DRAFT

Amendment 1 to the Consolidated Atlantic Highly Migratory Species Fishery Management Plan Essential Fish Habitat

Including:

A Draft Environmental Impact Statement

September 2008

DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Highly Migratory Species Management Division
Office of Sustainable Fisheries
National Marine Fisheries Service
1315 East-West Highway
Silver Spring, Maryland 20910

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Amendment 1 to the Consolidated Atlantic Highly Migratory Species Fishery Management Plan

Action:	Review and update Atlantic Highly Migratory Species (HMS) Essential Fish Habitat (EFH), identify new Habitat Areas of Particular Concern (HAPCs), and analyze fishing and non-fishing impacts on EFH.
Type of Statement:	Draft Environmental Impact Statement
Lead Agency:	National Marine Fisheries Service
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Abstract: The National Marine Fisheries Service (NMFS) is amending the Consolidated Atlantic Highly Migratory Species Fishery Management Plan based on a review of Atlantic HMS EFH. The purpose of the amendment is to examine alternatives for updating existing HMS EFH, consider additional HAPCs, and analyze fishing impacts on EFH consistent with the Magnuson-Stevens Fishery Conservation and Management Act and other relevant Federal laws, including the National Environmental Policy Act (NEPA). The Magnuson-Stevens Act EFH regulations call for a comprehensive review of all EFH information, and this amendment constitutes the comprehensive review and proposed update of EFH for all HMS that began with the Consolidated HMS FMP. In addition, new information has become available, including information on the biology, distribution, habitat requirements, life history characteristics, migratory patterns, spawning, pupping, and nursery areas of Atlantic HMS that were taken into consideration when updating EFH in this amendment.

EXECUTIVE SUMMARY

In 1996, Congress reauthorized the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) which included a requirement to identify and describe EFH for all Federally managed fisheries based on the guidelines established by the Secretary of Commerce (Secretary) under section 305(b)(1)(A), to minimize, to the extent practicable, adverse effects on such habitat caused by fishing, and to identify other actions to encourage the conservation and enhancement of EFH. EFH was defined in the Magnuson-Stevens Act as those habitats necessary for spawning, breeding, feeding, or growth to maturity. The EFH guidance published on January 17, 2002 (67 FR 2343), stated that EFH must be identified and described for each life stage of all species in the fishery management unit (FMU) as well as the physical, biological, and chemical characteristics of EFH and if known, how these characteristics influence the use of EFH by each species and life stage. Fishery Management Plans (FMPs) and FMP amendments must provide written descriptions of EFH and must also provide maps of the geographic locations of EFH or the geographic boundaries within which EFH for each species and life stage is found (50 CFR 600.815(a)(1)(i)).

In 1999, EFH for Atlantic tunas, swordfish, and sharks was identified and described in the FMP for Tunas, Swordfish and Shark, and EFH for billfish was described in the 1999 Amendment 1 to the Billfish FMP. The FMP and amendment included text descriptions, tables, and maps for each species and life stage depicting the geographic locations of HMS EFH. Habitat Areas of Particular Concern (HAPCs) were identified and described for sandbar sharks off Chesapeake Bay, MD, Delaware Bay, DE, Great Bay, NJ, and the Outer Banks off North Carolina.

In 2003, NMFS issued Amendment 1 to the FMP for Atlantic Tunas, Swordfish, and Sharks, which, among other things, updated EFH for five shark species (blacktip, sandbar, finetooth, dusky, and nurse sharks).

In 2004, NMFS began the comprehensive review of all HMS EFH in the Consolidated HMS FMP, which was released on July 14, 2006 (71 FR 40096). In that document, NMFS provided new information collected since the EFH boundaries were established in 1999. NMFS did not modify or update any of the existing EFH identifications, descriptions, or boundaries in the Consolidated HMS FMP or propose any new measures to minimize impacts from fishing gear. Rather, NMFS presented new EFH information and data collected since 1999, including an evaluation of fishing gear impacts. The purpose of the EFH review was to gather any new information and determine whether modifications to existing EFH descriptions and delineations were warranted.

On November 7, 2006 (71 FR 65088), NMFS published a Notice of Intent to prepare an Environmental Impact Statement (EIS) to examine alternatives for updating existing HMS EFH, consider additional HAPCs, analyze fishing impacts on EFH, and if necessary, identify ways to avoid or minimize, to the extent practicable, adverse fishing impacts on EFH consistent with the Magnuson-Stevens Act and other relevant Federal laws. At that time, NMFS requested new information not previously considered in the Consolidated HMS FMP, comments on potential HAPCs, and information regarding potential fishing and non-fishing impacts that may adversely affect EFH.

In this document, NMFS is providing the culmination to date of the review that began with the Consolidated HMS FMP. NMFS is proposing to update and revise existing EFH for Atlantic HMS, and to consider new HAPCs. Three alternatives, including a No Action alternative, are fully analyzed for identifying EFH. Four alternatives, including a No Action alternative, are fully analyzed to consider designation of HAPCs. As a component of the Draft EIS, preferred alternatives for updating EFH and for designating new HAPCs are identifed, and this document presents these proposed revisions to EFH and HAPCs and analyzes fishing impacts on EFH.

In addition to fulfilling the EFH requirements of the Magnuson-Stevens Act, NMFS' consideration of EFH designation must also be consistent with other applicable laws including, but not limited to, the National Environmental Policy Act of 1969 (NEPA) (42 U.S.C Sections 4321 to 4370(f)) and the Council on Environmental Quality (CEQ) NEPA implementing regulations (40 CFR Sections 1500 to 1508). This document is an integrated document prepared in accordance with the Magnuson Stevens Act and NEPA. Chapters 2 and 4 present and analyze the range of alternatives considered to meet NMFS purpose and need for action, and Chapter 3 describes the human environment affected by the proposed action. Other considerations specifically required under NEPA also are considered in Chapter 4. In accordance with MSA, Chapters 5 describes Atlantic HMS life history accounts and EFH descriptions and maps. Note that these chapter present EFH and HAPC in accordance with the DEIS preferred alternatives (EFH Alternative 3 and HAPC Alternative 2). An analysis of fishing and non-fishing impacts in Chapter 6 is provided as required under MSA, and also presents a cumulative impact analysis for purposes of MSA and consideration of potential cumulative impacts in accordance with NEPA. Chapter 7 presents research and information needs for Atlantic HMS, and Chapter 8 identifies the preparers of this document and other agencies consulted during preparation. NMFS conducted a thorough public scoping process, including release of Pre-Draft of Amendment 1. The scoping process resulted in input on the range of alternatives and analyses considered in this draft Amendment 1 and Draft EIS, and Appendix 1 summarizes the scoping comments received and how these comments were considered and addressed.

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1.0 INTRODUCTION

This document is the Draft Amendment 1 to the Consolidated Atlantic Highly Migratory Species (HMS) Fishery Management Plan (FMP) for Essential Fish Habitat (EFH). On November 7, 2006 (71 FR 65088), the National Marine Fisheries Service (NMFS) published a Notice of Intent to prepare an Environmental Impact Statement (EIS) to examine alternatives for updating existing HMS EFH, consider additional Habitat Areas of Particular Concern (HAPCs), analyze fishing gear impacts, and if necessary, identify ways to avoid or minimize, to the extent practicable, adverse fishing impacts on EFH consistent with the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) and other relevant Federal laws. At that time, NMFS requested new information not previously considered in the Consolidated HMS FMP, comments on potential HAPCs, and information regarding potential fishing and non-fishing impacts that may adversely affect EFH.

In addition to the Magnuson-Stevens Act, the document must be consistent with other applicable laws including, but not limited to the National Environmental Policy Act (NEPA), the Endangered Species Act (ESA), and the Marine Mammal Protection Act (MMPA). This document is an integrated document that includes both the Draft Environmental Impact Statement and the Draft Fishery Management Plan Amendment. Chapters 2 and 4 of this document provide a description of the alternatives considered and the analyses of the potential impacts. Chapter 3 provides a description of the affected environment, Chapter 5 describes the EFH life history accounts and provides EFH maps, Chapter 6 analyzes fishing and non-fishing impacts as well as cumulative impacts, Chapter 7 presents research and information needs for Atlantic HMS, and Chapter 8 identifies the preparers of this document and other agencies consulted during preparation.

On November 7, 2006, NMFS also made available a Pre-Draft of Amendment 1 that included a general description of the approaches being considered to update EFH, to consider new HAPCs, and where applicable, to minimize fishing impacts. The Pre-Draft also served to obtain additional information and input from the public and Atlantic HMS Consulting Parties on potential options or alternatives to consider prior to development of the formal Draft Environmental Impact Statement (DEIS) for Amendment 1 of the Consolidated HMS FMP. Consulting Parties for Atlantic HMS fisheries are defined under the Magnuson-Stevens Act as affected Regional Fishery Management Councils (Councils), International Commission for the Conservation of Atlantic Tunas (ICCAT) commissioners and advisory groups, and the HMS Advisory Panel (AP). The Magnuson-Stevens Act requires NMFS to consult with Consulting Parties regarding amendments to an FMP.

The Pre-Draft included a summary of the purpose and need, and a general description of the ecological, social, and economic impacts of alternatives that NMFS was considering at that time. The alternatives outlined in Chapter 2 are the result of comments received and additional analyses that were done to include additional alternatives or to update existing alternatives presented in the Pre-Draft. As such, new alternatives have been included in the DEIS that were not in the Pre-Draft. A summary of the comments received during the scoping period and on the Pre-Draft are provided in Appendix 1.

NMFS specifically solicited comments and advice from Atlantic HMS Consulting Parties on the range of alternatives and whether there were any additional alternatives that should be considered. Additionally, NMFS solicited comments on the impacts described for each of the alternatives. As described in Chapters 2 and 4, NMFS took into account comments received from the HMS AP and the public on how best to proceed with alternatives to update EFH. NMFS received a number of comments ranging from data considerations, extent of EFH, impacts on EFH, to concerns about HAPCs. Specific comments and responses are included in Appendix 1. In addition, on March 30, 2007, NMFS received a request from the Tag-A-Giant Foundation (TAG) and the National Coalition for Marine Conservation (NCMC) to consider HAPCs for bluefin tuna spawning areas in the Gulf of Mexico. The request was based in part on the importance of the ecological function provided by the habitat and the extent to which the habitat may be sensitive to human-induced environmental degradation.

Written comments on the DEIS should be submitted to Chris Rilling or Sari Kiraly, HMS Management Division, F/SF1, Office of Sustainable Fisheries, 1315 East-West Highway, Silver Spring, MD 20910 or faxed to (301) 713-1917 within 60 days of publication of the Notice of Availability of the Draft Environmental Impact Statement (DEIS). For further information, contact Chris Rilling or Sari Kiraly at 301-713-2347.

1.1 Management History

In 1996, Congress reauthorized the Magnuson-Stevens Act which included a requirement to identify and describe EFH for all Federally managed fisheries based on the guidelines established by the Secretary of Commerce (Secretary) under section 305(b)(1)(A), to minimize, to the extent practicable, adverse effects on such habitat caused by fishing, and to identify other actions to encourage the conservation and enhancement of EFH. EFH was defined in the Magnuson-Stevens Act as those habitats necessary for spawning, breeding, feeding, or growth to maturity. The EFH guidance published on January 17, 2002 (67 FR 2343), stated that EFH must be identified and described for each life stage of all species in the fishery management unit (FMU) as well as the physical, biological, and chemical characteristics of EFH and if known, how these characteristics influence the use of EFH by each species and life stage. Fishery Management Plans (FMPs) and FMP amendments must provide written descriptions of EFH and must also provide maps of the geographic locations of EFH or the geographic boundaries within which EFH for each species and life stage is found (50 CFR 600.815(a)(1)(i)).

The EFH regulations state that NMFS should periodically review and revise or amend the EFH provisions as warranted based on available information (50 CFR 600.815(a)(10)) and that NMFS should review all new EFH information at least once every five years. The Magnuson-Stevens Reauthorization Act of 2006, signed into law and enacted on January 12, 2007, did not include any revisions to the EFH provisions.

The EFH regulations also provided procedures for the Secretary, other Federal Agencies, and the Councils to coordinate, consult, or provide recommendations on Federal and state actions that may adversely affect EFH. Section 305(b)(1)(D) of the Magnuson-Stevens Act requires all Federal agencies to consult with the Secretary on all actions or proposed actions authorized, funded, or undertaken by the agency that may adversely affect EFH. Section 305(b)(3) and (4) direct the Secretary and the Councils to provide comments and EFH conservation recommendations to Federal or state agencies on actions that affect EFH. Such recommendations may include measures to avoid, minimize, mitigate, or otherwise offset adverse effects on EFH resulting from actions or proposed actions authorized, funded, or undertaken by the agency. Section 305(b)(4)(B) requires Federal agencies to respond in writing to such comments.

Table 1.1 Management history for HMS EFH.

