult would be 116 and that of a breeding animal would be 584. Sea turtles are long lived and may take decades to reach sexual maturity. Loggerheads reach sexual maturity at age 23-29 (Casale 2011) and green turtles reach maturity at 16-30 years (Van Houtan 2014). The females of each species lay approx. 100-130 eggs per clutch and lay 3-4 clutches every 2-4 years. Thus the death of an adult or juvenile female turtle could have generational impacts precluding the production of thousands of turtle eggs and hatchlings. NMFS is not aware of disproportionate adult female turtle mortality in the NC gill net fishery. Mortality of an adult or juvenile male turtle would also preclude their ability to contribute to future generations however that impact is difficult to quantify given minimal reproduction capability data available for male turtles.

In 2015, NMFS convened an expert workshop to gather individual input to inform development of national criteria to assess post-interaction mortality for turtles bycaught in trawl, net, and pot/trap fisheries (Stacy 2016). NMFS issued and has since updated a Policy Directive to define the process for post-interaction mortality determinations of sea turtles bycaught in trawl net, and pot/trap fisheries (NMFS 2022a). The criteria allow experts to use data collected from observed takes to evaluate the condition of turtles and assign a post-release mortality rate. To apply the criteria, experts review the data and video collected by the observers on the body condition, new and existing injuries, as well as the activity level and behavior of the captured animal prior to release and during release. At this time, NMFS is unable to apply the criteria to previous sea turtle interactions in NC inshore anchored gill nets because insufficient detail is currently collected on the activity level/behavior of the sea turtles by observers; however beginning in the fall of 2023, NCDMF will collect additional data and video to allow for the post-interaction mortality criteria to be applied in the future.

While the NMFS post-interaction mortality criteria are unable to be used to evaluate risk of post-interaction mortality at this time, the results of Snoddy (2010) is a useful tool for evaluating post-interaction mortality because the study occurred in the specific fishery and area subject to the ITP. To better understand post-interaction mortality in sea turtles captured in NC inshore anchored gill nets, Snoddy (2010) conducted a study to examine the rate of survival for sea turtles that were captured in shallow-set gill nets and released alive. In this study, the health of 14 live sea turtles captured in NC gill nets was assessed and the turtles were tagged with satellite transmitters prior to release. The primary goal of the study was to investigate the rate of post-interaction mortality of these turtles based on blood biochemistry and satellite telemetry results. The study documented one confirmed mortality and three suspected mortalities among the 14 turtles. Based on the data they collected, Snoddy (2010) estimated the post-release mortality of sea turtles captured in shallow-set gill nets ranges from 7.1 to 28.6%, although they caution that these rates are specific to soak times of 4 hours or less (Snoddy 2010). Post-interaction mortality of live released turtles is an additional factor that must be considered when evaluating the effects of the authorized take on sea turtle populations.

Despite the small sample size, the results of this study provide insight into the potential post-interaction mortality rates for shallow-set gill nets in NC. Given that the study was conducted in NC waters within the action area and within the fisheries that would be covered under the ITP, it is the best available data to assess post-interaction mortality for sea turtles in NC inshore anchored gill net fisheries. Snoddy (2010) estimated the post-release mortality of live sea turtles released from shallow-set gill nets in NC ranged from 7.1 to 28.6%, indicating that 7.1 to 28.6% of the sea turtles estimated to interact with gill nets in these fisheries may succumb to post-release mortality.

Given the range of reported post-release mortality, we anticipate the average of the two extremes to provide an approximation of the number of post-release mortalities. That would be approximately 17.85%. Therefore, of the 542 green sea turtles that will be released alive following bycatch, 97 are expected to later die as a result of the bycatch struggle.

8.2.3 Summary of Sea Turtle Bycatch

8.2.3.1 *Green sea turtles*

A total of 712 green sea turtles are expected to be captured as bycatch every 2 years. Of those, 170 are expected to be killed in the nets while 542 will be released alive. Of those 542 individuals released alive, post-release mortality is expected to result in the death of another 97 individuals every two years.

Both North Atlantic DPS and South Atlantic DPS green sea turtles are likely to be encountered in the NC nearshore gill net fishery. The breakdown of consequences to each DPS is shown in Table 18, where 93% of captured green sea turtles are likely to be North Atlantic DPS and 7% are likely to be South Atlantic DPS.

Table 18 Summary of green sea turtle bycatch based historical observed take.

DPS	Mesh Size	Type of Take	2-year rolling take	10-year total take
NA DPS (.93)	Large and small	Total Capture	662	3310
		Live	504	2520
		Post-release mortality (sub-set of live release)	90	450
		Dead	158	790
SA DPS (.07)	Large and small	Total Capture	50	250
		Live	38	190
		Post-release mortality (sub-set of live release)	7	35
		Dead	12	60

8.2.3.2 *Kemp's Ridley Sea Turtles*

Table 19 Summary of Kemp's ridley sea turtle take estimations.

Species	Mesh-size Category	Type of take	2-year rolling take	Total take 10 year ITP

Kemp's ridley	Large	Observed Live	10	50
	Large	Observed Dead	4	20
	Small	Observed Live or Dead	4	20

8.2.3.3 *Other Sea Turtles*

Table 20 Other sea turtle take estimations

Species	Mesh Size	Type of take	2-year rolling take	10-year total take
Hawksbill sea turtles	Large and small	Alive or dead	NA	2
Leatherback sea turtles	Large and small	Alive or dead	NA	2
Northwest Atlantic DPS loggerhead sea turtles	Large and small	Alive or dead	4	20

9 Cumulative Effects

Cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area (50 CFR §402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA. Water withdrawal, recreation, commercial shipping, urbanization, and changes in watershed use will continue in North Carolina's rivers, watersheds and estuaries in the future. In some cases, Federal permits will be required for these impacts, but in others these actions will be at the state, tribal, or local level. As the human population grows and is expected to continue to increase within the state of North Carolina, water withdrawal will increasingly be required for agriculture, drinking water, vessel ballast, etc.

Future recreational and commercial fishing activities in state waters may affect Atlantic sturgeon. Trawl fisheries for striped bass and flounder operate in state waters and are likely to capture Atlantic sturgeon, though no data are available on sturgeon interactions or mortality rates in these fisheries. This opinion assumes effects in the future would be similar to those in the past and are, therefore, reflected in the anticipated trends described in the Status of the Species and Environmental Baseline sections.

Counties and local governments are typically responsible for permitting the conversion of forested land for agriculture. As agriculture represents one of the most significant economic drivers for much of the state's coastal plain region, the clearing of land for agricultural use is expected to continue in the future. Agricultural runoff can include fertilizers, pesticides and animal waste from intensive animal feedlot operations, and results in increased nutrient loading, eutrophication and hypoxic conditions in streams and rivers. Atlantic sturgeon are already highly susceptible to the effects of hypoxia, especially at higher temperatures such as those experienced in North Carolina's rivers in summer and fall, as discussed in the Environmental Baseline and Effects sections of this opinion. Conversion of forested land to agricultural use also leads to increased sediment build-up in rivers used by Atlantic sturgeon as migratory and spawning habitat. As discussed in the Status of the Species section, Atlantic sturgeon rely on hard river substrates (such as cobble) for deposition of eggs and thus the sedimentation of rivers can negatively impact spawning (Smith 1997). All of these factors are expected to further limit the availability of suitable habitat for Atlantic sturgeon.

Sea turtles face numerous natural and man-made threats that shape their status and affect their ability to recover. Many of the threats either are the same or similar in nature for all ESA listed species analyzed in this opinion. Those identified in this section are discussed in a general sense for all sea turtles. There are also many non-fishery impacts affecting the status of sea turtle species, both in the ocean and on land. In nearshore waters of the U.S., the construction and maintenance of federal navigation channels has been identified as a source of sea turtle mortality. Other nearshore threats include harassment and/or injury resulting from private and commercial vessel operations, military operations and training exercises, in-water construction activities, and scientific research activities. Diseases, toxic blooms from algae and other microorganisms, and cold stunning events are additional sources of mortality that can range from local and limited to wide-scale and impacting hundreds or thousands of animals.

10 INTEGRATION AND SYNTHESIS OF EFFECTS

This opinion includes a jeopardy analysis for the endangered New York Bight DPS, Chesapeake Bay DPS, Carolina DPS, and South Atlantic DPS Atlantic sturgeon, endangered shortnose sturgeon, green sea turtle (NA and SA DPSs), Kemp's ridley sea turtle, Hawksbill sea turtle, leatherback sea turtles, and loggerhead sea turtle (NWA DPS).