FMP or Amendment	Species for which EFH was identified
1999 FMP for Atlantic Tunas, Swordfish, and Sharks	EFH first identified and described for Atlantic tunas, swordfish and sharks
1999 Amendment 1 to the Billfish FMP	EFH first identified and described for Atlantic billfish
2003 Amendment 1 to the FMP for Atlantic Tunas, Swordfish and Sharks	EFH updated for five shark species (blacktip, sandbar, finetooth, dusky, and nurse sharks)
2006 Consolidated Atlantic HMS FMP	Comprehensive review of EFH for all HMS. EFH for all Atlantic HMS consolidated into one FMP No changes to EFH descriptions or boundaries
2008 Amendment 1 to the Consolidated Atlantic HMS FMP	EFH updated for all Atlantic HMS

1.1.1 1999 Fishery Management Plan for Atlantic Tunas, Swordfish, and Sharks and Amendment 1 to the Billfish Fishery Management Plan

NMFS issued two separate FMPs in April 1999 for the Atlantic HMS fisheries. The 1999 FMP for Atlantic Tunas, Swordfish, and Sharks, combined, amended, and replaced previous management plans for swordfish and sharks, and was the first FMP for tunas. Amendment 1 to the Billfish FMP updated and amended the 1988 Billfish FMP.

EFH for Atlantic tunas, swordfish, and sharks was identified and described in the 1999 FMP, and EFH for billfish was identified and described in the 1999 Amendment 1 to the Billfish FMP. The FMP and amendment included text descriptions, tables, and maps for each species and life stage depicting the geographic locations of HMS EFH. There were some species for which insufficient information prevented identification and description of EFH, and in those cases, text descriptions and maps were not provided. HAPCs were identified and described for sandbar sharks (*Carcharhinus plumbeus*) off Chesapeake Bay, MD, Delaware Bay, DE, Great Bay, NJ, and the Outer Banks off North Carolina.

1.1.2 Amendment 1 to the 1999 FMP for Tunas, Swordfish, and Sharks

In November 2003, NMFS issued Amendment 1 to the FMP for Atlantic Tunas, Swordfish, and Sharks, which, among other things, updated EFH for five shark species. NMFS decided to update EFH for these five species based on either a change in management status (*e.g.,* from overfished to not overfished or vice versa) or based on new information that had become available. Species for which management status had changed at the time of drafting Amendment 1 to the 1999 FMP included the blacktip shark (*Carcharhinus limbatus*) (had been determined to be no longer overfished), sandbar shark (overfishing was occurring), and finetooth shark (*C. isodon*) (overfishing was occurring). Species for which new information had become available included the dusky shark (*C. obscurus*) and nurse shark (*Ginglymostoma cirratum*). As described below, these updated descriptions and maps were also included in the Consolidated HMS FMP.

The focus of Amendment 1 to the 1999 FMP was a comprehensive review of management measures for Atlantic sharks and did not consider any changes to the management of tunas, swordfish, or billfish. No new HAPCs were proposed at that time, and NMFS did not update EFH for any of the other species in the HMS management unit.

1.1.3 Consolidated HMS FMP

NMFS began the comprehensive review of all HMS EFH in the Consolidated HMS FMP, which was released on July 14, 2006 (71 FR 40096). In that document, NMFS provided new information collected since the EFH boundaries were established in 1999. NMFS did not modify or update any of the existing EFH identifications, descriptions, or boundaries in the Consolidated HMS FMP or propose any new measures to minimize impacts from fishing gear. Rather, NMFS presented new EFH information and data collected since 1999, including an evaluation of fishing gear impacts, and requested public comment on any additional data or information that needed to be included in the review. The purpose of the EFH review was to gather any new information and determine whether modifications to existing EFH descriptions and delineations were warranted. While NMFS has presented new information relative to HMS EFH in the annual Stock Assessment and Fishery Evaluation (SAFE) reports in previous years, the Consolidated HMS FMP included the first comprehensive review of all new information related to EFH that had been completed since 1999.

As part of the comprehensive review, a search of all new literature and information was undertaken to assess habitat use and ecological roles of HMS EFH. Published and unpublished scientific reports, fishery dependent and independent datasets, and expert and anecdotal information detailing the habitats used by the managed species were evaluated and synthesized for inclusion in the review process in the Consolidated HMS FMP. Ongoing research on the biology, ecology, and early life history of Atlantic HMS and research and publications relating to HMS EFH are described in Chapter 10 of the Consolidated HMS FMP.

Based on the data collected and presented in the Consolidated HMS FMP, NMFS determined that modification to existing EFH for some species and/or life stages may be warranted, but that any changes to EFH, including new HAPCs and potential measures to minimize fishing impacts, should be considered in a separate amendment. NMFS also conducted a comprehensive review of all Federal and non-Federally managed fishing gears that will form the basis for further analysis on gear impacts in this amendment.

In order to consolidate all Atlantic HMS EFH into one document, all EFH text descriptions and maps previously provided in separate documents were combined in the Consolidated HMS FMP. Specifically, all the EFH descriptions and maps from the 1999 FMP for Tunas, Swordfish, and Sharks, Amendment 1 to the Billfish FMP (1999), and Amendment 1 to the FMP for Tunas, Swordfish, and Sharks (2003) were provided in the Consolidated HMS FMP. Maps in the Consolidated HMS FMP also depicted distribution data acquired through the review process and provided an opportunity for public comment on the need for any additional information to be considered. The original EFH descriptions and boundaries from the 1999 FMP, as well as updates from the 2003 FMP Amendment, may be found in Appendix B (Volume III) of the Consolidated HMS FMP. In addition, as described in Chapter 2, an internet-based mapping program (HMS EFH Evaluation Tool) is being used to make proposed changes to EFH boundaries available to the public. Throughout the comment period and the DEIS phase, the site will also provide all of the original 1999 EFH boundaries for comparative purposes.

1.2 Purpose and Need for Action

The purpose of this amendment is to update and revise existing HMS EFH as necessary, consider any new HAPCs or modifications to existing HAPCs, analyze fishing and non-fishing impacts on EFH, and consider measures to minimize fishing impacts, as necessary, if any gears are determined to have a negative effect on EFH. The Magnuson-Stevens Act regulations call for a comprehensive review of all EFH information at least once every five years, and this amendment constitutes Phase 2 of the comprehensive review and update of EFH for all HMS that began with the Consolidated HMS FMP. In addition, new information has become available since 2006, including information on the biology, distribution, habitat requirements, life history characteristics, migratory patterns, spawning, pupping, and nursery areas of Atlantic HMS that were taken into consideration when updating EFH in this amendment.

2.0 SUMMARY OF ALTERNATIVES

This section considers alternatives to update EFH and designate new HAPCs. In addition, NMFS considers fishing gear impacts on EFH and whether any measures to minimize fishing impacts on EFH are necessary. The final action for purposes of NEPA would consist of the selection in a Record of Decision of an alternative for EFH and an alternative for designation of new HAPCs.

2.1 Essential Fish Habitat Identifications

As part of this amendment, NMFS is incorporating new information and data available for HMS to update EFH identifications, descriptions, and resulting boundaries, as appropriate. EFH for HMS was initially designated in the 1999 HMS FMP, and updated in 2003 for five shark species in Amendment 1 to the 1999 HMS FMP. Part of this process will include considering a range of alternatives to update EFH for Atlantic HMS. NMFS considered a number of different approaches for updating the EFH boundaries described below and in Chapter 4.

Proposed Alternatives for Identifying Essential Fish Habitat

The following alternatives represent a range of potential methods that could be used to identify EFH. Since the primary data type used to delineate EFH boundaries is species-specific distribution data, NMFS has identified geographic areas, rather than specific habitat types, that are considered EFH. Where possible, NMFS has included specific habitat requirements for individual species in the text descriptions, however the spatial boundaries described below will define the EFH boundaries. NMFS considered a number of different analytical approaches to mapping and analyzing the data in an effort to develop a methodology that would be reproducible, transparent, and would result in specific areas that could be mapped and identified with spatial boundaries. Regardless of the alternative considered, the resulting boundaries were compared to existing EFH boundaries, verified and corroborated, to the extent possible, with NMFS scientists and researchers familiar with the habitat requirements for particular species, and then modified based on an analysis of the data. There are no direct environmental consequences associated with identifying and describing EFH, however, the areas subject to consultation would change if the areas are increased or decreased in size. The approach used to determine EFH as described in the alternatives below would be applied to all HMS species in the Fishery Management Unit (FMU). There were some species for which there was insufficient information to identify EFH for each individual life stage (adult, juvenile, and young-of-the-year/neonate). For those species, the data for all life stages have been combined into one comprehensive data set to allow identification of EFH for all life stages combined. There were other species (primarily sharks) for which there was insufficient information to identify and describe EFH, either spatially or with text descriptions.

Alternative 1 No Action - maintain current EFH boundaries.

EFH was originally identified and described for Atlantic HMS in the 1999 FMP and Billfish Amendment 1 and updated for five shark species in Amendment 1 to the 1999 FMP and changes may not be needed. As described above, there are no direct ecological impacts associated with the identification and description of EFH. Any positive ecological impacts would be the result of measures, if any, taken to minimize fishing impacts. However, no measures are being proposed at this time.

Alternative 2 Establish new EFH boundaries based on the highest concentration of a particular species by selecting high count cells.

This alternative would establish EFH boundaries based on high count cells which are the cells that contain the highest number of observations for a given species. The high count cells were created by superimposing individual data points onto a grid covering waters in the Atlantic, Gulf of Mexico, and U.S. Caribbean EEZ. The grid was constructed of 10 x 10 minute squares (or cells) where one minute equals one nautical mile, resulting in squares that represent approximately 100 square nautical miles. The grid and individual data points for individual species and life stages were spatially joined and each cell was given a number representing the sum of all the points that fell within the cell. The counts within the cells were symbolized using classes created with Jenks natural breaks (ESRI, 2007). Jenks natural breaks are based on identifying break points that best group similar values and maximize the differences between classes. The features were divided into four classes whose boundaries were set where there are relatively large jumps in the data values. NMFS then selected the three highest classes of cells (high count cells) and drew boundaries around those cells to delineate EFH boundaries. As a precautionary measure, and due to uncertainty about the exact location of points within a cell, NMFS included a ten nautical mile buffer around high count cells.

There are several disadvantages to using this approach, including a lack of consistency in the classes that are created for different species and life stages, determining the appropriate threshold for high count cells to include in the new boundaries, and greater variability in the boundaries which must be manually created. An example of this type of approach is shown for blacktip sharks (Figure 2.1).

Alternative 3 *Establish new EFH boundaries based on the 95 percent probability boundary. (Preferred alternative).*

This alternative would establish new EFH boundaries based on the 95 percent probability boundary using ESRI ArcGIS and Hawth's Analysis Tools (www.spatialecology.com). The probability boundary was created by taking all of the available distribution points for a particular species and life stage and creating a percent volume contour (PVC or probability boundary). A detailed description of the tool and the analytical approach used to create the boundary is provided in Chapter 4. For comparative purposes, NMFS also generated the 70, 80, and 90 percent probability boundaries for all species. The probability boundary takes into account the distance between each point and the next nearest point, thereby excluding the least dense points (outliers) where the species occurred in relatively low concentrations. Although the 70, 80, and 90 percent probability boundaries are shown for comparative purposes, the 95 percent probability boundary is the preferred boundary because it represented the most precautionary approach of the percent probability boundaries analyzed, and corresponded most closely to the 1999 EFH boundaries. The 95 percent probability boundary would include, on average, 95 percent of the points used to generate the probability boundary for a specific species and life stage. Note that the specific EFH boundaries that are proposed for the preferred alternative are the edited (e.g., clipped) 95 percent probability boundaries.

As described in further detail in Chapter 4, this approach was selected as the preferred alternative because it is based on the actual data points as opposed to points that are merged with a grid as in alternative 2, provides a standardized and transparent method for delineating EFH, and is reproducible. Disadvantages are that data poor species result in smaller, discontinuous areas than data rich species. An example of this type of approach is shown for blacktip sharks (Figure 2.2 and Figure 2.3). Figure 2.2 shows the raw, unedited 95 percent probability boundary that results from running Hawth's Analysis tool, whereas Figure 2.3 shows the edited 95 percent probability boundary that was clipped to the shoreline and the 90m contour line as well as filled in along the coast of Louisiana and Texas based on comments from scientific reviewers.

For ease of interpretation and viewing, the hardcopy maps included in this amendment only include the preferred 95 percent probability boundary. All of the probability boundaries (70, 80, 90, and 95 percent and 95 percent preferred alternative) are provided for each species and life stage in the electronic pdf version of the DEIS and on the website:

> http://sharpfin.nmfs.noaa.gov/website/EFH_Mapper/HMS/map.aspx
> Username: EFH
> Password: Reviewer!

The site is referred to hereafter as the HMS EFH Evaluation Tool site. The internet and electronic versions show all of the probability boundaries because the viewer has the flexibility to turn layers on and off, thus making them easier to view.

Alternative 4 Establish new EFH boundaries using all points or cells where species are present.

This alternative would use all data points for a particular species to delineate new EFH boundaries. This represents a more precautionary approach than alternatives 2 or 3 and would result in larger EFH areas due to the wide distribution of HMS. Analysis of distribution data indicates that, under this alternative, very large areas could potentially be identified as EFH. In some cases, this could result in EFH including nearly all Federal waters within the EEZ, which may run counter to the intent of identifying areas that are considered essential. Because of this, the alternative was considered but not further analyzed.

Alternative 5 Establish new EFH boundaries using the entire range of distribution for each species and life stage.

This alternative would use the entire known range of distribution for a particular species (rather than specific data points) to define EFH, and as such, would represent the most precautionary approach of all the alternatives. Similar to concerns for alternative 4, this alternative would result in very large areas being identified as EFH, and could include the entire EEZ for some species. Because of this, the alternative was considered but not further analyzed.

2.2 Designation of Habitat Areas of Particular Concern (HAPC)

To further the conservation and enhancement of EFH, the EFH guidelines (§600.815(a)(8)) encourage FMPs to identify HAPCs. HAPCs are areas within EFH that should be identified based on one or more of the following considerations:

i) The importance of the ecological function provided by the habitat;

ii) The extent to which the habitat is sensitive to human-induced environmental degradation;

iii) Whether, and to what extent, development activities are, or will be, stressing the habitat type;

iv) The rarity of the habitat type.

HAPCs can be used to focus conservation efforts on specific habitat types that are especially important ecologically or particularly vulnerable to degradation. HAPCs are not required to have any specific management measures and a HAPC designation does not automatically result in closures or other fishing restrictions. Rather, these areas are intended to focus conservation efforts and bring heightened awareness to the importance of the habitat being considered as a HAPC. HAPCs are a management tool that could be used to inform the public of areas where fishing and/or non-fishing actions could receive increased scrutiny from NMFS regarding impacts to EFH. HAPCs can also be used to target areas for research. Measures intended to reduce impacts on habitat would need to be proposed and analyzed and could include gear restrictions, time/area closures, or other measures to minimize impacts to the habitat at such time as the information indicates such action is necessary to protect the habitat. NMFS is not proposing any new measures to protect habitat in this amendment because the majority of HMS gears that are fished in the water column do not have a direct impact on habitat. However, NMFS may consider proposing such measures in future rulemaking.

Several areas were identified in the 1999 FMP as HAPCs for sandbar sharks, including waters off Chesapeake Bay, MD, Delaware Bay, DE, Great Bay, NJ, and the Outer Banks off North Carolina (NMFS, 1999). Although no new HAPCs have been identified since the 1999 FMP, NMFS is considering alternatives for new HAPCs that meet one or more of the criteria, as articulated in the EFH guidelines, based upon information provided by scientific experts, or from other information gathered during development of this amendment. For example, comments received during scoping indicated that NMFS should consider areas in the Gulf of Mexico as HAPCs for bluefin tuna. Recent research indicates the central and western Gulf of Mexico may be important bluefin tuna spawning habitat. NMFS has considered the new information and proposes additional alternatives for HAPCs as described below.

Alternative 1. No Action - maintain current HAPCs.

This alternative would maintain existing HAPCs, several of which have been designated for sandbar sharks along the U.S. Atlantic coast. One of the areas off North Carolina has also been designated as a seasonal time/area closure to protect sandbar and dusky shark pupping and nursery areas. Current HAPCs provide positive ecological benefits and no new HAPCs may be needed. However, existing HAPCs may not provide the level of habitat protection necessary for certain species or stocks, particularly for overfished stocks, where additional habitat protection may be warranted.

Alternative 2. *Designate a HAPC for spawning bluefin tuna in the Gulf of Mexico while maintaining current HAPCs (Preferred Alternative).*

This alternative would establish a new HAPC in the Gulf of Mexico for spawning bluefin tuna (Figure 2.4) while maintaining the current HAPCs for sandbar sharks along the Atlantic coast. Specific boundary coordinates are provided in. New information and research in recent years indicates that certain areas in the Gulf of Mexico may be important spawning habitat for bluefin tuna. NMFS received a request from the Tag-a-Giant (TAG) Foundation and the National Coalition for Marine Conservation (NCMC) to consider establishing a new HAPC for spawning bluefin tuna in the Gulf of Mexico that coincides with the area proposed in a petition submitted to NMFS in June 2005. The area also includes a majority of the locations where bluefin tuna larval collections have occurred, overlaps with proposed and existing adult and larval bluefin tuna EFH, and incorporates portions of an area identified as a primary spawning location by Teo *et al.* (2007). The area meets at least one, and possibly more, of the requirements for HAPC designation, including "the importance of the ecological function provided by the habitat." A HAPC designation would highlight the importance of the area for bluefin tuna spawning and provide added conservation benefits if steps are taken to reduce impacts from development activities.

Alternative 3. Designate a HAPC for spawning bluefin tuna in the Gulf of Mexico based on the 95 percent probability boundary from bluefin tuna larval data collections.

This alternative would establish a new HAPC for spawning bluefin tuna based on the 95 percent probability boundary for bluefin tuna larvae in the Gulf of Mexico, identical to the approach that was used to identify proposed EFH boundaries (Figure 2.5). Ichthyoplankton collections have documented the presence of larval bluefin tuna throughout the Gulf of Mexico with higher abundances in some areas. This alternative would be smaller than the area proposed in alternative 2 and may not encompass all areas where bluefin tuna spawning may occur.

Alternative 4. Designate a HAPC for spawning bluefin tuna based on the 95 percent probability boundary for adult bluefin tuna in the Gulf of Mexico.

This alternative would establish a new HAPC for spawning bluefin tuna based on the 95 percent probability boundary for adult bluefin tuna in the Gulf of Mexico, identical to the approach that was used to identify proposed EFH boundaries (Figure 2.6). This alternative relies on data collections for adult bluefin tuna which show widespread distribution throughout the Gulf, but with the highest concentrations in the northwestern portions. This alternative would be smaller than the area proposed in alternative 2 and would not encompass all areas where bluefin tuna spawning may occur.

2.3 Analysis of Fishing Impacts on EFH

The Magnuson-Stevens Act and the EFH regulations require NMFS to identify fishing activities that may adversely affect EFH. If there are fishing activities that have an adverse affect on EFH, then steps must be taken to minimize adverse effects on EFH to the extent practicable. Adverse effects from fishing may include physical, chemical, or biological alterations of the substrate, and loss of or injury to benthic organisms, prey species and their habitat, and other components of the ecosystem. Based on an assessment of the potential adverse effects of all fishing equipment types used within an area identified as EFH, NMFS must propose measures to minimize fishing impacts if there is evidence that a fishing practice is having more than a minimal and not temporary adverse effect on EFH.

In deciding whether fishing gears are having a negative effect, and if minimization of an adverse effect from fishing is practicable, NMFS must consider: (1) whether, and to what extent, the fishing activity is adversely impacting EFH and the fishery; (2) the nature and extent of the adverse effect on EFH; and, (3) whether the management measures are practicable, taking into consideration the long and short-term costs as well as the benefits to the fishery and its EFH, along with other appropriate factors consistent with the National Standards of the Magnuson-Stevens Act. The best scientific information available must be used as well as other appropriate information sources, as available.

Since most HMS gears are fished in the water column, the impacts on EFH are generally considered negligible. HMS gears do not normally affect the physical characteristics that define HMS EFH such as salinity, temperature, dissolved oxygen, and depth. Similarly, most HMS gears are not expected to impact other fisheries' EFH, with the possible exception of bottom longline (BLL) gear, depending on where it is fished. Each HMS gear, along with all other state and Federally managed fishing gears, the means by which they are fished, and their potential impacts on HMS and other species' EFH were described in the Consolidated HMS FMP. A preliminary determination was made that HMS gears, with the exception of BLL, were not having a negative impact on

EFH. Similarly, other state and Federally managed gears do not appear to have an impact on HMS EFH, with the possible exception of some bottom-tending gears in shark nursery areas in coastal bays and estuaries. Thus, the impacts of shark BLL gear and other bottom tending gears on shark nursery areas are analyzed in Chapter 4 of this amendment. If the analysis determines that BLL gear, or any other gears, are having a more than minimal and not temporary effect on EFH as described above, then NMFS will propose alternatives to avoid or minimize those impacts in a subsequent rulemaking.

Table 2.1 Latitude and Longitude coordinates of the HAPC for bluefin tuna spawning areas in the Gulf of Mexico beginning with the northeast corner and proceeding clockwise around the perimeter of the HAPC. Alternative 3 – preferred.

Point	Latitude	Longitude
1	29	-86
2	28	-86
3	28	-86
4	27	-86
5	27	-86
6	26	-86
7	25.9942	-86.296
8	26.2219	-86.1742
9	26.4111	-86.2736
10	26.4845	-86.5534
11	26.5019	-86.61
12	26.3155	-86.8622
13	26.1817	-87.0741
14	26.0062	-87.4091
15	25.8731	-87.7317
16	25.7596	-88.0972
17	25.7029	-88.347
18	25.7146	-88.7848
19	25.7249	-89.0497
20	25.74	-89.4372
21	25.762	-90.0029
22	25.7761	-90.533
23	25.733	-90.8641
24	25.7038	-91.1681
25	25.7315	-91.4561
26	25.7855	-91.7725
27	25.8916	-92.1744
28	26.0139	-92.5138
29	26.1592	-92.8303
30	26.2615	-93.0169
31	26.125	-93.2217
32	25.9995	-93.4394
33	26	-94
34	26	-96
35	28	-96
36	28	-92
37	29	-92

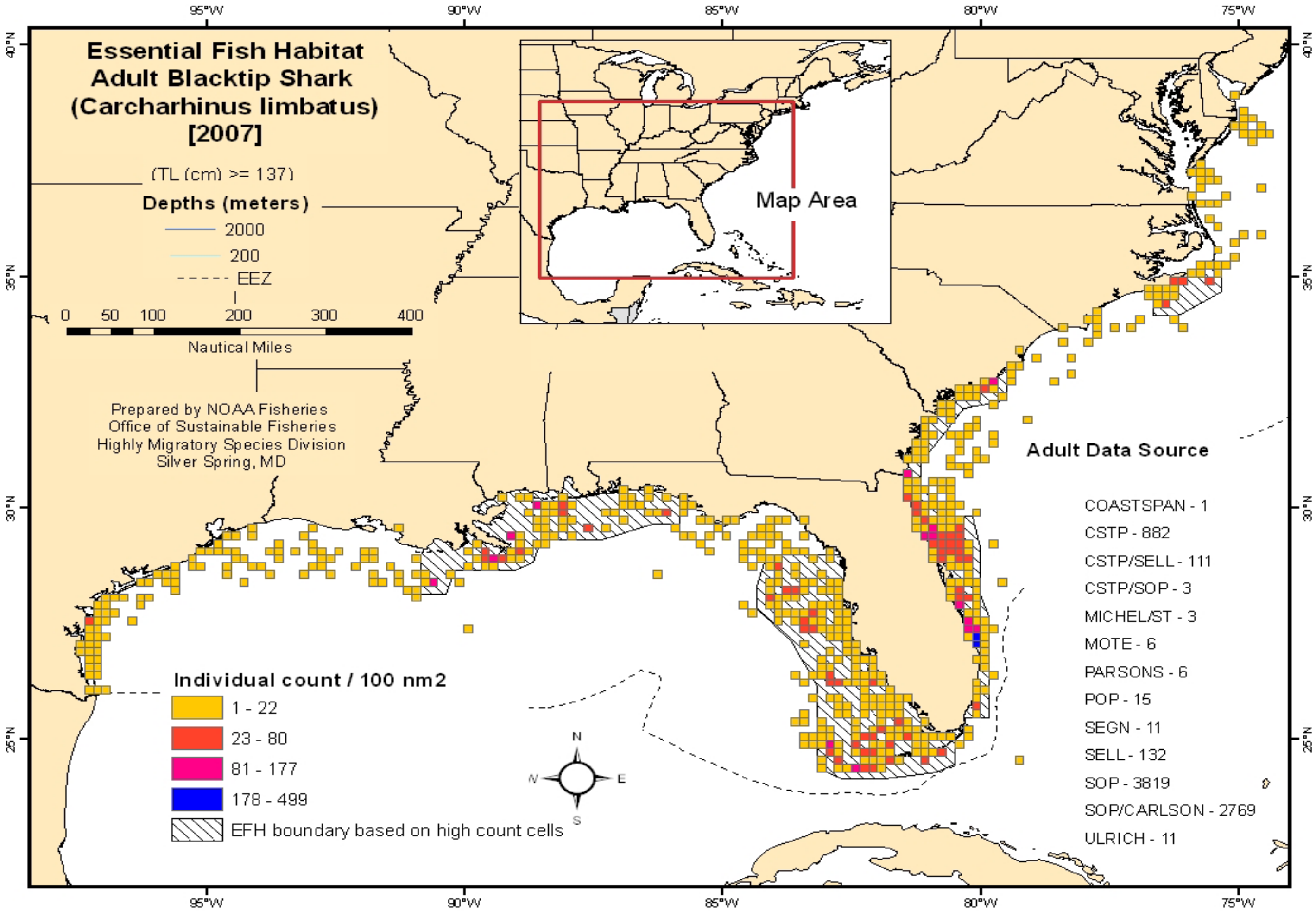

Figure 2.1 Essential fish habitat for blacktip shark based on high count cells. In this case, the highest three classes of cells with >23 observations per cell were used to delineate the EFH boundary (Alternative 2).