We concluded that the PBFs and, therefore, entire critical habitats, for Atlantic sturgeon and NA DPS green sea turtle were not likely to be adversely affected by this action and, thus, are not analyzed further in this opinion. Section 7(a)(2) of the Act and its implementing regulations require every Federal agency, in consultation with and with the assistance of the Secretary, to insure that any action it authorizes, funds, or carries out, in whole or in part, in the United States or upon the high seas, is not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat.

Jeopardize the continued existence of means "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR §402.02). *Recovery*, used in that definition, means "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" (50 CFR §402.02).

The Integration and Synthesis section is the final step in our jeopardy analysis. In this section, we add the effects of the action (Section 8) to the environmental baseline (Section 7) and the cumulative effects (Section 9), taking into account the status of the species, critical habitat, and recovery planning (Section 6), to formulate the agency's biological opinion as to whether the Conservation Divisions insure its proposed action of issuing an ITP to the North Carolina inshore commercial gill net fishery is not likely to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution.

It is important to recognize that an adverse effect on a single individual or a small group of animals does not translate into an adverse effect on the population or species unless it results in reduced reproduction, numbers, or distribution of the individual(s) that causes an appreciable reduction in the likelihood of survival and recovery for the species.

10.1 Carolina DPS Atlantic sturgeon

The status of the populations of the Carolina DPS of Atlantic sturgeon has only recently begun to be the focus of research. Generally, it is well-known that high water temperatures and low dissolved oxygen concentrations lead to mortality and reduced growth (Niklitschek 2001), which is reflected to some extent in estimates of natural mortality rates (Boreman 1997, Kahnle et al. 1998). The reproductive strategies of this DPS are complicated. Several rivers support dual Atlantic sturgeon spawning, genetically distinct populations that reproduce in the spring and fall in the same river. Somewhat complicating matters is that spring spawning populations natal to neighboring rivers are more closely related than the spring and fall populations in the same river (White et al. 2021a). The spring spawning populations may be from straying of individuals with that life history strategy because the spring spawning populations are more closely related to one another than to other fall spawning populations (White et al. 2021a). Because summer temperatures in the Carolina DPS are stressful to all life stages of Atlantic sturgeon (Niklitschek 2001), effective population analyses (White et al. 2021a) suggest spring spawning populations are smaller than fall spawning populations. There hasn't been sufficient sampling in North Carolina to understand all Atlantic sturgeon spawning populations, with most information about this DPS coming from South Carolina, the Cape Fear River, and Roanoke River. Most research done in North Carolina is from Albemarle Sound, an estuary likely supporting rearing habitat for several spawning populations, but at least one from the Roanoke River (Smith et al. 2015). The effective population of juvenile Atlantic sturgeon captured in Albemarle Sound is between 19 and 29 (Waldman et al. 2019; White et al. 2021a). While this is the second smallest effective population estimate on the East Coast, independent gill net monitoring by NCDMF reveals successful reproduction every year (presence of juveniles under 500 mm TL) and an increasing trend in catch per unit effort in recent years.

Modeling monitoring data shows a general decrease in Atlantic sturgeon bycatch rates (almost entirely juvenile fish) from 2013 until the three lowest years in 2019-2021. Fishing effort in this ITP is expected to be similar to years 2020 and 2021. As discussed in the analysis of effects, we anticipate 231 Atlantic sturgeon are expected to be captured alive each year. We applied the upper 95% confidence limits identified in Kazyak et al. (2021) for the mid-Atlantic region to estimate the maximum number of Carolina DPS Atlantic sturgeon that are likely to be captured by this fishery. Therefore, 153 Carolina DPS Atlantic sturgeon are likely to be captured each year. Of those, 130 will be released alive with no short-or long-term effects, 15 will experience injury or post-release mortality, and 9 will be killed in the nets. This will amount to 1540 captured in the next 10 years and of those, 1300 will have no adverse effects, 150 will be injured or become delayed mortality and 90 will be killed in the nets.

While Hightower et al. (2015) and ASMFC (2017) reveal survival rates of Carolina DPS Atlantic sturgeon are below a sustainable level, bycatch since those years has been much lower and more research is needed to understand whether those studies (of a 3 year time period) represented a short, stressful period of a long-lived species' life, or if those results are longer-term and more concerning. However, the amount of take anticipated under this ITP is considerably less than was anticipated under the previous ITP. If the commercial fishery under the previous ITP was responsible for the depressed survival estimates being below the modeled sustainable levels for Atlantic sturgeon (Boreman 1997, Kahnle et al. 1998), then the estimated decline in mortality from a predicted 127 fish per year to only nine per year over the next decade (or 26 if 10% of released fish endure post-release mortality) should allow for much greater population-level survival.

While there is still limited information about the numbers of sturgeon in this DPS, the increasing CPUE data observed by NCDMF is encouraging and may indicate increasing abundance. The loss of nine juvenile sturgeon per year is expected to primarily affect the Albemarle Sound complex population – those fish reproducing in the Roanoke and Chowan Rivers. The other populations reproducing in North Carolina are likely to be largely unaffected by the commercial fishery and we would not anticipate their numbers decreasing. The distribution of Atlantic sturgeon in the Carolina DPS is not restricted and continuing to have the inshore commercial fishery, operating at lower effort than before, will likely not have much of an effect on sturgeon distribution, but if it does have an effect, fewer nets would allow for more movement than in the last 10 years. The fishery has almost no effect on adult Atlantic sturgeon, so the only way reproduction is affected is by removing juvenile individuals and the loss of their future reproductive potential. While the Carolina DPS is likely the most imperiled Atlantic sturgeon DPS, the commercial fishery as proposed with lower fishing effort, is not likely to have an appreciable reduction to the numbers, distribution, or reproduction of any of the populations in North Carolina.

The recovery outline (NMFS 2023) for Atlantic sturgeon is focused on increasing access to spawning habitat and improving water quality and quantity. Specifically for the Carolina DPS, the concerns affecting recovery are water withdrawals for human consumption, vessel strikes, dams, and commercial fisheries. While commercial fisheries are discussed in the recovery outline, it is in terms of Federal fisheries, limited observer coverage, and uncertainty about post-release mortality. The monitoring proposed as part of the conservation plan, included in the ITP will address many of these knowledge gaps and establish adaptive management approaches to modify the fishery when bycatch begins to approach the identified levels indicated in Table 13.

After evaluating the effects of the NC inshore commercial gill net fishery on the reproduction, numbers, and distribution of Carolina DPS Atlantic sturgeon, this action is not expected to appreciably reduce their likelihood of survival and recovery in the wild. Therefore, the continued operation of this fishery is not likely to jeopardize Carolina DPS Atlantic sturgeon.

10.2 Chesapeake Bay DPS Atlantic sturgeon

The Chesapeake Bay DPS is comprised of all Atlantic sturgeon spawned in the watersheds that drain into the Chesapeake Bay and into coastal waters from the Delaware-Maryland border on Fenwick Island to Cape Henry, Virginia (77 FR 5880; February 6, 2012). Spawning is currently supported in the James, York, and Nanticoke Rivers while likely also occurring in the Rappahannock River (Hilton et al. 2016).

Fall spawning activity has been documented in the James River; the Pamunkey River, a tributary of the York River; and in Marshyhope Creek, a tributary of the Nanticoke River (Balazik et al. 2012; Hager et al. 2014; Kahn et al. 2014; Richardson and Secor 2016; Secor et al. 2021). The James River is currently the only river of the Chesapeake Bay DPS where evidence suggests genetically distinct populations of Atlantic sturgeon spawn during both spring and fall. The York and James River populations were analyzed in White et al. (2021a) and were genetically differentiated at the first split between coast-wide groups (both spring and fall James River populations are more similar to northern populations and the York River is more similar to the southern group). However, Kazyak et al. (2021) suggests approximately 1.2% of bycatch in the inshore mid-Atlantic was from the York River population and 1.3% was from the James River population. But these samples were collected from New York to North Carolina. The James River representation is more likely from more northern bycatch events. The York River population is very closely related to the Nanticoke River population (Atlantic Sturgeon Tissue Research Repository, USGS; data available from J. Kahn, NMFS, OPR). Because of this, the York River and Nanticoke River populations are more likely to be the Atlantic sturgeon affected by the NC inshore gill net commercial fishery.