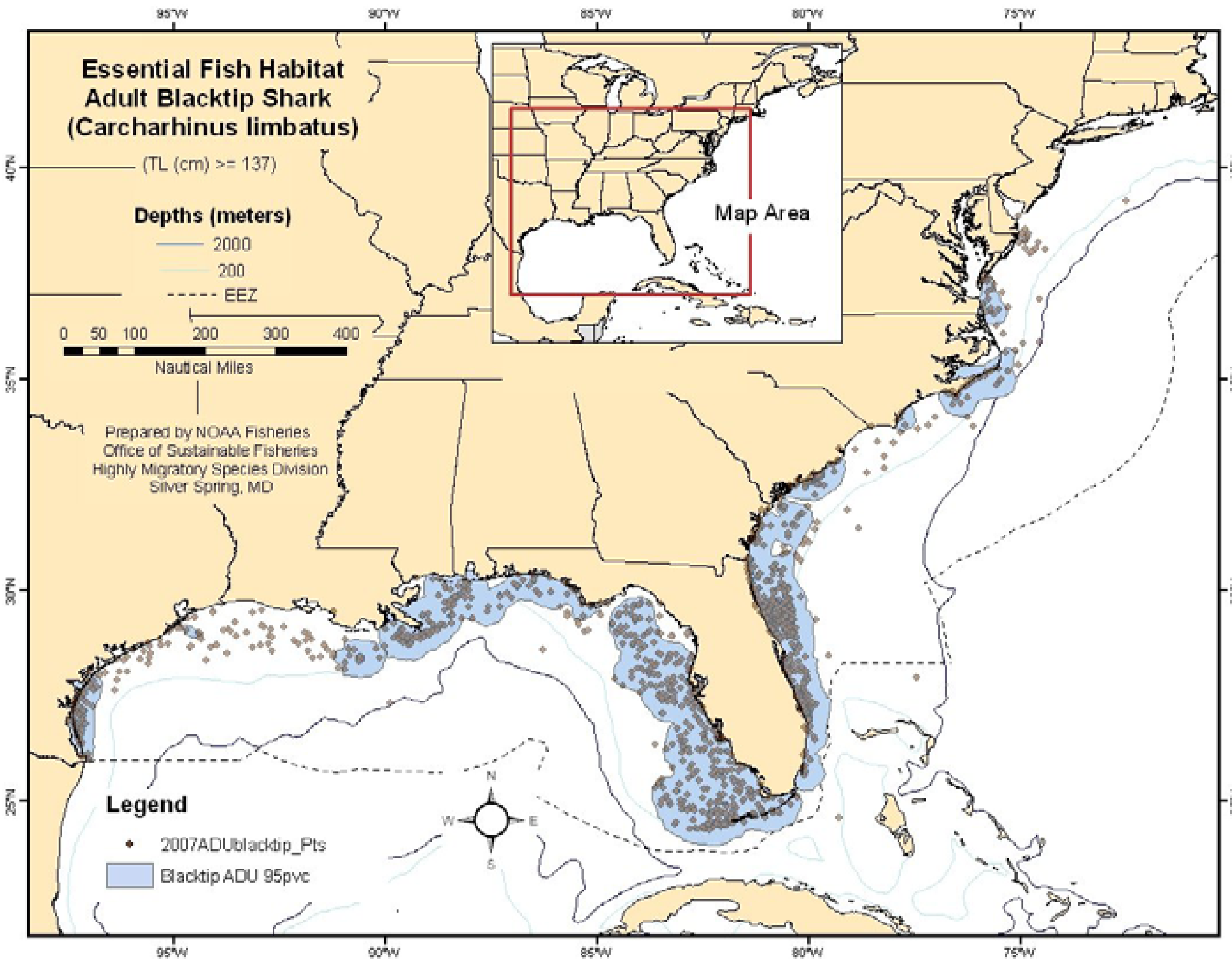

Figure 2.2 Essential fish habitat for blacktip sharks based on probability boundaries. In this case, the individual datapoints were used to generate the 95 percent probability boundary (Alternative 3 - preferred).

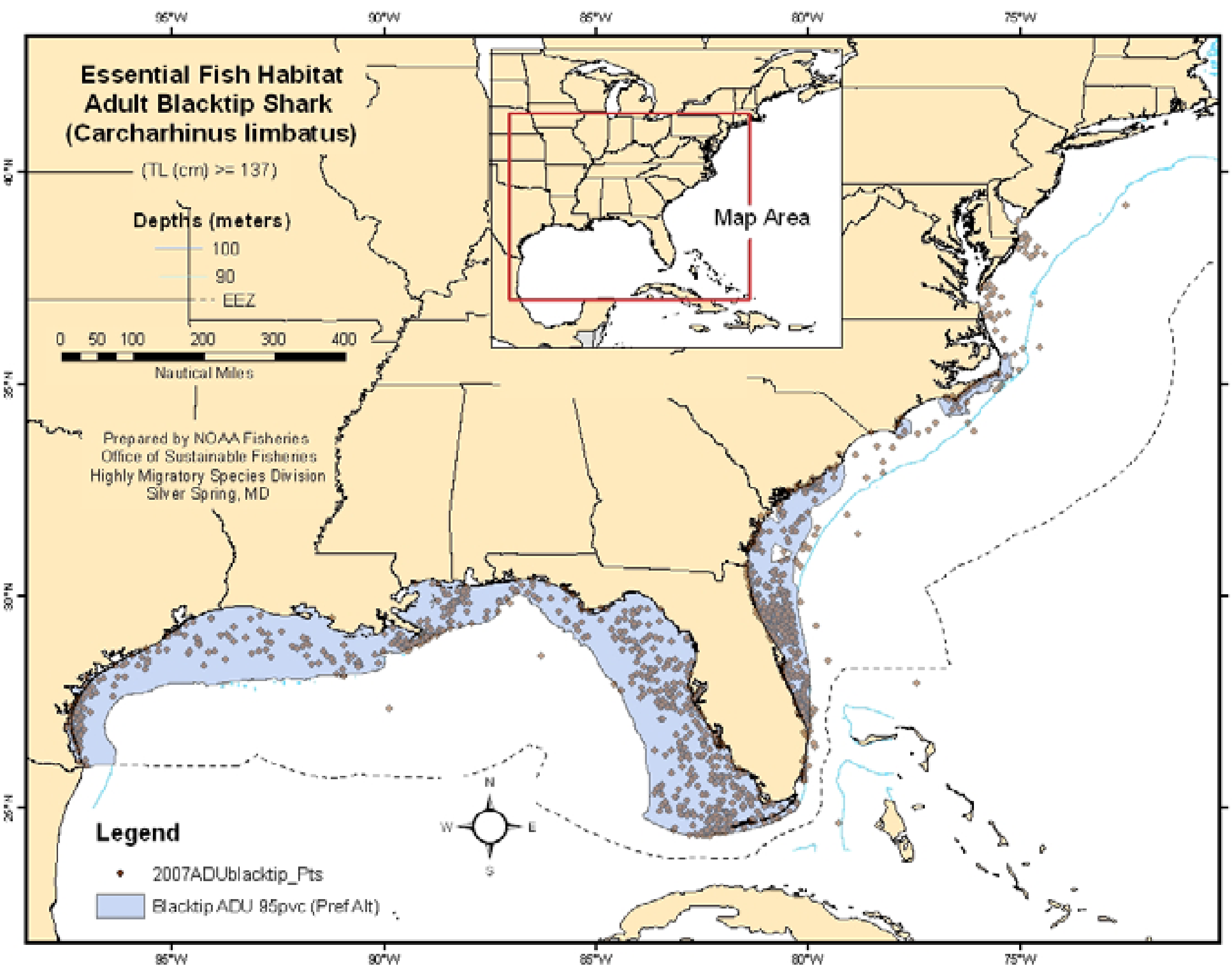

Figure 2.3 Essential fish habitat for adult blacktip shark. The figure shows the 95 percent probability boundary edited by clipping to the shoreline and the 90 m isobath and including additional areas in the Gulf of Mexico (Alternative 3 - preferred).

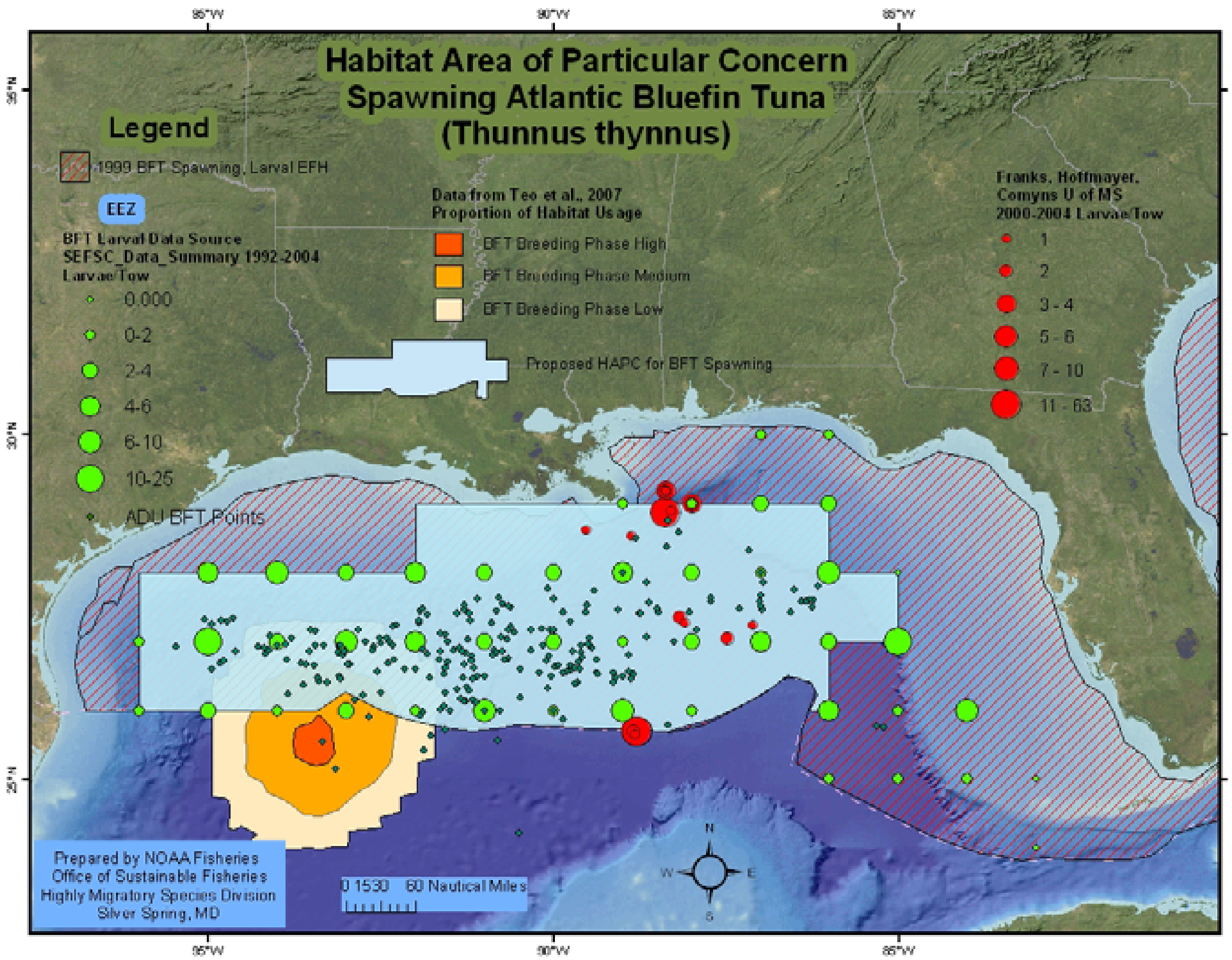

Figure 2.4 Proposed HAPC for Spawning Bluefin Tuna in the Gulf of Mexico (in blue). The figure shows existing EFH boundaries for bluefin tuna spawning/larval EFH (hatched areas) and potential new HAPC boundaries based on preferred alternative 2. The hatched area is continuous underneath the HAPC area.

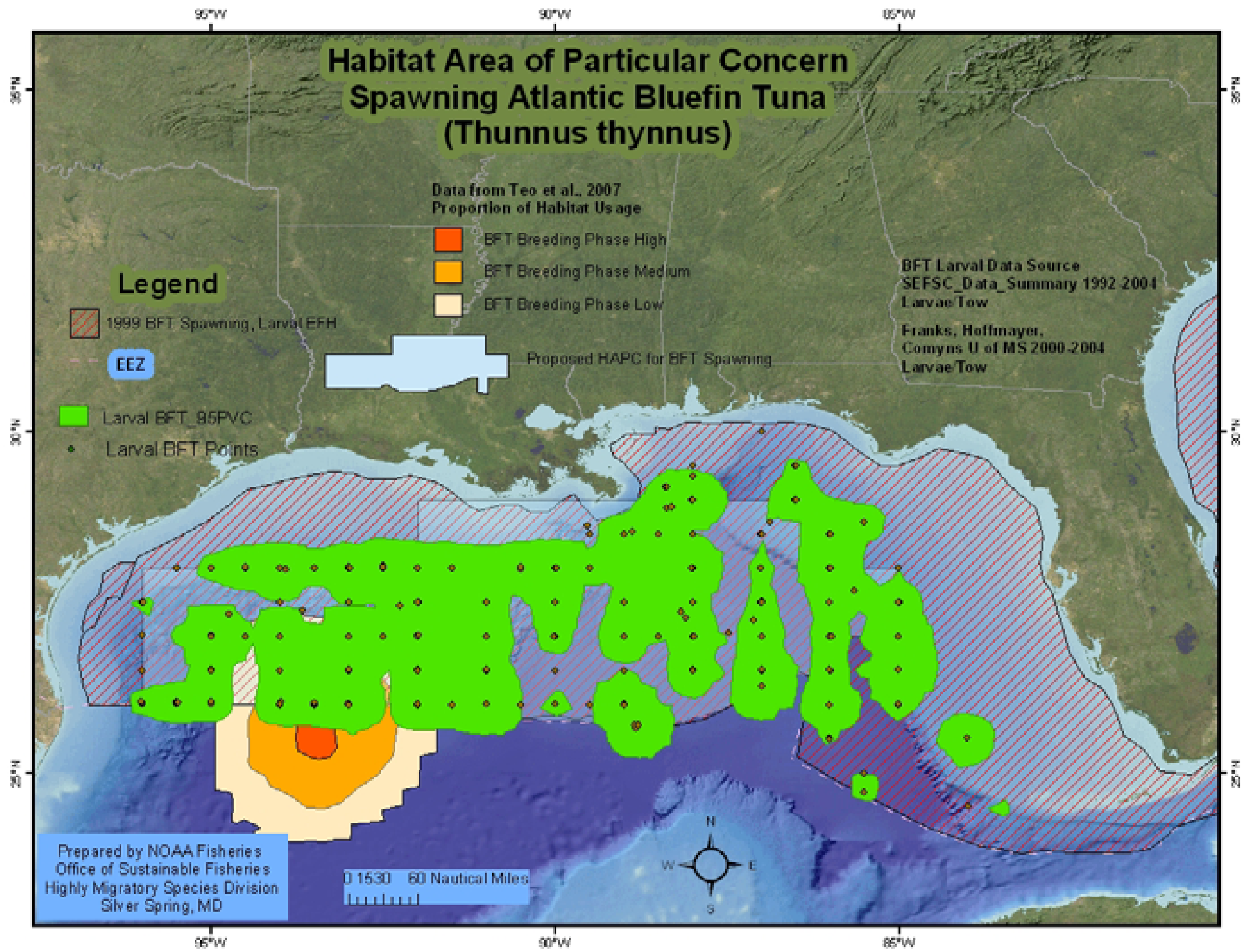

Figure 2.5 HAPC for Spawning Bluefin Tuna (shown in green) in the Gulf of Mexico based on the 95 probability boundary for bluefin tuna larvae as described in alternative 3. Other boundaries are shown for reference.

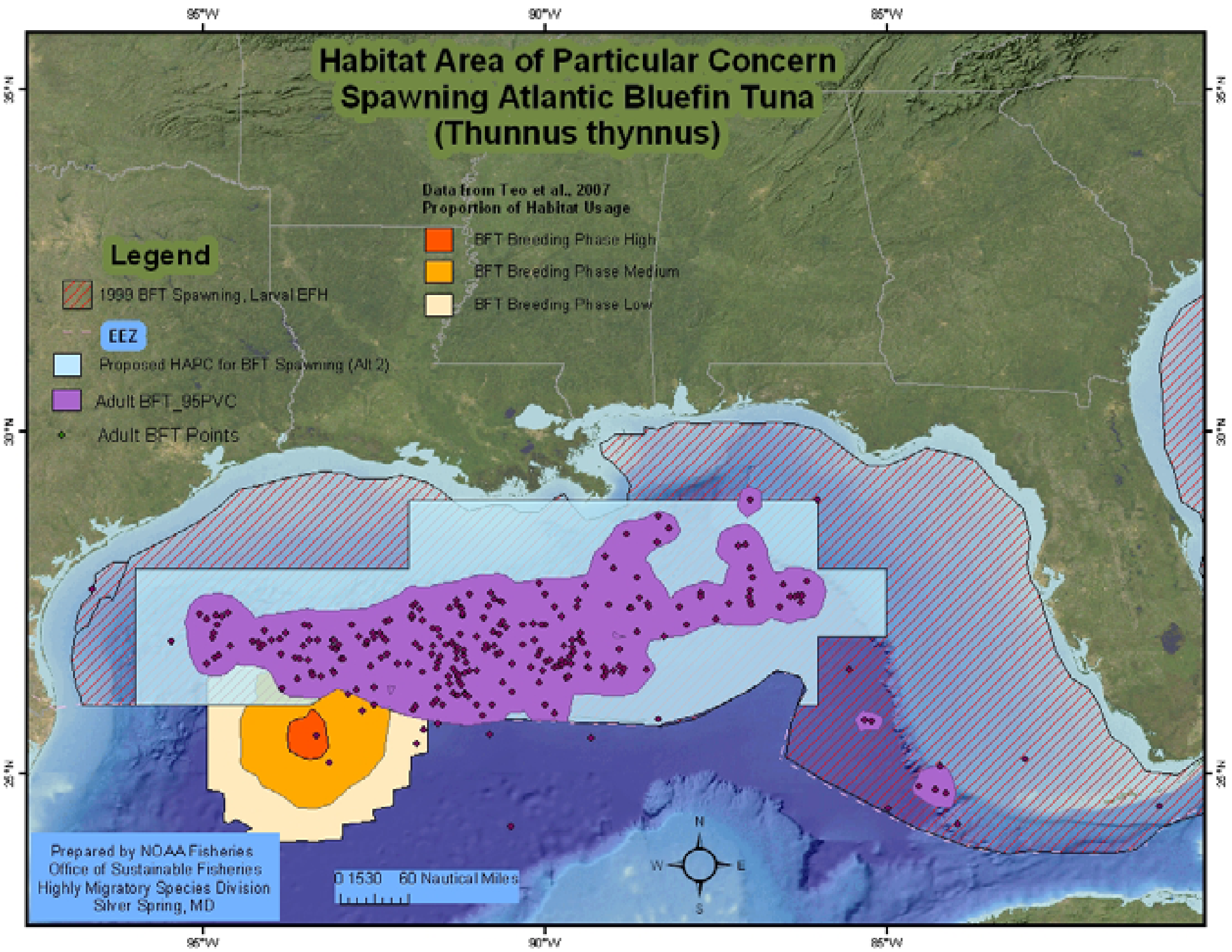

Figure 2.6 HAPC for Spawning Bluefin Tuna (shown in light blue) in the Gulf of Mexico based on the 95 percent probability boundary for adult bluefin tuna as described in alternative 4. Other boundaries are shown for reference.

CHAPTER 2 REFERENCES

ESRI 2007. ArcGIS 9.2 User Manual. Environmental Systems Research Institute, Inc., 380 New York Street, Redlands, California 92373-8100.

Teo, S.L.H., A. Boustany, and B.A. Block. 2007b. Oceanographic preferences of Atlantic bluefin tuna, *Thunnus thynnus*, on their Gulf of Mexico breeding grounds. Marine Biology. 152:1105–1119.

3.0 DESCRIPTION OF THE AFFECTED ENVIRONMENT

3.1 Introduction

Habitats for federally-managed HMS fish species are the primary components of the affected environment. Chapter 5 provides a list of the Atlantic HMS species for which habitat is described in the following section. Note that other living marine resources (e.g., marine mammals, non-HMS fish species, and invertebrates) are also components of the environment in which EFH is considered. Since the designation of EFH principally affects habitat and does not, in itself, directly affect other living marine resources, these resources are not described in detail in this section.

HMS may be found in large expanses of the world's oceans, straddling jurisdictional boundaries. Although many of the species frequent other oceans of the world, the Magnuson-Stevens Act only authorizes the description and identification of EFH in Federal, state or territorial waters, including areas of the U.S. Caribbean, the Gulf of Mexico and the Atlantic coast of the United States to the seaward limit of the U.S. EEZ. These areas are connected by currents and water patterns that influence the occurrence of HMS at particular times of the year. On the largest scale, the North and South Equatorial currents occur in the U.S. Caribbean islands. The North Equatorial Current continues through the Caribbean Basin to enter the Gulf of Mexico through the Yucatan Straits. The current continues through the Florida Straits to join the other water masses (including the Antilles Current) to form the Gulf Stream along the eastern coast of the United States. Variations in flow capacities of the Florida Straits and the Yucatan Straits produce the Loop Current, the major hydrographic feature of the Gulf of Mexico. These water movements in large part influence the distributions of HMS pelagic life stages.

Tuna, swordfish, and billfish distributions are most frequently associated with hydrographic features such as density fronts between different water masses. The scales of these features may vary. For example, the river plume of the Mississippi River extends for miles into the Gulf of Mexico and is a fairly predictable feature, depending on the season. Fronts that set up over the DeSoto Canyon in the Gulf of Mexico, or over the Charleston Bump or the Baltimore Canyon in the Mid-Atlantic, may be of a much smaller scale. The locations of many fronts or frontal features are statistically consistent within broad geographic boundaries. These locations are influenced by riverine inputs, movement of water masses, and the presence of topographic structures underlying the water column, thereby influencing HMS habitat. Those areas that are known spawning grounds, or areas of aggregation for feeding or other reasons, are considered to be EFH for those species.

Sharks are found in a wide variety of coastal and ocean habitats including estuaries, nearshore areas, the continental shelf, continental slope, and open ocean. Many species are migratory and, like other marine species, are affected by the condition of the habitat. Atlantic sharks are broadly distributed as adults but have been found to utilize specific estuaries as pupping and nursery areas during pupping season and throughout their neonate (newborn) and young-of-the-year life stages. Since coastal species frequently appear near shore and have pupping and nursery areas near shore, much more is known about their habitat requirements, particularly for early life history stages. Much less is known about the habitat requirements, pupping areas, and other details of pelagic and deep-dwelling species.

The following sections are intended to provide a general overview of the various habitats with which HMS are most frequently associated. A more detailed description is contained in the 1999 Tunas, Swordfish, and Shark FMP.

Atlantic Ocean

(Material in this section is largely a summary of information in MMS, 1992; 1996. Original sources of information are referenced in those documents)

The region of the Atlantic Ocean within which EFH for Federally managed HMS is identified spans the area between the Canadian border in the north to the Dry Tortugas in the south. It includes a diverse spectrum of aquatic species of commercial, recreational, and ecological importance. The distribution of marine species along the Atlantic seaboard is strongly affected by the cold Labrador Current in the north, the warm Gulf Stream in the middle and southern portions of the region, and generally by the combination of high summer and low winter temperatures. For many species, Cape Hatteras forms a strong zoogeographic boundary between the Mid- and South Atlantic areas, while the Cape Cod/Nantucket Island area is a somewhat weaker zoogeographic boundary in the north.

Coastal and Estuarine Habitat

Coastal habitats that may be encountered by HMS are described in this section. Those areas that are known nursery or spawning grounds, or areas of HMS aggregation for feeding or other reasons, are considered to be EFH for those species. It should be noted that characteristics of coastal and offshore habitats may be affected by activities and conditions occurring outside of those areas (further up-current) due to water flow or current patterns that may transport materials that could cause negative impacts.

Although HMS move primarily through open ocean waters, they do periodically utilize coastal or inshore habitats. This is especially true for several species of sharks that move inshore, often into shallow coastal waters and estuaries, to pup, or give birth; these areas then become nursery areas as the young develop. Examples include Great Bay, New Jersey, Chesapeake Bay, Maryland, and Delaware Bay, Delaware which provide important nursery habitat for sandbar sharks, and Bull's Bay, South Carolina, and Terrebone Bay, Louisiana which are important blacktip shark nursery areas. Typically, the pups (neonates) remain in these same areas throughout their early life stages, which may vary from a few to many months. Recent tagging studies have shown that some sharks return to summer nursery areas in subsequent years. Although billfish move primarily throughout open-ocean waters, two species, the white marlin and the sailfish, may be found inshore. Sailfish are also known to move inshore to spawn off the east coast of Florida and in the Florida Keys.

Along the Atlantic seaboard, coastal wetlands are located predominantly south of New York because these coastal areas have not been glaciated. Nearly 75 percent of the Atlantic coast salt marshes are found in the states of North Carolina, South Carolina, and

Georgia. These three states contain approximately nine million acres of salt marsh. Wetland vegetation plays an important role in nutrient cycling, and provides stability to coastal habitats by preventing the erosion of sediments and by absorbing storm energy.

Estuaries are highly productive, yet fragile, environments that support a great diversity of fish and wildlife species, including sharks. Many commercially valuable fish and shellfish stocks are dependent on these areas during some stage of their development. For example, in the vicinity of North Carolina, Virginia, and Maryland, approximately 90 percent of the commercially valuable fish species are dependent on estuaries for at least part of their life cycle.

There are 13,900 square miles (sq mi) (36,000 square kilometers (sq km)) of estuarine habitat along the Atlantic coast, of which approximately 68 percent (9,400 sq mi) occurs north of the Virginia/ North Carolina border, with Chesapeake Bay contributing significantly to the total. South of the Gulf of Maine, where there is a wider coastal plain and greater agricultural activity, estuaries carry higher sediment and nutrient loads. The increased fertility and generally higher water temperatures resulting from these nutrient loads allow these estuaries to support greater numbers of fish and other aquatic organisms.

South of the Virginia/North Carolina border, there are approximately 4,500 sq mi (11,655 sq km) of estuarine habitat. The Currituck, Albemarle, and Pamlico Sounds, which together constitute the largest estuarine system along the entire Atlantic coast, make up a large portion of these southern estuaries. A unique feature of these sounds is that they are partially enclosed and protected by a chain of fringing islands, the Outer Banks, located 32 to 48 km (20 to 30 mi) from the mainland.

Because of their low tidal flushing rates, estuaries are generally more susceptible to pollution than other coastal water bodies, yet the severity of the problem varies depending on the extent of tidal flushing. In Maryland and Virginia, the primary problems reported are excessive nutrients (nitrates and phosphates), particularly in the Chesapeake Bay and adjoining estuarine areas. Other problems included elevated bacterial and suspended sediment levels. Non-point sources of pollution are considered one of the main causes of pollution. Elevated bacterial levels were also listed as a local coastal pollution problem in Maryland.