York River adult annual spawning abundance is approximately 350 individuals each year (Kahn 2021; Kahn 2019b). Nanticoke River adult spawning run abundance is up to approximately 70 individuals (Coleman 2024). These are adult abundance estimates. Juveniles are the primary capture representation in the NC inshore commercial fishery, but there are no estimates of juvenile abundance for either population. Reproduction is known to occur in the Pamunkey River (Hager 2014; Hager 2020), Juvenile Atlantic sturgeon of the Chesapeake Bay DPS remain in the natal estuary for one to four years before emigrating to marine waters (Balazik 2012)). Males mature at about age 10 and females at 15 years old, have at least a 25-year lifespan, and can live as long as 64 years (Balazik 2012; Hilton 2016), although the natural life expectancy of Atlantic sturgeon belonging to the Chesapeake Bay DPS is still uncertain. Survival of the York River population is estimated to be 99.2% per year (Kahn 2023).

Modeling monitoring data shows a general decrease in Atlantic sturgeon bycatch rates (almost entirely juvenile fish) from 2013 until the three lowest years in 2019-2021. Fishing effort in this

ITP is expected to be similar to years 2020 and 2021. As discussed in the analysis of effects, we anticipate 231 Atlantic sturgeon are expected to be captured alive each year. We applied the upper 95% confidence limits identified in Kazyak (2021a) for the mid-Atlantic region to estimate the maximum number of Chesapeake Bay DPS Atlantic sturgeon that are likely to be captured by this fishery. Therefore, 10 Carolina DPS Atlantic sturgeon are likely to be captured each year. Of those, eight will be released alive with no short-or long-term effects, one will experience injury or post-release mortality, and one will be killed in the nets. This will amount to 100 captured in the next 10 years and of those, 80 will have no adverse effects, 10 will be injured or experience delayed mortality, and 10 will be killed in the nets (Table 13).

The York River and Nanticoke River populations may be a metapopulation or two small populations. The loss of a single juvenile fish each year, or possibly two, if each year there is a post-release mortality associated with their capture, is unlikely to be detectable to the adult population abundances of either population over the next generation. Likewise, reproductive potential will be affected, but not in an appreciable manner by the loss of these juveniles. While reproduction is known to occur every year, it is less clear whether juveniles survive in large numbers before leaving their natal systems. This is because the threats facing this population, as discussed in the recovery outline, are from non-native predators and habitat displacement rather than out-of-state or Federal commercial fishery bycatch. Therefore, the loss of these individuals would not be expected to appreciably reduce future reproduction of the populations, much less the Chesapeake Bay DPS. And like for the Carolina DPS, the fishery will not affect distribution of this species, either in terms of movement within the North Carolina estuaries or within the Chesapeake Bay as they return to spawn in a few years. The Recovery Outline (NMFS 2023) identifies a number of threats facing the Chesapeake Bay DPS Atlantic sturgeon, including water flow, sedimentation, dredging, water quality, and vessel strikes. While bycatch is not identified as a threat to the species' recovery, all of these threats combine to affect the likelihood of recovery. However, the minimal injury and mortality anticipated to the Chesapeake Bay DPS is not likely to appreciably affect the species' likelihood of recovery.

After evaluating the effects of the NC inshore commercial gill net fishery on the reproduction, numbers, and distribution of Chesapeake Bay DPS Atlantic sturgeon, this action is not expected to appreciably reduce their likelihood of survival and recovery in the wild. Therefore, the continued operation of this fishery is not likely to jeopardize Chesapeake Bay DPS Atlantic sturgeon.

10.3 New York Bight DPS Atlantic sturgeon

The New York Bight DPS comprises known spawning populations in the Connecticut, Hudson, and Delaware Rivers. The Connecticut River appears to be a newly established population and is extremely small. There is also no historical information to suggest a population existed historically based on genetic studies (Waldman et al. 2019) or landings (Secor 2002). Historically, the Delaware and Hudson Rivers supported two of the largest Atlantic sturgeon populations along the coast and were responsible for over half of the annual landed tons in the entire coastal sturgeon commercial fishery (Secor 2002). Based on landed weights, Secor (2002) estimated that the Hudson and Delaware Rivers supported 185,000 female Atlantic sturgeon pre-fishery. Current abundance estimates for individual spawning runs in the Hudson are approximately 500 individuals (Kazyak et al. 2020) and in the Delaware are approximately 250 individuals (White et al. 2021a).

While the fisheries have been closed since 1998, recent abundance estimates are very similar to abundance estimates from the time the Atlantic sturgeon coastal fishery was closed (Kahnle et al. 2007; Kazyak et al. 2021). Increases in juvenile catch rates in the Hudson River between 2004 and 2019 are encouraging and it is possible that if those juveniles reach maturity, the adult abundance may start to increase (Pendleton and Adams 2021). The effective population sizes of the Hudson River population are the largest on the East Coast, Kazyak (2020) produced an abundance estimate of the 2014 adult spawning run size of 466 individuals (95% CL, 310-745). While the Delaware River population's effective population size is similar to most other populations along the East Coast, fewer than 250 adults (White 2021a) exist. Waldman et al. (2019) suggest that effective population size may have a crude relationship (a power function) to census population size and allow for inferences to relative abundances of various populations.

In the action area, the New York Bight DPS of Atlantic sturgeon likely represents as much as 14.6% of individuals encountered. This is likely further support for the suggestion that the larger effective population size may indicate a larger census size because outside of the Carolina DPS, where the fishery is located, this is comparable to the South Atlantic DPS and larger than the Chesapeake DPS, which is closer in proximity. While the baseline section notes many stressors such as fisheries, dredging, vessel strikes, river degradation, coastal development, erosion, contaminants, marine debris, and climate change, because Atlantic sturgeon are so highly migratory, they are also subjected to many stressors from outside the action area, the effects of which they generally carry with them into the action area. While those were not analyzed as part of this opinion, they are detailed in both the listing documents (NMFS 2012) and status reviews (NMFS 2007, 2022).

The survival rate of the New York Bight DPS is estimate to be 91.4% (ASMFC 2017). Boreman (1997) calculated that a survival rate of 88% for Atlantic sturgeon would be sufficient to support the continued existence of the species (each female would be able to produce a new individual). Because this rate of survival is based on egg lifetime egg production, there is no reason to believe this rate of survival to sustain the population has changed in 25 years. Therefore, this estimate of survival rate likely also supports the findings above from Pendleton and Adams (2021).

Modeling monitoring data shows a general decrease in Atlantic sturgeon bycatch rates (almost entirely juvenile fish) from 2013 until the three lowest years in 2019-2021. Fishing effort in this ITP is expected to be similar to years 2020 and 2021. As discussed in the analysis of effects, we anticipate 231 Atlantic sturgeon are expected to be captured alive each year. We applied the upper 95% confidence limits identified in Kazyak et al. (2021) for the mid-Atlantic region to estimate the maximum number of New York Bight DPS Atlantic sturgeon that are likely to be captured by this fishery. Therefore, 37 New York Bight DPS Atlantic sturgeon are likely to be captured each year. Of those, 30 will be released alive with no short-or long-term effects, four will experience injury or post-release mortality, and 3 will be killed in the nets. This will amount to 370 captured in the next 10 years and of those, 300 will have no adverse effects, 40 will be injured or become delayed mortality and 30 will be killed in the nets (Table 18). Typically, there are more juveniles in a population than adults, though for Atlantic sturgeon, estimating the abundance of migratory juveniles is extremely difficult.

ASMFC (2017) reveal survival rates of New York Bight DPS Atlantic sturgeon are approximately 91.4%. Estimates by Boreman (1997) and Kahnle et al. (1998) suggest this level of survival will sustain sturgeon abundance, but not allow for rapid population increases (though it will allow for slower, more gradual population growth). While there is still limited information about the numbers of sturgeon in this DPS, the increasing juvenile abundance (Hudson River), consistent annual juvenile production (both rivers), and evidence of either stable adult abundance (Hudson River) or new observed adult reproduction (Delaware River) is encouraging and likely indicates stable overall abundance in both rivers. Similarly, while the Connecticut River Atlantic sturgeon population is newly identified, it appears to support annual reproductive events (NMFS research permit reports). The loss of 7 juvenile sturgeon per year (3 directly and up to 4 from post-release mortality) is expected to be a small proportion of the juvenile abundance from the entire DPS (Hale et al. 2016; Savoy et al. 2017; Pendleton and Adams 2021). Therefore, we do not expect this level of bycatch related mortality to appreciably reduce the juvenile abundance of the Hudson or Delaware Rivers and it is extremely unlikely all New York Bight DPS bycatch in North Carolina would affect the Connecticut River because of its proximity (the furthest possible river from this fishery and the smallest abundance in the New York Bight DPS). The distribution of Atlantic sturgeon in the New York Bight DPS is not restricted, and even appears to be expanding. We do not anticipate the projected bycatch in the North Carolina inshore gill net fishery will affect the distribution of populations within the New York Bight DPS. The fishery has almost no effect on adult Atlantic sturgeon, so the only way reproduction is affected is by removing juvenile individuals and the loss of their future reproductive potential. But with the documented successful annual reproduction in all three known spawning populations of this DPS, this level of bycatch is not expected to have any detectable effect on future reproduction potential.