In North Carolina, the primary problems occurring in estuarine areas are enrichment in organics and nutrient enrichment, fecal coliform bacteria, and low dissolved oxygen. Insufficient sewage treatment, wide-spread use of septic systems in coastal areas, and agricultural runoff are considered to be major causes of these pollution problems. Oil spills from vessel collisions and groundings, as well as illegal dumping of waste oil, are a common cause of local, short-term water quality problems, especially in estuaries along the North and Mid-Atlantic coasts. These sources of pollution and habitat degradation may have a negative impact on coastal shark populations, particularly during vulnerable early life stages.

Many of the coastal bays and estuaries along the Atlantic East Coast and Gulf of Mexico are described in greater detail in the 1999 Tunas, Swordfish, and Shark FMP, including the distribution, size, depth, freshwater inflow, habitat types, tidal range, and salinity for each of the major estuaries and bays on the East coast and Gulf coast, and are not repeated here.

Continental Shelf and Slope Areas

Moving seaward away from the coast, the next major geologic features encountered are the continental shelf and slope areas. The continental shelf is characterized by depths ranging from a few meters to approximately 60 m (198 ft), with a variety of bottom habitat types. Far less research has been done in this area than on the coasts and estuaries, and consequently much less is known about the specific habitat requirements of HMS within these regions.

Along the northeast Atlantic shelf, the circulation patterns of the Gulf of Maine and Georges Bank dominate the oceanographic regime. The Gulf of Maine is a deep indentation in the continental shelf with irregular bottom topography. Its bottom consists of three major basins and many smaller ones separated by numerous ridges and ledges. It is a semi-enclosed sea, with Nova Scotia as its north and east boundary and the northeast U.S. coast as its west boundary. Georges and Browns Banks significantly separate the Gulf of Maine from the Atlantic Ocean.

Georges Bank is a large, relatively shallow topographic high that lies southeast of the Gulf of Maine, its seaward edge comprising part of the shelf break in the north Atlantic. Georges Bank is consistently one of the most productive habitats for plankton in the world. The tidal and oceanographic current regimes in the area and Georges Bank's proximity to deep slope water allow upwelling events to occur that transport nutrient-rich deep water to the shallow, euphotic areas of the bank. This provides increased primary productivity that benefits higher trophic level fish and shellfish species. On the seaward side, Georges Bank is incised by numerous submarine canyons.

From the Scotian Shelf in the north, past Georges Bank and through the Mid-Atlantic Bight, a shelf-slope front exists. This hydrographic boundary separates the fresher, colder, and more homogeneous waters of the shelf and the horizontally stratified, warmer, and more saline waters of the continental slope. The shelf-slope front may act as a barrier to shelf-slope transfer of water mass and momentum.

From Nova Scotia to Cape Hatteras, 26 large valleys which originate on the shelf cut into the seafloor downward across the continental slope and rise. The current regimes in these submarine canyons promote significant biological productivity and diversity. Peak currents occur near the canyon heads and flow down the canyon, while currents at intermediate depths flow up the canyon. These patterns suggest a circulation that may trap sediments in the canyon heads and produce conditions conducive to front development. HMS are known to aggregate in the areas where these fronts form, most likely as productive feeding grounds.

The shelf area of the Mid-Atlantic Bight averages about 100 km (60 mi) in width, reaching a maximum of 150 km (90 mi) near Georges Bank, off New England, and a minimum of 50 km (30 mi) offshore Cape Hatteras, NC. Current speeds are strongest at the narrowest part of the shelf where wind-driven current variability is highest. The distribution of marine species, including HMS, along the Atlantic seaboard may be strongly influenced by currents, the warm Gulf Stream in the middle and south portions of the region, and generally by the combination of high summer and low winter temperatures.

The Mid-Atlantic area from Cape Cod, MA to Cape Hatteras, NC represents a transition zone between northern cold-temperate waters of the north and the warm-temperate waters to the south. Water temperatures in the Mid-Atlantic vary greatly by season. Consequently, many of the fish species of importance in the Mid-Atlantic area migrate seasonally, whereas the major species in the other three areas are typically resident throughout the year (MMS, 1992; 1996). The shelf-edge habitat may range in water depth between 40 and 100 m (131 and 328 ft). The bottom topography varies from smooth sand to mud to areas of high relief with associated corals and sponges.

The continental shelf in the South Atlantic Bight varies in width from 50 km (32 mi) off Cape Canaveral, FL to a maximum of 120 km (75 mi) off Savannah, GA. The shelf is divided into three cross-shelf zones. Waters on the inner shelf (0-20 m (0-66 ft)) interact extensively with rivers, coastal sounds, and estuaries. This interaction tends to form a band of low-salinity, stratified water near the coast that responds quickly to local wind-forcing and seasonal atmospheric changes. Mid-shelf (20-40 m (66-132 ft)) current flow is strongly influenced by local wind events with frequencies of two days to two weeks. In this region, vertically well mixed conditions in fall and winter contrast with vertically stratified conditions in the spring and summer. Gulf Stream frontal disturbances (*e.g.*, meanders and cyclonic cold core rings) that occur on time scales of two days to two weeks dominate currents on the outer shelf (40-60 m (132-197 ft)).

A topographic irregularity southeast of Charleston, SC, known as the Charleston Bump, is an area of productive sea floor, which rises abruptly from 700-300 m (2,300-980 ft) within a distance of about 20 km (12 mi), and at an angle which is approximately transverse to both the general isobath pattern and the Gulf Stream currents. The Charleston Gyre is a persistent oceanographic feature that forms in the lee of the Charleston Bump. It is a location in which larval swordfish have been commonly found and may serve as nursery habitat.

The continental slope generally has smooth mud bottoms in water depths of 100- 200 m (328-656 ft). Many of the species in this zone are representatives of cold-water northern species exhibiting tropical submergence (*i.e.*, being located in deeper, cooler water as latitude decreases).

Pelagic Environment

Many HMS spend their entire lives in the pelagic, or open ocean environment. These species are highly mobile and physiologically adapted to traveling great distances with minimal effort. Much of what is known about the association between HMS and their migrations across vast open ocean habitat comes from tagging studies.

While the open ocean may appear featureless, there are major oceanographic features such as currents, temperature gradients, eddies, and fronts that occur on a large scale and may influence the distribution patterns of many oceanic species, including HMS. For instance, the Gulf Stream produces meanders, filaments, and warm and cold core rings that significantly affect the physical oceanography of the continental shelf and slope. These features tend to aggregate both predators and prey, and are frequently targeted by commercial fishing vessels. This western boundary current has its origins in the tropical Atlantic Ocean (*i.e.*, the Caribbean Sea). The Gulf Stream system is made up of the Yucatan Current that enters the Gulf of Mexico through the Yucatan Straits; the Loop Current which is the Yucatan Current after it separates from Campeche Bank and penetrates the Gulf of Mexico in a clockwise flowing loop; the Florida Current as it travels through the Straits of Florida and along the continental slope into the South Atlantic Bight; and the Antilles Current as it follows the continental slope (Bahamian Bank) northeast to Cape Hatteras. From Cape Hatteras it leaves the slope environment and flows into the deeper waters of the Atlantic Ocean.

The flow of the Gulf Stream as it leaves the Straits of Florida reaches maximum speeds of about 200 cm/s. During strong events, maximum current speeds greater than 250 cm/s have been recorded offshore of Cape Hatteras. The width of the Gulf Stream at the ocean surface ranges from 80-100 km (50-63 mi) and extends to depths of between 800 and 1,200 m (2,624-3,937 ft).

As a meander passes, the Gulf Stream boundary oscillates sequentially onshore (crest) and offshore (trough). A meander can cause the Gulf Stream to shift slightly shoreward or well offshore into deeper waters. The Gulf Stream behaves in two distinct meander modes (small and large), with the size of the meanders decreasing as they move northward along the coast. During the large meander mode the Gulf Stream front is seaward of the shelf break, with its meanders having large amplitudes. Additionally, frontal eddies and accompanying warm-water filaments are larger and closer to shore. During the small meander mode the Gulf Stream front is at the shelf break. Frontal eddies and warm-water filaments associated with small amplitude meanders are smaller and farther from shore. Since HMS tend to follow the edge of the Gulf Stream, their distance from shore can be greatly influenced by the patterns of meanders and eddies.

Meanders have definite circulation patterns and conditions superimposed on the statistical mean (average) condition. As a meander trough migrates in the direction of the Gulf Stream's flow, it upwells cool nutrient-rich water, which at times may move onto the shelf and may evolve into an eddy. These boundary features move south-southwest. As warm-water filaments, they transfer momentum, mass, heat, and nutrients to the waters of the shelf break.

Gulf Stream filaments are mesoscale events, which occur regularly offshore the southeast United States. The filament is a tongue of water extending from the Gulf Stream pointing to the south. These form when meanders cause the extrusion of a warm surface filament of Gulf Stream water onto the outer shelf. The cul-de-sac formed by this extrusion contains a cold core that consists of a mix of outer-shelf water and nutrient-rich water. This water mix is a result of upwelling as the filament/meander passes along the slope. The period from genesis to decay typically is about two to three weeks.

The Charleston Gyre is a permanent oceanographic feature of the South Atlantic Bight, caused by the interaction of the Gulf Stream waters with the topographically irregular Charleston Bump. The gyre produces an upwelling of nutrients, which contributes significantly to primary and secondary productivity of the Bight. The degree of upwelling varies with the seasonal position and velocity of the Gulf Stream currents.

In the warm waters between the western edge of the Florida Current/Gulf Stream and 20°N and 40°N, pelagic brown algae, *Sargassum natans* and *S. fluitans*, form a dynamic structural habitat. The greatest concentrations are found within the North Atlantic Central Gyre in the Sargasso Sea. Large quantities of *Sargassum* frequently occur on the continental shelf off the southeastern United States. Depending on prevailing surface currents, this material may remain on the shelf for extended periods, be entrained into the Gulf Stream, or be cast ashore. During calm conditions *Sargassum* may form irregular mats or simply be scattered in small clumps. Oceanographic features such as internal waves and convergence zones along fronts aggregate the algae along with other flotsam into long linear or meandering rows collectively termed "windrows."

Pelagic *Sargassum* supports a diverse assemblage of marine organisms including fungi, micro- and macro-epiphytes, sea turtles, numerous marine birds, at least 145 species of invertebrates, and over 100 species of fishes. The fishes associated with pelagic *Sargassum* include juveniles as well as adults, including large pelagic adult fishes. HMS such as swordfish and billfish are among the fishes that can be found associated with *Sargassum*. The *Sargassum* community, consisting of the floating *Sargassum* (associated with other algae, sessile and free-moving invertebrates, and finfish) is important to some epipelagic predators such as wahoo and dolphin. The *Sargassum* community provides food and shelter from predation for juvenile and adult fish, including HMS, and may function as habitat for fish eggs and larvae.

Offshore water quality in the Atlantic is controlled by oceanic circulation, which, in the Mid-Atlantic is dominated by the Gulf Stream and by oceanic gyres. A shoreward, tidal and wind-driven circulation dominates as the primary means of pollutant transport between estuaries and nearshore waters. Water quality in nearshore water masses adjacent to estuarine plumes and in water masses within estuaries is also influenced by density-driven circulation. Suspended sediment concentration can also be used as an indication of water quality. For the Atlantic coastal areas, suspended sediment concentration varies with respect to depth and distance from shore, the variability being greatest in the Mid-Atlantic and South Atlantic. Re-suspended bottom sediment is the principal source of suspended sediments in offshore waters.

Gulf of Mexico

(Material in this section is largely a summary of information in MMS, 1996; Field *et al.*, 1991; and NOAA 1997. Original sources of information are referenced in those documents.)

The Gulf of Mexico supports a great diversity of fish resources that are related to a variety of ecological factors, such as salinity, primary productivity, and bottom type. These factors differ widely across the Gulf of Mexico and between inshore and offshore waters. Characteristic fish resources are not randomly distributed; high densities of fish resources are associated with particular habitat types (*e.g.*, east Mississippi Delta area, Florida Big Bend seagrass beds, Florida Middle Grounds, mid-outer shelf, and the DeSoto Canyon area). The highest values of surface primary production are found in the upwelling area north of the Yucatan Channel and in the DeSoto Canyon region. In terms of general biological productivity, the western Gulf is considered to be more productive in the oceanic region compared to the eastern Gulf. Productivity of areas where HMS are known to occur varies between the eastern and western Gulf, depending on the influence of the Loop Current.

Coastal and Estuarine Habitats

There are 6.12 million hectares (ha) (13.88 million acres) of estuarine habitat among the five states bordering the Gulf. This includes 3.2 million ha (8 million acres) of open water, 2.43 million ha (6 million acres) of emergent tidal vegetation (including about 162,000 ha (400,318 acres) of mangroves), and 324,000 ha (800, 636 acres) of submerged vegetation. Estuaries are found from east Texas through Louisiana, Mississippi, Alabama, and northwest Florida and encompass more than 62,000 sq km (23,938 sq mi) of water surface area. Estuaries of the Gulf of Mexico export considerable quantities of organic material, thereby enriching the adjacent continental shelf areas. Many of these estuaries provide important habitat as pupping and nursery grounds for juvenile stages of important invertebrate and fish species including many species of Atlantic sharks.

Coastal wetland habitat types that occur along the Gulf Coast include mangroves, non-forested wetlands (fresh, brackish, and saline marshes), and forested wetlands. Marshes and mangroves form an interface between marine and terrestrial habitats, while forested wetlands occur inland from marsh areas. Wetland habitats may occupy narrow bands or vast expanses, and can consist of sharply delineated zones of different species, monospecific stands of a single species, or mixed plant species communities.

Continental Shelf and Slope Areas

The Gulf of Mexico is a semi-enclosed, subtropical sea with a surface area of approximately 1.6 million sq km (0.6 million sq mi). The main physiographic regions of the Gulf basin are the continental shelf, continental slope and associated canyons, the Yucatan and Florida Straits, and the abyssal plains. The U.S. continental shelf is narrowest, only 16 km (9.9 mi) wide, off the Mississippi River. The continental shelf width varies significantly from about 350 km (217 mi) off western Florida, 156 km (97 mi) off Galveston, Texas, and decreases to 88 km (55 mi) off Port Isabel near the Mexican border. The depth of the central abyss ranges to 4,000 m (13,000 ft). The Gulf is unique because it has two entrances: the Yucatan Strait and the Straits of Florida. The Loop Current dominates the Gulf's general circulation and its associated eddies. The Loop Current is caused by differences between the sill depths of the two straits. Coastal and shelf circulation, on the other hand, is driven by several forcing mechanisms: wind stress, freshwater input, buoyancy and mass fluxes, and transfer of momentum and energy through the seaward boundary.

In the Gulf, the continental shelf extends seaward from the shoreline to a depth of approximately 200 m (660 ft), and is characterized by a gentle slope of less than one degree. The continental slope extends from the shelf edge to the continental rise, usually at about the 2,000 m (6,500 ft) water depth. The topography of the slope in the Gulf is uneven and is broken by canyons, troughs, and escarpments. The gradient on the slope is characteristically one to six degrees, but may exceed 20 degrees in some places, particularly along escarpments. The continental rise is the apron of sediment accumulated at the base of the slope. The incline is gentle with slopes of less than one degree. The abyssal plain is the basin floor at the base of the continental rise.

Physical Oceanography

The Gulf receives large amounts of freshwater runoff from the Mississippi River as well as from a host of other drainage systems. In recent years, large amount of nutrient laden runoff from the Mississippi River have resulted in large hypoxic or low oxygen areas in the Gulf. This "dead zone" may affect up to 16,500 sq km (6,371 sq mi) during the summer, resulting in unfavorable habitat conditions for a wide variety of species.

Sea-surface temperatures in the Gulf range from nearly constant throughout (isothermal) (29° to 30°C (84° to 86°F)) in August to a sharp horizontal gradient in January, 25°C (77°F) in the Loop Current core to 14° to 15°C (57° to 59°F) along the northern shelf. The vertical distribution of temperature reveals that in January, the thermocline depth is about 30 to 61 m (98 to 200 ft) in the northeast Gulf and 91 to 107 m (298 to 350 ft) in the northwest Gulf. In May, the thermocline depth is about 46 m (150 ft) throughout the entire Gulf.

Sea surface salinities along the northern Gulf vary seasonally. During months of low freshwater input, salinities near the coastline range between 29 to 32 parts per thousand (ppt). High freshwater input conditions during the spring and summer months result in strong horizontal gradients and inner shelf salinities less than 20 ppt. The mixed layer in the open Gulf, from the surface to a depth of approximately 100 to 150 m (330 to 495 ft), is characterized by salinities between 36.0 and 36.5 ppt.

Sharp discontinuities of temperature and/or salinity at the sea surface, such as the Loop Current front or fronts associated with eddies or river plumes, are dynamic features that may act to concentrate buoyant material such as detritus, plankton, or eggs and larvae. These materials are transported, not by the front's movements or motion across the front, but mainly by lateral movement along the front. In addition to open ocean fronts, a coastal front, which separates turbid, lower salinity water from the open-shelf regime, is probably a permanent feature of the north Gulf shelf. This front lies about 30-50 km (19-31 mi) offshore. In the Gulf, these fronts are the most commonly utilized habitat of the pelagic HMS species.

The Loop Current is a highly variable current entering the Gulf through the Yucatan Straits and exiting through the Straits of Florida (as a component of the Gulf Stream) after tracing an arc that may intrude as far north as the Mississippi-Alabama shelf. This current has been detected down to about 1,000 m (3,300 ft) below the surface. Below that level there is evidence of a countercurrent. When the Loop Current extends into or near shelf areas, instabilities, such as eddies, may develop that can push warm water onto the shelf or entrain cold water from the shelf. These eddies consist of warm water rotating in a clockwise fashion. Major Loop Current eddies have diameters on the order of 300-400 km (186-249 miles), and may extend to a depth of about 1,000 m. Once these eddies are free from the Loop Current, they travel into the western Gulf along various paths to a region between 25° N to 28°N and 93° W to 96° W. As eddies travel westward a decrease in size occurs due to mixing with resident waters and friction with the slope and shelf bottoms. The life of an individual eddy is about one year, after which it is typically assimilated by regional circulation in the western Gulf. Along the Louisiana/Texas slope, eddies are frequently observed to affect local current patterns, hydrographic properties, and possibly the biota of fixed oil and gas platforms or hard bottoms. Once an eddy is shed, the Loop Current undergoes major dimensional adjustments and reorganization.

U.S. Caribbean

(Material in this section is largely a summary of information in Appeldoorn and Meyers, 1993. Original sources of information are referenced in that document.)

The waters of the Caribbean region include the coastal waters surrounding the U.S. Virgin Islands and Puerto Rico. All of these Caribbean islands, with the exception of St. Croix, are part of a volcanic chain of islands formed by the subduction of one tectonic plate beneath another. Tremendously diverse habitats (rocky shores, sandy beaches, mangroves, seagrasses, algal plains, and coral reefs) and the consistent light and temperature regimes characteristic of the tropics are conducive to high species diversity.

The waters of the Florida Keys and southeast Florida are intrinsically linked with the waters of the Gulf of Mexico and the Caribbean to the west, south, and east, as well as the waters of the South Atlantic Bight to the north. These waters represent a transition from insular to continental regimes and from tropical to temperate regimes, respectively, resulting in a zone which contains one of the richest floral and faunal complexes.

Coastal and Estuarine Habitats

Although the U.S. waters of the Caribbean are relatively nutrient poor, resulting in low rates of primary and secondary productivity, they display some of the greatest diversity within the South Atlantic region. High and diverse concentrations of biota are found where habitat is abundant. Coral reefs, sea grass beds, and mangrove ecosystems are the most productive of the habitat types found in the Caribbean, but other areas such as soft-bottom lagoons, algal hard grounds, mud flats, salt ponds, sandy beaches, and rocky shores are also important in overall productivity. These diverse habitats allow for a variety of floral and faunal populations.

Offshore, between the seagrass beds and the coral reefs and in deeper waters, sandy bottoms and algal plains dominate. These areas may be sparsely or densely vegetated with a canopy of up to one meter of red and brown algae. Algal plains are not areas of active sand transport. These are algae-dominated sandy bottoms, often covered with carbonate nodules.

They occur primarily in deep water (> 15 m, or 50 ft), and account for roughly 70 percent of the area of the insular shelf of the U.S. Virgin Islands. Algal plains support a variety of organisms including algae, sponges, gorgonian corals, solitary corals, mollusks, fish, and worms. These areas may also serve as critical juvenile habitat for commercially important (and diminishing) species such as queen triggerfish and spiny lobsters.

Coral reefs and other coral communities are some of the most important ecological (and economic) coastal resources in the Caribbean. They act as barriers to storm waves and provide habitat for a wide variety of marine organisms, including most of the economically important species of fish and shellfish. They are the primary source for carbonate sand, and serve as the basis for much of the tourism. Coral communities are created by the build up of calcium carbonate produced by living animals, coral polyps, in symbiosis with a dinoflagellate, known as zooxanthellae. During summer and early fall, most of the coral building organisms are at or near the upper temperature limit for survival and thus living under natural conditions of stress. Further increase in local or global temperature could prove devastating.

Seagrass beds are highly productive ecosystems that are quite extensive in the Caribbean; some of the largest seagrass beds in the world lie beyond the shore on both sides of the Keys. Seagrass beds often occur in close association with shallow-water coral reefs. Seagrasses are flowering plants that spread through the growth of roots and rhizomes. These act to trap and stabilize sediments, reduce shoreline erosion, and buffer coral reefs; they provide food for fish, sea turtles (heavy grazers), conch, and urchins; they provide shelter and habitat for many adult species and numerous juvenile species that rely on the seagrass beds as nursery areas; and they provide attachment surfaces for calcareous algae.

Mangrove habitats are very productive coastal systems that support a wide variety of organisms. The mangrove food web is based largely on the release of nutrients from the decomposition of mangrove leaves, and in part on the trapping of terrestrial material. Red mangroves (*Rhizophora mangle*), with their distinctive aerial prop roots; grow along the shoreline, often in mono-specific stands. The roots of the red mangroves help to trap sediments and pollutants associated with terrestrial runoff and help to buffer the shore from storm waves. Red mangrove forests support a diverse community of sponges, tunicates, algae, larvae, and corals, as well as juvenile and adult fish and shellfish. Black mangroves (*Aveicennia germinans*) and white mangroves (*Laguncularia racemosa*) grow landward of the red mangroves. They also act as important sediment traps. Exposed and sheltered mangrove shorelines are common throughout the U.S. Caribbean.

Throughout the U.S. Caribbean, both rocky shores and sandy beaches are common. While many of these beaches are high-energy and extremely dynamic, buffering by reefs and seagrasses allows some salt-tolerant plants to colonize the beach periphery. Birds, sea turtles, crabs, clams, worms, and urchins use the intertidal areas.

Salt ponds, common in the U.S. Virgin Islands, are formed when mangroves or fringing coral reefs grow or storm debris is deposited, effectively isolating a portion of a bay. The resulting "pond" undergoes significant fluctuations of salinity with changes in relative evaporation and runoff. As a result, the biota associated with salt ponds are, therefore, very specialized, and usually somewhat limited. Salt ponds are extremely important in trapping terrestrial sediments before they reach the coastal waters.

Insular Shelf and Slope Areas

Puerto Rico and the U.S. Virgin Islands contain a wide variety of coastal marine habitats, including coral and rock reefs, sea grass beds, mangrove lagoons, sand and algal plains, soft bottom areas, and sandy beaches. Often times, these habitats are very patchily distributed. Nearshore waters range from zero to 20 m (66 ft) in depth, and outer shelf waters range from 20 to 30 m (66 to 99 ft) in depth, the depth of the shelf break. Along the north coast the insular shelf is very narrow (two to three km wide), seas are generally rough, and few good harbors are present. The coast is a mixture of coral and rock reefs, and sandy beaches. The east coast has an extensive shelf that extends to the British Virgin Islands with depths ranging from 18 to 30 m (59 to 99 ft). Much of the bottom is sandy, commonly with algal and sponge communities. The southeast coast has a narrow shelf (eight km wide). About 25 km (15.5 mi) to the southeast is Grappler Bank, a small seamount with its summit at a depth of 70 m (231 ft). The central south coast broadens slightly to 15 km (99 mi) and an extensive seagrass bed extends nine km (5.5 mi) offshore to Caja de Muertos Island. Further westward, the shelf narrows again to just two km (1.2 mi) before widening at the southwest corner to over 10 km (6 mi). The entirety of the southern shelf is characterized by hard or sand-algal bottoms with emergent coral reefs, grass beds, and shelf edge. Along the southern portion of the west coast the expanse of shelf continues to widen, reaching 25 km (15.5 mi) at its maximum. A broad expanse of the shelf is found between 14 and 27 m (46 and 99 ft), where habitats are similar to those of the south coast. Along the west coast and to the north, the shelf rapidly narrows to two to three kilometers.

Physical Oceanography

U.S. Caribbean waters are primarily influenced by the westward flowing North Equatorial Current, the predominant hydrological driving force in the Caribbean region. It flows from east to west along the northern boundary of the Caribbean plateau and splits at the Lesser Antilles, flowing westward along the northern coasts of the islands.

The north branch of the Caribbean Current flows west into the Caribbean Basin at roughly 0.5 m (1.7 ft) per second. It is located about 100 km (62 mi) south of the islands, but its position varies seasonally. During the winter it is found further to the south than in summer. Flow along the south coast of Puerto Rico is generally westerly, but this is offset by gyres formed between the Caribbean Current and the island. The Antilles Current flows to the west along the northern edge of the Bahamas Bank and links the waters of the Caribbean to those of southeast Florida.

Coastal surface water temperatures remain fairly constant throughout the year and average between 26° and 30°C (79° and 86°F). Salinity of coastal waters is purely oceanic and therefore is usually around 36 ppt. However, in the enclosed or semi-enclosed embayments, salinity may vary widely depending on fluvial and evaporational influences.

It is believed that no upwelling occurs in the waters of the U.S. Caribbean (except perhaps during storm events) and, since the waters are relatively stratified, they are severely nutrient-limited. Nitrogen is the principal limiting nutrient in tropical waters.

CHAPTER 3 REFERENCES

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4.0 ENVIRONMENTAL CONSEQUENCES OF ALTERNATIVES

4.1 Essential Fish Habitat

As described in Chapter 2, the alternatives considered for identifying and updating EFH are:

Alternative 1 No Action - maintain current EFH boundaries.