The Recovery Outline (NMFS 2023) identifies a number of threats facing the New York Bight DPS Atlantic sturgeon, including water flow, sedimentation, dredging, water quality, and vessel strikes. While bycatch is not identified as a threat to the species' recovery, all of these threats, including bycatch, combine to affect the likelihood of recovery. However, the minimal injury and mortality anticipated to the New York Bight DPS is not likely to appreciably affect the species' likelihood of recovery.

After evaluating the effects of the NC inshore commercial gill net fishery on the reproduction, numbers, and distribution of New York Bight DPS Atlantic sturgeon, this action is not expected to appreciably reduce their likelihood of survival and recovery in the wild. Therefore, the continued operation of this fishery is not likely to jeopardize New York Bight DPS Atlantic sturgeon.

10.4 South Atlantic DPS Atlantic sturgeon

The South Atlantic DPS includes all Atlantic sturgeon that spawn or are spawned in the watersheds (including all rivers and tributaries) of the ACE (Ashepoo, Combahee, and Edisto) Basin southward along the South Carolina, Georgia, and Florida coastal areas to the St. Johns River, Florida (77 FR 5914; February 6, 2012). The South Atlantic DPS historically supported eight spawning populations. At the time of listing, only six populations were believed to have contemporary spawning: the Combahee River, Edisto River, Savannah River, Ogeechee River, Altamaha River (including the Oconee and Ocmulgee tributaries), and Satilla River. The two remaining historical spawning populations in the Broad-Coosawatchie River and St. Marys River were believed extirpated. However, the capture of juvenile Atlantic sturgeon in the St. Marys River since listing suggests that the population is not extirpated, but successful spawning does not appear to occur every year (Fox et al. 2018).

The Altamaha River likely supports one of the largest spawning populations of Atlantic sturgeon along the Atlantic Coast and the Savannah and Edisto Rivers also support large spawning populations. While census estimates are not available, effective population estimates of South Atlantic DPS populations reveals the Savannah River has the largest effective population size within Atlantic sturgeon's range (154.5), while the Altamaha (141.7) and Hudson (145.1) Rivers support the next largest (White et al. 2021a). The Edisto River supports spring and fall runs (Collins et al. 2000) with effective population estimates of 16.4 and 47.9, respectively (White et al. 2021a). Geneticists believe there is a relationship between effective population size and census size, though for endangered species, it can be more variable (Frankham 2005). Therefore, the South Atlantic DPS of Atlantic sturgeon may support two of the healthiest populations and also two of the most at risk populations.

Modeling monitoring data shows a general decrease in Atlantic sturgeon bycatch rates (almost entirely juvenile fish) from 2013 until the three lowest years in 2019-2021. Fishing effort in this ITP is expected to be similar to years 2020 and 2021. As discussed in the analysis of effects, we anticipate 231 Atlantic sturgeon are expected to be captured alive each year. We applied the upper 95% confidence limits identified in Kazyak et al. (2021) for the mid-Atlantic region to estimate the maximum number of South Atlantic DPS Atlantic sturgeon that are likely to be captured by this fishery. Therefore, 32 South Atlantic DPS Atlantic sturgeon are likely to be captured each year. Of those, 27 will be released alive with no short- or long-term effects, three will experience injury or post-release mortality, and 2 will be killed in the nets. This will amount to 320 captured in the next 10 years and of those, 270 will have no adverse effects, 30 will be injured or become delayed mortality and 20 will be killed in the nets.

Because of the size of the South Atlantic DPS populations, we do not anticipate the projected bycatch and loss of between two (two individuals killed in nets; no individuals experience post-release mortality) and five (two individuals killed in nets; all three individuals released with injuries suffer post-release mortality) juvenile individuals per year from this DPS in the North Carolina inshore gill net fishery will appreciably reduce the abundance of any individual population. Likewise, because the level of potential mortality and delayed mortality are not expected to significantly reduce the abundance of any of the South Atlantic DPS populations, we would not expect the operation of this commercial fishery to affect the distribution of populations within the South Atlantic DPS. Less than 1% of the commercial fishery bycatch affects adult Atlantic sturgeon (only three of 359 observed captured sturgeon in the last 10 years), so the only way reproduction is affected is by removing juvenile individuals and the loss of their future reproductive potential. But with documented successful annual reproduction in every South Atlantic population except the St. Marys River, this level of bycatch is not expected to have any appreciable effect on future reproduction potential.

The Recovery Outline (NMFS 2023) identifies a number of threats facing the South Atlantic DPS Atlantic sturgeon, including water flow, sedimentation, dredging, water quality, and vessel strikes. While bycatch is not identified as a threat to the species' recovery, all of these threats, including bycatch, combine to affect the likelihood of recovery. However, the minimal injury and mortality anticipated to the South Atlantic DPS is not likely to appreciably affect the species' likelihood of recovery. After evaluating the effects of the NC inshore commercial gill net fishery on the reproduction, numbers, and distribution of South Atlantic DPS Atlantic sturgeon, this action is not expected to appreciably reduce their likelihood of survival and recovery in the wild. Therefore, the continued operation of this fishery is not likely to jeopardize South Atlantic DPS Atlantic sturgeon.

10.5 Shortnose sturgeon

Shortnose sturgeon can be found in 41 bays and rivers along the U.S. East coast, but their distribution across this range is broken up, with a large gap of about 250 miles (400 km) separating the northern and mid-Atlantic metapopulations from the southern metapopulation (King 2014). Little to no reproduction occurs from just south of the Delaware River, through the Chesapeake Bay and Pamlico Sound, south to the populations in South Carolina. A majority of rivers in NC do not support shortnose sturgeon populations, despite historical records indicating their presence (VanDerwarker 2001). Shortnose sturgeon were historically present in the Roanoke, Chowan, and Cape Fear Rivers and the Winyah Bay System (SSSRT 2010). Cape Fear estuary likely serves as a migration or staging corridor for spawning, perhaps in Brunswick River. More likely, there is no more spawning in this system and the Pee Dee River in South Carolina is the closest spawning population of shortnose sturgeon to North Carolina.

Because there are no known spawning populations of shortnose sturgeon in North Carolina, they are rarely encountered in the inshore gill net fishery. No shortnose sturgeon were observed between 2000 and 2015, but then one was captured in 2016 and another in 2017. Like this fishery's observers, the NCDMF have not encountered a shortnose sturgeon in North Carolina waters since 2017. Recent detection of sturgeon in North Carolina waters is, however, encouraging and may suggest habitat is becoming more favorable for the species and some individuals are exploring currently unoccupied habitat.

Because encounters are so rare, and mortality rates of Atlantic sturgeon have been observed to be roughly 6%, we expect shortnose sturgeon likely react similarly to Atlantic sturgeon when captured in gill nets. If the trend of increasing use of North Carolina waters continues over the next 10 years, it is likely that as many as 4 shortnose sturgeon could be captured. The two shortnose sturgeon that were captured during the last 10-year ITP cycle were released alive. It's likely that any shortnose sturgeon captured under the next 10-year cycle will also be released alive, but it is possible they could die. These individuals likely come from populations in South Carolina and Georgia. Those populations have stable to increasing trends in abundance. The loss of up to 4 individuals from those systems would not appreciably reduce their abundance. Similarly, shortnose sturgeon captured as bycatch in North Carolina are not likely a part of a spawning population in North Carolina. In the past, gravid shortnose sturgeon captured in North Carolina and given acoustic tags move to rivers in South Carolina and Georgia where they remain (Moser and Ross 1995). We would not anticipate any appreciable effect to shortnose sturgeon reproduction as a result of bycatch in the North Carolina inshore gill net fishery.

Despite being correctly identified as a unique species in 1818, historic distribution of shortnose sturgeon is complicated by their misidentification as juvenile Atlantic sturgeon in commercial landings until the 1960s (Vladykov and Greeley 1963). Because of this, data on use of North Carolina rivers for reproduction are uncertain (NMFS 1998). The recovery plan is focused on recovering individual populations to large sizes and restoring access to habitat blocked by dams, but there is not a focus on establishing populations in the currently uninhabited 400 km stretch of the mid-Atlantic. Therefore, because it is uncertain whether North Carolina rivers supported spawning habitat historically and because range expansion would benefit the species (it is, however, not a requisite for delisting the species), the bycatch of 4 individuals over the next 10 years is not likely to appreciably affect the distribution or recovery potential of the species.

After evaluating the effects of the NC inshore commercial gill net fishery on the reproduction, numbers, and distribution of shortnose sturgeon, this action is not expected to appreciably reduce their likelihood of survival and recovery in the wild. Therefore, the continued operation of this fishery is not likely to jeopardize shortnose sturgeon.

10.6 Green Sea Turtles

Green sea turtles from the North Atlantic DPS (93% of the green sea turtles in the action area) have an increasing abundance trend and green sea turtles from the South Atlantic DPS (7% of greens in the action area) have a mixed trend (driven by differences in trends on nesting beaches). The density of green sea turtles and their habitat use likely increases their co-occurrence with some anchored gill net fisheries in North Carolina (McClellan and Read 2009). Data from strandings and fisheries incidental capture data (pound nets and gill nets) indicate an increase in the relative abundance of green sea turtles in NC inshore estuarine waters (Epperly et al. 2007, Byrd et al. 2011, Braun-McNeill et al. 2018, Shamblin et al. 2018, NCWRC unpublished data).

Of the 247 observed green sea turtles takes in reporting years 2013-2021, 187 of them were alive and 60 were dead. These observations can be modeled to produce an estimate of annual bycatch events for green sea turtles of approximately 356, but 331 of those will be from the North Atlantic DPS and the other 25 will be from the South Atlantic DPS. Of those captured, 79 North Atlantic DPS green sea turtles are likely to die and 6 South Atlantic sea turtles are likely to die. Of the 252 and 19 North Atlantic and South Atlantic DPS green sea turtles to be released alive, 45 and 4, respectively are expected to die after release due to post-release mortality. These levels of anticipated take over the next 10 years are similar, but slightly lower than what was calculated over the past 10 years (385 vs 356). When bycatch levels were higher during the previous 10 years, the North Atlantic DPS green sea turtle abundance trends were increasing as was density in the inshore waters of North Carolina. Likewise, the less-represented South Atlantic DPS green sea turtles had stable abundance trends despite more threats from outside the US or the high seas. This suggests that despite the bycatch in this fishery, the general trend of the North Atlantic DPS is increasing and for the South Atlantic DPS, it is stable.

These levels of bycatch are expected to have an effect on the amount of green sea turtle reproduction. We expect all South Atlantic DPS turtles captured to be age classed as juveniles and not sexually mature, so reproductive effects would be as a result of fewer individuals maturing to adults. For the North Atlantic DPS, we would anticipate both adults and juveniles would be killed. This would reduce the number of adults available to reproduce. As discussed above, the trend in abundance is increasing, so these losses would not reduce the numbers of adults nesting, but it will slow the rate of increase. Regardless, this is not expected to result in an appreciable reduction of the species' reproduction. Likewise, the loss of these individuals would not have a detectable effect on the distribution of green sea turtles. Green sea turtle distribution is driven less by density of individuals and more by temperature, meaning that as long as North Carolina's inshore waters are warm and hospitable, green sea turtles will continue to use this habitat.

The recovery goals for green sea turtles along the US Atlantic Coast relate to number of nests per year, nesting beaches in public ownership, and abundance trends on foraging grounds. Recent trends indicate that where these goals have not currently being achieved, the expansion of nesting areas and increased densities are trending in the right direction. Further the recovery plan recommends the use of observers to monitor fisheries bycatch, which is proposed as part of this commercial fishery. As noted above, the North Carolina inshore fishery has been affecting the North Atlantic DPS of green sea turtles for the last 10 years at higher impacts than are anticipated over the next 10 years. Because of that and the fact that abundance and densities are generally increasing, the North Carolina inshore gill net fishery is not likely to appreciably affect the species' likelihood of recovery.

After evaluating the effects of the NC inshore commercial gill net fishery on the reproduction, numbers, and distribution of North Atlantic DPS and South Atlantic DPS green sea turtles, this action is not expected to appreciably reduce their likelihood of survival and recovery in the wild. Therefore, the continued operation of this fishery is not likely to jeopardize either the North Atlantic DPS or South Atlantic DPS of green sea turtles.

10.7 Kemp's Ridley Sea Turtles

Kemp's ridley sea turtles are the least abundant sea turtle in the world. They received protections under the ESA in 1967. Nesting turtles declined sharply from the 1940s through the 1980s before reversing trend and increasing through 2014. The trend of abundance and nesting attempts in the last decade has fluctuated between good and bad years giving a mixed impression of population health. There are typically fewer than 10 Kemp's ridley sea turtle nests in North Carolina each year and the majority of bycatch interactions in North Carolina's gillnet fisheries are juveniles.

The trend of commercial fishing effort in the past 10 years was that of a steep decline, ending with less than half the effort in 2021 than in 2013. Not surprisingly, the number of observed Kemp's ridley captures declined as well, with only 1 observation in the last 2 years of the fishery. While effort is expected to remain similar to the effort in 2020 and 2021, bycatch depends on both commercial fishing effort as well as Kemp's ridley sea turtle presence. With no estimates of the number of Kemp's ridley sea turtles in North Carolina inshore waters, less effort alone is not an indicator of lower anticipated bycatch. Therefore, we anticipate that each year 5 Kemp's ridley sea turtles will be observed alive and another 2 dead in large mesh nets. Similarly, we anticipate up to 2 live or dead observations in small mesh gill nets. This equates to 50 released alive over the next decade and as many as 40 dead Kemp's ridley turtles.

The primary threat to Kemp's ridley sea turtles is egg collection and with translocation of nests to incubators, populations are projected to increase in abundance (NMFS 2011), though now 13 years later, the trend is uncertain. One possible outcome of increased nest and juvenile survival to the juvenile neritic stage is those individuals are now at carrying capacity and increased competition is causing a decrease in adults (Caillouet et al. 2018). Increased competition may also drive more Kemp's ridley sea turtles further from the Gulf of Mexico and into waters of North Carolina and other East Coast estuaries. An increased distribution of Kemp's ridley sea turtles would be positive for the species. In either event, the observation of up to 9 Kemp's ridley sea turtles per year in the inshore gill net fishery and the loss of up to 4 per year will not appreciably reduce the abundance of Kemp's ridley sea turtles. Likewise, this loss would not appreciably reduce the distribution of the species, which as just noted, may be expanding due to increased competition and resource limitation at their current densities. Reproductive potential will be affected by the loss of these individuals, but not in an appreciable manner because those lost will be juveniles. The 2011 recovery plan (NMFS 2011) identifies downlisting criteria for nests in a season and recruitment of hatchlings. The downlisting criteria must be met for 6 consecutive years and while the nesting females and number of recruits frequently meet the downlisting criteria, the species does not have consistently high enough nesting females to be downlisted. Kemp's ridley sea turtle reproduction (nesting attempts) is not increasing at the rate it is modeled to increase. As discussed above, this may be due to resource limitation, restricting the very life stage being captured in the inshore gill net fishery. However, the species' nesting and recruitment is trending in a direction where it could be downlisted. Regardless, the loss of these few individuals is not likely to appreciably reduce the likelihood of recovery.

After evaluating the effects of the NC inshore commercial gill net fishery on the reproduction, numbers, and distribution of Kemp's ridley sea turtles, this action is not expected to appreciably reduce their likelihood of survival and recovery in the wild. Therefore, the continued operation of this fishery is not likely to jeopardize the Kemp's ridley sea turtle.

10.8 Hawksbill Sea Turtles

Globally, hawksbill sea turtles have been declining. Hawksbill sea turtles are rare in North Carolina (Epperly et al. 1995). They are rarely observed north of Florida. There have been two hawksbill sea turtle nests documented in North Carolina, both relatively recently (2015). These are the two northernmost hawksbill sea turtle nests ever observed. The biggest threats to hawksbill sea turtles are the harvesting of their eggs, degradation or inaccessibility of nesting habitat, and fisheries interactions.

Only two hawksbill sea turtles have been observed in inshore commercial gill nets since 2000. The two anticipated over the next decade would match that previous rate. Every year, between 22,004 and 29,035 females make nests. And hawksbill sea turtles have been increasing in abundance in the Gulf of Mexico over the past 40 years. The loss of two sea turtles over the next decade would not appreciably reduce the abundance of this species. Likewise, with the documentation of two nests in North Carolina within the last 10 years, the species may be expanding its range, more likely as a result of climate change and warmer water temperatures along the Atlantic Coast than from increased nearby densities. Indeed, some in the scientific community anticipate hawksbill sea turtle range expansion as a result of changing environmental conditions (Maurer 2021).

The hawksbill sea turtle recovery plan (NMFS 1993) establishes objectives for increasing female abundance on 5 index beaches, protecting nesting habitat, and increases of all life stages in foraging areas. All of the recovery plan goals focus on Florida and islands in the Gulf of Mexico. Nesting habitat will not be affected at all by this fishery. The abundance of adult females or any life stage on foraging grounds could be reduced by the loss of individuals here who would later travel to Gulf of Mexico nesting or foraging locations. But the loss of two individuals from the fishery is not likely to appreciably reduce hawksbill sea turtles' ability to recover.

After evaluating the effects of the NC inshore commercial gill net fishery on the reproduction, numbers, and distribution of hawksbill sea turtles, this action is not expected to appreciably reduce their likelihood of survival and recovery in the wild. Therefore, the continued operation of this fishery is not likely to jeopardize the hawksbill sea turtle.

10.9 Leatherback Sea Turtles

Leatherback sea turtles are a wide ranging sea turtles species with decreasing nest abundance in the northwest Atlantic. In North Carolina, leatherback sea turtles are observed off the coast of North Carolina, but they are not common nesters on NC beaches and they are relatively rare in inshore estuarine waters. With limited numbers of nesting surveys, leatherback sea turtle nests in North Carolina decreased from 4 in 1998 to 0 by 2017. Of all the sea turtles recovered as strandings along the coast of these inshore North Carolina waters, only 0.2% (12/5,456) were leatherback sea turtles. While observers of the North Carolina inshore gill net fishery have not documented a leatherback sea turtle as bycatch since 2000, their presence along the Atlantic Coast and recovery as strandings suggest their capture is possible in the fishery, although exactly how many could interact with the large mesh gill net fishery is difficult to estimate based on existing observer coverage levels..

As with hawksbill sea turtles, our modeling allows us to anticipate 2 leatherback sea turtles may be observed during the course of the 10 years of the ITP. These observations may be live or dead. But with over 20,000 leatherback sea turtles estimated (NMFS and USFWS 2020), the loss of two is not expected to appreciably affect the population. Leatherback sea turtles are not aggregate nesters and are not likely attempting to nest on the beaches of North Carolina. The individuals that may be caught as bycatch likely represent foraging individuals. However, those two individuals if lost, would affect the reproductive population as a loss of reproductive potential. But this loss would not appreciably reduce the reproductive potential of the northwest Atlantic population. The other consideration we make is whether the bycatch will appreciably reduce leatherback sea turtle distribution. Again, we do not anticipate that the loss of two individuals will appreciably reduce the distribution of leatherback sea turtles.

The leatherback sea turtle recovery plan (NMFS and USFWS 1992) focuses on increasing abundance of leatherback sea turtles in the Gulf of Mexico and Florida and nesting habitat in the same locations. As before, the commercial fishery will not affect nesting habitat, but it may affect the number of individuals. However, the loss of two individuals over the next decade is not likely to prevent the recovery of the species.

After evaluating the effects of the NC inshore commercial gill net fishery on the reproduction, numbers, and distribution of leatherback sea turtles, this action is not expected to appreciably reduce their likelihood of survival and recovery in the wild. Therefore, the continued operation of this fishery is not likely to jeopardize the leatherback sea turtle.

10.10 Loggerhead Sea Turtles

Loggerhead sea turtles in the northwest Atlantic Ocean nest as far north as Virginia. Most nesting occurs in Florida, but the recovery unit from Georgia to Virginia has exhibited a positive growth rate over the past 37 years (NMFS and USFWS 2023). Estimated abundance along the United States' Atlantic Coast is likely over half a million loggerhead sea turtles (NMFS 2011) with abundance around the Chesapeake Bay ranging between approximately 3,000 and 27,000 depending on the season (Barco et al. 2018).

The North Carolina inshore commercial gill net fishery has captured loggerhead sea turtles in the past. Between 2013 and 2021, 8 loggerhead sea turtles were observed. Given the abundance of loggerhead sea turtles in the area, this is a relatively small number, possibly explained by habitat preference of the turtles relative to the target commercial species. It is likely that observers with the commercial fishery may see as many as two individuals each year as bycatch. Those two individuals, or 20 individuals over the next decade, are not likely to appreciably reduce the robust population of loggerhead sea turtles in the action area. Likewise, the loss of those two individuals is not expected to appreciably reduce their distribution along the coast or their future reproductive success.

The loggerhead sea turtle recovery plan (NMFS and USFWS 2008) focuses on numbers of females and nests, abundance on foraging grounds, and relative in-water abundance. The loss of two loggerhead sea turtles each year (or 20 in the next decade) out of a local abundance that is measured in the thousands is not expected to appreciably reduce the likelihood of recovery.

After evaluating the effects of the NC inshore commercial gill net fishery on the reproduction, numbers, and distribution of Northwest Atlantic DPS of loggerhead sea turtles, this action is not expected to appreciably reduce their likelihood of survival and recovery in the wild. Therefore, the continued operation of this fishery is not likely to jeopardize the Northwest Atlantic DPS of loggerhead sea turtles.

11 CONCLUSION

After reviewing and analyzing the current status of the listed species, the environmental baseline within the action area, the consequences of the proposed action and associated activities, and the cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of New York Bight DPS Atlantic sturgeon, Chesapeake Bay DPS Atlantic sturgeon, Carolina DPS Atlantic sturgeon, South Atlantic DPS Atlantic sturgeon, North Atlantic DPS green sea turtles, South Atlantic DPS green sea turtles, Kemp's ridley sea turtles, hawksbill sea turtles, leatherback sea turtles, or Northwest Atlantic DPS loggerhead sea turtles. Section 5.1 assessed the effects of the proposed action to Carolina DPS Atlantic sturgeon designated critical habitat and determined the effects of the proposed action may affect, but are not likely to adversely affect that critical habitat.

We also conducted a conference on the North Atlantic DPS of green sea turtles' proposed critical habitat. We assessed the effects of the proposed action to North Atlantic DPS green sea turtle proposed critical habitat and determined the effects of the proposed action may affect, but are not likely to adversely affect that critical habitat. In the event the proposed designation is finalized and 1) no new PBFs are identified, 2) there is no new substantive information that reveals effects of the action that may affect the critical habitat in a manner or to an extent not previously considered, and 3) the proposed action has not changed; the Conservation Divisions can request, via email, that we adopt this biological and conference opinion to a biological opinion in order to satisfy the requirements of section 7(a)(2) of the ESA.

12 INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "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 in the definition of ''take'' in the Act means an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including, breeding, spawning, rearing, migrating, feeding or sheltering. (50 CFR §222.102).

Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR §402.02). Section 7(b)(4) and section 7(o)(2) of the ESA, as well as in regulation at 50 CFR §402.14(i)(5) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS.

12.1 Amount or Extent of Take

The amount or extent of take is identified in the summary sections of the effects analysis and carried forward into Table 21 in this section. The amount or extent of take that is anticipated is modeled, where underlying data support an extrapolation from observations to predicted occurrences as a result of anticipated fishing effort. However, where underlying data are lacking and there are insufficient data to estimate the total numbers of ESA-listed species taken by the fishery, take is expressed as a number of observations anticipated. However, for the purposes of monitoring, reporting, and reinitiating consultation as required under 50 CFR §§402.14(i)(4), 402.14(i)(5), and 402.16(a)(1), NCDMF plans to enter observer data into the ZIP model developed as part of this consultation to estimate actual take within the fishery based on fishery effort and bycatch observed. For species that are relatively rare as bycatch and, therefore, underlying data does not allow for modeling their captures throughout the fishery, we estimate a number of observed captures that is supported by the previous observer reports. While we identify and anticipate post-release bycatch, there is no way to monitor this after the listed species are released and therefore, they are identified as a subset of the estimated "live release" numbers and the numbers of "live releases" serve as the reinitiation trigger. Table 21 identifies the amount and extent of take of Atlantic sturgeon in total, as well as by DPS, shortnose sturgeon, green sea turtles in total, as well as by DPS, Kemp's ridley sea turtles based on mesh size, and hawksbill, leatherback, and loggerhead NW Atlantic DPS sea turtles in any sized mesh. All take in Table 21 is modeled and extrapolated from observed to anticipated, except where data are lacking. Where data are lacking, the amount or extent of take is identified as observed.

Occasionally, takes cannot be identified to species by the observers (e.g., animal falls out of net, animal is released by the fisherman and not provided to the observer). Because shortnose sturgeon are so rare in NC, any unidentified sturgeon will be treated as if it were an Atlantic sturgeon for take estimation but reported separately. Unidentified sea turtles will be apportioned based on historical interaction rate with the fishery.

Table 21. Amount or extent of take anticipated

Atlantic Sturgeon†				
Species	**Mesh size category**	**Disposition**	**Requested 2-year rolling take**	**Total take over 10 year permit**
All DPSs	Large or small	Live	436	2180
	Large or small	Dead and injured	70	350
	Large or small	Dead (observed)	6	30
New York Bight DPS	Large or small	Capture	74	370
	Large or small	Post-release harm	7	35
	Large or small	Dead	5	25
Chesapeake Bay DPS	Large or small	Capture	20	100
	Large or small	Post-release harm	2	10
	Large or small	Dead	1	5
Carolina DPS	Large or small	Capture	306	1,530
	Large or small	Post-release harm	30	150

	Large or small	Dead	18	90
South Atlantic DPS	Large or small	Capture	64	320
	Large or small	Post-release harm	6	30
	Large or small	Dead	4	20
Shortnose Sturgeon				
Mesh-size Category		**Disposition**	**Total take over 10 year permit**	
Large & Small		Live or Dead (observed)	4	
Green sea turtle				
DPS		**Condition/ Exposure**	**Requested 2-year rolling take**	**Total take over 10 year permit**
All DPSs		Total	712	3560
		Live	542	2710
		Dead	170	850
North Atlantic DPS		Exposure	662	3310
		Live	504	2520
		Dead	158	790
South Atlantic DPS		Exposure	250	26
		Live	190	21
		Dead	60	5
Kemp's Ridley sea turtle				

Mesh-size Category	Disposition	Requested 2-year rolling take	Total take over 10 year permit
Large	Live (observed)	10	50
Large	Dead (observed)	4	20
Small	Live or Dead (observed)	4	20
Hawksbill sea turtle			
Large and small mesh	**Alive or dead (observed)**	**Total take over 10 year permit**	
		2	
Leatherback sea turtle			
Large and small mesh	**Alive or dead (observed)**	**Total take over 10 year permit**	
		2	
Loggerhead sea turtle (Northwest Atlantic Ocean DPS)			
Mesh Size	Take type	**Requested 2-year rolling take**	**Total take over 10 year permit**
Large or small	Alive or dead	4	20

† Take of Atlantic sturgeon will affect 4 DPSs, at a rate up to 15.9% New York Bight DPS, 4.2% Chesapeake Bay DPS, 66.2% Carolina DPS, and 13.8% South Atlantic DPS.

12.2 Reasonable and Prudent Measures

"Reasonable and prudent measures" refer to those actions the Director considers necessary or appropriate to minimize the impact of the incidental take on the species (50 CFR §402.02). NMFS believes the reasonable and prudent measures described below are necessary and appropriate to minimize the impacts of incidental take on threatened and endangered species:

12.2.1 RPM #1 Tracking of Incidental Take

The Conservation Divisions will require NCDMF through the issuance of the ITP to record and track the reported observations of ESA-listed species that occur as bycatch in the inshore gill net fishery.

12.2.2 RPM #2 Reporting of Incidental Take

The Conservation Divisions will require NCDMF through the issuance of the ITP to provide reports on incidental takes and observer coverage to the Conservation Divisions.

12.2.3 RPM #3 Disposition of Lethal Take

For observed lethal takes, the Conservation Divisions will require NCDMF through the issuance of the ITP to provide an incidental take form and available photographs and video will be provided in email to the NCWRC and NMFS Conservation Divisions within 24 hours of the interaction. Whenever possible, keep the carcasses of ESA-listed turtles and fish for research needs. Saving and providing the remains enables research that's otherwise not possible with ESA-listed species. If the carcass is able to be salvaged please prepare to transfer to appropriate research location.

12.3 Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the Conservation Divisions must comply (or must ensure that any applicant complies) with the following terms and conditions. The Conservation Divisions or any applicant have a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species, as specified in this ITS (50 CFR §402.14(i)(3)). Any incidental take that is identified in Section 10.1 and is in compliance with the terms and conditions identified in this section is not a prohibited taking under the ESA (16 U.S.C. §1536(o)(2)), and no other authorization or permit under the ESA is required (50 CFR §402.14(i)(5)).

The following terms and conditions implement RPM #1:

- Conservation Divisions will require NCDMF report take to ensure adherence to the observed values in Table 18 which establish the reinitiation triggers.
- The Conservation Divisions will require NCDMF Observers to record bycatch as it occurs and report bycatch to NCDMF management within 24 hours.
- Conservation Divisions will require NCDMF through the issuance of the ITP to update cumulative counts of observed takes within 24 hours of receipt of observation data.
- Within 24 to 48 hours, a summary will be provided to the Conservation Divisions from NCDMF management team (i.e., Fisheries Management Section Chief, Division Deputy Director and Division Director). Adaptive management options such as area and/or gear closure, will be considered to avoid exceeding the reinitiation triggers.
- At the end of each ITP year, Conservation Divisions will require NCDMF through the issuance of the ITP to update the ZIP model with observer data and effort (trip) data to produce an annual report of the estimated numbers of species (where data allows) taken during each ITP year.

The following terms and conditions implement RPM #2:

- The Conservation Divisions will provide a brief monthly report submitted to the NMFS-OPR Endangered Species Act Interagency Cooperation Division (nmfs.hq.esa.consultations@noaa.gov) for each month in a given season such that the last month of that season would serve as a seasonal report. These reports will be provided by the end of the first month following a given month. They will include details of any takes that occurred during the month and across months in a season, an estimate of observer coverage (by MU and mesh-size category), and a comparison of estimates and/or counts of incidental takes to authorized takes in the ITP.

- The Conservation Divisions will provide an annual report submitted to the NMFS-OPR Endangered Species Act Interagency Cooperation Division (nmfs.hq.esa.consultations@noaa.gov) by June 30 of each year to include, the total observations and calculated estimates, where possible, of take occurring in the previous ITP year with the updated TTP data.

The following terms and conditions implement RPM #3:

- For each observed lethal take the Conservation Divisions will require NCDMF through the issuance of the ITP to, file an incidental take form and include available photographs and video in email submitted to NMFS Conservation Divisions and the NMFS-OPR Endangered Species Act Interagency Cooperation Division (nmfs.hq.esa.consultations@noaa.gov) within 24 hours of the interaction. The email notification will also be provided to the NCWRC.
- Whenever possible, keep the carcasses of ESA-listed turtles and fish for research needs. Saving and providing the remains enables research that's otherwise not possible with ESA-listed species.
    - For NCDMF Observers: If practicable, NCDMF staff may retain incidentally captured dead sturgeon and submit an Incidental Take Report as described in Condition C.1. If retaining dead sturgeon is not practicable, they should immediately be returned to the waters from which they were retrieved and submit an Incidental Take Report. Upon submission of the Incidental Take Report, NCDMF will report the dead sturgeon to NOAA Fisheries Southeast at (844) STURG-911 or (844) 788-7491, or send an email to: noaa.sturg911@noaa.gov for direction on the final disposition of dead sturgeon.
    - For fishermen: Injured sturgeon should be reported to NOAA Fisheries Southeast at (844) STURG-911 or (844) 788-7491, or send us an email at noaa.sturg911@noaa.gov. Any Dead incidentally captured sturgeon found dead may not be retained, consumed, sold, landed, off loaded, or transported. Dead sturgeon should immediately be returned to the waters from which they were retrieved.

13 Conservation Recommendations

Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on ESA-listed species or critical habitat, to help implement recovery plans or develop information (50 CFR §402.02).

NMFS should support data collection for in-water abundance estimates of sea turtles, and sturgeon to achieve more accurate status assessments for these species and to better assess the impacts of incidental take during fishing.

NMFS should collect data describing locations and movements of sea turtles and sturgeon in the NC estuary and coastal region to assist in future assessments of interactions between fishing gear and migratory and feeding behavior. NMFS should fund future research or collect data to identify ways to reduce the mortality rate of incidentally captured animals.

14 Reinitiation of Consultation

This concludes formal consultation for the Conservation Divisions of NMFS' Office of Protected Resources Issuing an ITP (File No. 27106) to the NCDMF for the bycatch from the commercial anchored gill net fisheries in the internal coastal waters of North Carolina.

As 50 CFR §402.16(a) states, reinitiation of consultation is required and shall be requested by the Federal agency, where discretionary Federal involvement or control over the action has been retained or is authorized by law and:

(1) If the amount or extent of taking specified in the incidental take statement is exceeded;

(2) If new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered;

(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 written concurrence; or

(4) If a new species is listed or critical habitat designated that may be affected by the identified action.

15 References

15.1 NCDMF Regulations set forth in proclamations

Proclamations can be found on the NC Department of Environmental Quality "Fisheries Management Proclamations" webpage.

Proclamation Number	Effective Date	Description
M-8-2010 (REVISED)	6/13/2010	The intent of this proclamation is to implement gill net restrictions while the Division applies for a statewide incidental take permit from NMFS under Section 10 of the Endangered Species Act.
M-31-2013	9/30/2013	The intent of this proclamation is to implement gill net restrictions under Incidental Take Permit No. 16230 from NMFS under Section 10 of the Endangered Species Act.

Proclamation Number	Effective Date	Description
M-24-2014	9/1/2014	It is unlawful for holders of a Standard Commercial Fishing License (SCFL), Retired Standard Commercial Fishing License (RSCFL), or Recreational Commercial Gear License (RCGL) to deploy gill nets in Internal Coastal Waters with an exception for run around, strike, drop or drift gill nets, without possessing a valid Estuarine Gill Net Permit issued by the Division of Marine Fisheries.
M-5-2016	4/10/2016	It is unlawful to use gill nets with a stretched mesh length of 4 in through 6 ½ in in Internal Coastal Waters except those described below. Areas not listed below are closed to gill nets (including trammel gill nets) with a stretched mesh length of 4 in through 6 ½ in; except as described in Section III.
M-19-2017	11/9/2017	This proclamation supersedes proclamation M-17-2017 dated October 12, 2017. This proclamation closes MU D1 (See map) to the use of gill nets with a stretched mesh length of 4 in through 6 ½ in (except as described in Section III.) in accordance with the Sea Turtle Incidental Take Permit.
M-6-2019	3/18/2019	During an emergency meeting on March 13, 2019, the N.C. Marine Fisheries Commission directed the N.C. Division of Marine Fisheries Director to issue this proclamation pursuant to N.C. General Statute 113-221.1 (d). The Director has no legal authority to modify or change a proclamation when the proclamation is specifically directed by the Commission under this statute. This proclamation supersedes proclamation M-5-2019, dated March 7, 2019. This proclamation prohibits the use of ALL gill nets upstream of the ferry lines from the Bayview Ferry to Aurora Ferry on the Pamlico River and the Minnesott Beach Ferry to Cherry Branch Ferry on the Neuse River. It maintains tie-down (vertical net height restrictions) and distance from shore restrictions for gill nets with a stretched mesh length 5 in and greater in the western Pamlico Sound and rivers (excluding the areas described in Section I. B.) in accordance with Supplement A to Amendment 1 to the N.C. Estuarine Striped Bass Fishery Management Plan.

Proclamation Number	Effective Date	Description
FF-34-2019	9/15/2020	This proclamation supersedes Proclamation FF-31-2019, dated August 28, 2019. It establishes commercial flounder season dates for Internal Coastal Waters by Flounder Management Area. It maintains a 15-in total length minimum size limit. It also maintains the regulation making it unlawful to possess flounder taken from anchored large mesh gill nets with a stretched mesh length less than 6 in. It makes it unlawful for a commercial fishing operation to possess flounder from the Atlantic Ocean Waters taken by any method other than trawls. This action is being taken to comply with the requirements of Amendment 2 to the N.C. Southern Flounder Fishery Management Plan.
FF-25-2020	9/15/2020	This proclamation supersedes Proclamation FF-34-2019, dated September 12, 2019. It establishes commercial flounder season dates for Internal Coastal Waters by Flounder Management Area. It maintains a 15-in total length minimum size limit. It also maintains the regulation making it unlawful to possess flounder taken from anchored large mesh gill nets with a stretched mesh length less than 6 in. It makes it unlawful for a commercial fishing operation to possess flounder from the Atlantic Ocean Waters taken by any method other than trawls. This action is being taken to comply with the requirements of Amendment 2 to the N.C. Southern Flounder Fishery Management Plan.
M-4-2020	4/20/2020	Gill net restrictions for gill nets with a stretched mesh length less than 4 in and attendance requirements for gill nets with a stretched mesh length less than 5 in
M-9-2020	5/1/2020	This proclamation supersedes proclamation M-4-2020 dated March 19, 2020. It implements attendance requirements for gill nets with a stretched mesh length less than 4 in in Subunit B.1
M-11-2020	5/8/2020	This proclamation supersedes proclamation M-9-2020 dated April 24, 2020. It increases yardage limits for the commercial Spanish mackerel drift gill-net fishery in MU B.
M-16-2021	9/14/2021	This proclamation supersedes proclamation M-12-2021 dated April 30, 2021. It opens MU A to the use of gill nets for the purpose of harvesting flounder in accordance with Amendment 2 to the N.C. Southern Flounder Fishery Management Plan and the Incidental Take Permit for Sea Turtles. It maintains the exempted areas in MU A open to the use of run-around, strike, drop, and trammel gill nets to harvest blue catfish. It also maintains small mesh gill net attendance requirements in the entirety of MU A.

Proclamation Number	Effective Date	Description
FF-40-2021	9/15/2021	This proclamation supersedes Proclamation FF-25-2020, dated June 15, 2020. It establishes commercial flounder season dates for Internal Coastal Waters by Flounder Management Area. It maintains a 15-in total length minimum size limit. It also maintains the regulation making it unlawful to possess flounder taken from anchored large mesh gill nets with a stretched mesh length less than 6 in. It makes it unlawful for a commercial fishing operation to possess flounder from the Atlantic Ocean Waters taken by any method other than trawls. This action is being taken to comply with the requirements of Amendment 2 to the N.C. Southern Flounder Fishery Management Plan.
M-17-2021	9/30/2021	This proclamation supersedes proclamation M-11-2021 dated April 9, 2021. This proclamation opens MUs B (subunits only), C, D2 and E to the use of gill nets with a stretched mesh length of 4 in through 6 ½ in (except as described in Section III.) in accordance with Amendment 2 to the N.C. Southern Flounder Fishery Management Plan and the Incidental Take Permit for Sea Turtles.
M-4-2022	2/15/2022	This proclamation supersedes proclamation M-23-2021 dated October 14, 2021. This proclamation opens Management Unit C to the use of gill nets with a stretched mesh length of 4 inches through 6 ½ inches and implements gear exemptions for the shad fishery in all areas south of Management Unit A in accordance with Amendment 2 to the N.C. Southern Flounder Fishery Management Plan.
M-5-2022	3/22/2022	This proclamation supersedes proclamation M-2-2022 dated December 17, 2021. It opens a portion of Management Unit A to the use of floating gill nets configured for harvesting American shad by removing vertical height and setting restrictions for all gill nets with stretched mesh lengths of 5 ¼ through 6 inches.
M-10-2022	4/28/2022	This proclamation supersedes proclamation M-9-2022 dated April 26, 2022. This proclamation makes it unlawful to use fixed or stationary gill nets of any mesh size in Management Unit A due to dead sturgeon takes nearing the authorized amount for Management Unit A. A portion of Management Unit A remains open to the use of run-around, strike and drop gill nets with a stretched mesh length of 5 ½ inches through 6 ½ inches for harvesting blue catfish. Runaround, strike and drop gill nets with a stretched mesh length of 3 inches through 4 inches may also still be used in portions of Management Unit A. This action is being taken to comply with the Division of Marine Fisheries' Federal Incidental Take Permit for endangered Atlantic sturgeon.

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