Alternative 2 Establish new EFH boundaries based on the highest concentration of a particular species by selecting high count cells.

Alternative 3 *Establish new EFH boundaries based on the 95 percent probability boundary. (Preferred alternative).*

Alternative 4 Establish new EFH boundaries using all points or cells where species are present.

Alternative 5 Establish new EFH boundaries using the entire range of distribution for each species and life stage.

As described in Chapter 2, Alternatives 4 and 5 are not further analyzed, as they result in overly-broad designation of EFH that runs counter to the intent to identify habitats that are "essential." Although these alternatives do not meet the purpose of this action and are not fully analyzed, they are briefly mentioned in this section for context in the comparison of the fully-analyzed EFH alternatives (Alternative 1 through 3).

Ecological, Social, and Economic Impacts

The following section describes the environmental, social, and economic impacts of the alternatives considered. While designation of EFH does not result in any environmental, social, or economic impacts, it establishes a process whereby fishing impacts on EFH must be carefully considered, analyzed, and if necessary, avoided or minimized to prevent negative effects on EFH. This is accomplished through a formal process of consultation between NMFS and other Federal agencies for all actions authorized, funded, or undertaken by the agency that may adversely affect EFH. NMFS also conducts consultations on other non-fishing federal actions that may adversely affect EFH. As a result, identifying appropriate EFH areas is an important first step in ensuring that EFH is not degraded or harmed.

Conservation measures to encourage the conservation and enhancement of EFH are described in Chapter 6, and these measures may be among those provided to an agency during an EFH consultation process. Since the measures are non-binding and are not specific to a particular project at this time, the description of these measures does not have an environmental consequence associated with their development as a part of this proposed

FMP amendment. Therefore, the conservation measures are not analyzed in more detail in this section.

4.1.1 Data Sources Used to Update HMS EFH

One of the overarching challenges of identifying EFH for HMS is that the available data sets for HMS are largely based on presence/absence data. By nature, these species are highly migratory and occupy a wide range of habitats, including estuarine, coastal, and offshore pelagic environments. HMS are typically associated with fronts and current boundaries or oceanographic conditions with specific temperatures, salinity, dissolved oxygen, or other physical characteristics that may be seasonal or ephemeral and therefore difficult to map. Furthermore, not all areas where water characteristics appear to be ideal habitat for a particular species constitute EFH. Basing EFH exclusively on the presence of specific environmental conditions may therefore not be the most appropriate means for identifying true EFH. Stationary features such as shelf edges and sea mounts are more easily identified and represent sites of higher abundance for some HMS on a seasonal basis. For some species and life stages, particularly young-of-the-year sharks (less than age 1) and juvenile sharks, specific benthic habitat associations (such as submerged aquatic vegetation or sandy bottom) have been observed and documented in the scientific literature. Where appropriate, these areas were included in the EFH descriptions. As in the past, geographic features such as the shoreline or bathymetric features such as depth contours (isobaths) were used to delineate the boundary, or a portion of an EFH boundary. In some cases, such as pelagic species, the U.S. Exclusive Economic Zone (EEZ) boundary was used to delineate the seaward extent of EFH because the EEZ is the limit of authority to identify and describe EFH. EFH boundaries were determined based primarily on the data indicating the presence of species in a specific area, and additional features described above may have been used to further refine or create natural borders on the EFH boundaries. Due to the inherent difficulties in identifying EFH, a precautionary approach of selecting larger areas may have been used in the past. Where possible, NMFS tried to refine EFH using an analysis and approach described below. In certain circumstances however, this approach may result in larger areas being identified for some species or life stages.

Distribution data alone may not provide sufficient information on whether the habitat should be considered essential even if correlations can be drawn between the presence of HMS in a given area and a particular habitat. For many HMS, additional information from the scientific literature, research publications, field surveys, or observations of feeding or spawning (or pupping in the case of sharks) may be used to further confirm the importance of a specific geographic area as EFH. Information about the life history of a particular species, such as the timing of the reproductive cycle, may also be used to correlate the presence of HMS and establish the importance of a particular area or habitat. NMFS relied on peer-reviewed literature, unpublished scientific reports, fisheries observer data, research information, and personal communication with the scientific community to assist in making proposed changes to EFH boundaries.

EFH information for most of the data sets used in the analysis are based largely on distribution information (level 1) derived from systematic presence/absence sampling and fishery independent and dependent data. The NMFS guidelines (§600.815(a)(1)(iii)) indicate that level 1 information is appropriate for delineating EFH if it is the only information available. Level 2, or density information (*i.e.,* number of fish/m^3), is generally not available for HMS due to the way in which data is collected and the types of gear used to collect HMS. For example, data from the McCandless *et al.* (2007) synthesis document on shark nursery areas in coastal waters were gathered using a wide variety of sampling techniques including gillnet, longline, and trawl surveys. Of the 21 separate research studies conducted from Massachusetts to Texas that contributed to the report, only one provided trawl data that might have been used to generate habitat related densities. Additional equipment would have been needed to collect information on water volume sampled in order to estimate densities. The other sampling techniques (gillnet and longline) provided presence/absence or relative abundance through catch per unit effort (CPUE) data (*e.g.,* number of sharks/gillnet hour, or number of sharks/100 hooks), but not density data. Additionally, due to the differences in fishing effort, a cross comparison of CPUE among the different studies was not possible. The wide variety of gears used to sample HMS (longline, rod and reel, handline, harpoon, gillnet), causes difficulties in standardizing effort for nearly all HMS. However, the information is nonetheless useful in providing an overview of the current and historical distributions, habitat requirements, and nursery areas for a wide variety of species. Although there are exceptions, such as the NMFS longline survey in the Gulf of Mexico that collected CPUE data, the data were restricted to areas in which the surveys occurred and did not encompass all areas that could potentially be considered EFH. Other data sets that include CPUE data, such as the Pelagic Longline Logbook, could not be used because they did not include fish length measurements that are necessary to delineate EFH by life stage. Level 3 information regarding growth, reproduction, or survival rates within habitats, and level 4 information regarding production rates by habitat type are generally not available for HMS. Although there may be site-specific studies that include this type of information, they are not necessarily applicable across the broad spectrum of habitat types that may be considered EFH.

Despite the lack of density information, or level 3 and 4 data, other valuable information may be derived from studies including data on growth rates from recaptured tags and habitat utilization information through sampling, telemetry, and tagging efforts. By determining the life stage of a species at capture through size measurements, additional information may be derived about habitat utilization. Information on where and when HMS are located in a given area, what life stage is found in the area, how long they may have been in the area, when migrations occur, and whether they return to the same area in subsequent years may be determined. In combination, all of these data help to determine the importance of habitat types and provide a more complete overview of habitat utilization than simple distribution data might suggest. As described in the Preface to McCandless *et al*. 2007:

> *Using presence absence data to identify potential shark nursery areas is a good starting point, but it does not provide information on the importance of the areas in supporting juvenile shark populations. A handful of neonates caught in one area over a short period of time could easily have been born from a single female out of its range. For this reason, it is necessary to conduct long-term fishery independent surveys in putative shark nursery areas to monitor the juvenile shark relative abundance over time. This information*

will help managers determine whether or not a putative shark nursery area constitutes EFH for that species. By also incorporating conventional mark-recapture and/or acoustic telemetry studies in areas that appear to support relatively high numbers of juvenile sharks, one can develop a better picture of how the nursery habitat is used.

To the extent possible, these and other types of information from studies of life history dynamics of HMS, reports, and expert opinion were used to identify EFH. Above all, the studies help confirm or refute the presence of EFH for particular species as determined through mapping of presence/absence data. The sources that are used to identify EFH areas are referenced in the text and on the maps. Environmental information was included in the habitat requirements descriptions, when available. This information may include temperature, salinity ranges, dissolved oxygen, depths, seasons, benthic habitat type (in the case of shark pupping areas), and geographic locations. Maps were generated to provide the specific geographic locations of HMS, in part because this is the information most frequently sought by other agencies in their consultation process with NMFS. The maps are designed to facilitate accurate identification of EFH boundaries and to provide better resolution on the location of EFH in specific areas.

In addition to the alternatives below, NMFS considered additional factors such as stock status, potential Endangered Species Act (ESA) concerns, and any bycatch concerns in updating EFH. For example, if a stock is overfished, NMFS may consider a more precautionary approach toward delineating EFH. Conversely for stocks that are not overfished, NMFS may consider refining EFH, particularly if the original EFH boundaries were broadly defined (§600.815(a)(1)(iv)(C)).

A number of fishery dependent and independent databases as well as data from individual researchers were used to analyze and identify EFH. They include data from the Pelagic Observer Program (POP), Cooperative Tagging Center (CTC), Shark Bottom Longline Observer Program (SOP), Cooperative Shark Tagging Program (CSTP), Virginia Institute of Marine Science Longline Survey, Mote Marine Laboratory Center for Shark Research, South Carolina Department of Natural Resources Marine Game Fish Tagging Program, American Littoral Society, The Billfish Foundation (TBF), and NMFS Northeast and Southeast Longline Shark Surveys. Data from individual researchers contributing to the NMFS Cooperative Atlantic States Shark Pupping and Nursery Areas (COASTSPAN) program and the synthesis document "Shark nursery grounds of the Gulf of Mexico and the East Coast water of the United States: an overview" (McCandless *et al.,* 2007) were also included. At a minimum, these databases include latitude and longitude coordinates of the location of tagging or capture, species name, length, date of capture, and identification of the source or program responsible for collecting the data. Since NMFS is required to identify and describe EFH for each species by life stage (adult, juvenile, young-of-the-year or larvae/eggs/spawning areas), only data which included length measurements could be used. If the data did not include length measurements and/or specific locations where the samples were collected, then the data could not be included.

Several of the major sources of the data used to identify EFH came from voluntary tagging programs. NMFS, Southeast Fisheries Science Center (SEFSC) Cooperative Tagging

Center (CTC), and TBF collect data primarily on tunas and billfish, whereas the Northeast Fisheries Science Center (NEFSC) Apex Predators Program which runs the CSTP primarily collects data on sharks. The SEFSC formed the CTC in 1992 in response to the expansion of tag release and recapture activities, data requests from other tagging agencies, and domestic and international tagging research needs. The CTC also includes the Cooperative Tagging System (CTS), as well as other research projects such as tag development and performance research and cooperative work with endangered species. The CSTP has collected data on sharks since the 1960s and represents the longest time series of any data set used to identify HMS EFH. The CSTP was initiated in 1962 with an initial group of less than 100 volunteers. The program has expanded in subsequent years and currently includes over 6,500 volunteers distributed along the Atlantic and Gulf coast of North America and Europe. There are inherent limitations in voluntary data collection programs that may include misidentification, inaccurate or inconsistent size determination, in part due to the fish being kept in the water while being measured, or incomplete data collection. NMFS removed any records that were incomplete, did not include a size measurement, or that did not indicate the type of measurement taken (e.g. fork length, total length).

Other factors that were taken into consideration include gear selectivity and the type of fishing effort (fishery dependent vs. independent) being employed. For example, fishery independent data collections of sharks tend to be weighted toward areas closer to shore. This may be the result of a focus on nursery areas where young-of-the-year and juvenile sharks are more abundant than adults. Commercial longline fishery data from the shark bottom longline and pelagic observer programs tends to be collected further offshore and consists predominantly of adult specimens. Geographic difference in data by gear type were also evident for gillnet gear which is typically fished closer to shore than bottom longline gear. Since NMFS sorted the species by size and life stage, the inherent gear biases in the data collection were minimized.

NMFS considered using catch rates as a means to identify EFH, but found that most of the datasets did not include sufficient information to estimate fishing effort, or were collected with gears such as rod and reel from which estimates of fishing effort could not be derived. Although CPUE data may have been available for some species in certain areas, it was not consistently collected across all areas that could be considered EFH. Thus, although CPUE may have been available for some species, it was not available for all species and would have required a separate approach for mapping EFH areas. As described above, one of the objectives of updating EFH was to develop a consistent, reproducible approach for delineating EFH. Although CPUE data may have helped to delineate areas of highest concentration, there would have been insufficient data to delineate EFH for all species. NMFS opted instead to take all available data sources and use them to identify EFH using the probability boundary approach described below. In most cases, it is likely that the distribution data that were used to develop the probability boundaries included areas where the highest CPUEs would have occurred.

New data collected since the 1999 FMP for Atlantic Tunas, Swordfish, and Sharks, Amendment 1 to the Billfish FMP, and Amendment 1 to the 1999 FMP as well as previously existing data used to identify the 1999 EFH boundaries, were analyzed using Geographic

Information System (GIS) software (ESRI Arcview 9.2). The data from all the datasets were combined into a single dataset for each species and life stage.

4.1.2 Analysis of EFH Alternatives - Approaches Used to Analyze and Map Data

NMFS considered a number of different approaches for mapping and identifying EFH. The first approach was similar to the one used to update EFH for five shark species in the 2003 Amendment 1 to the FMP for Atlantic Tunas, Swordfish, and Sharks. In that Amendment, NMFS used the areas with the highest concentration of a particular species and associated life stages (adult, juvenile, and young-of-the-year or larval/spawning areas) to determine changes to EFH boundaries. Individual points were superimposed on a grid covering coastal waters in the Atlantic, Gulf of Mexico, and Caribbean U.S. EEZ. The grid was constructed of ten-minute squares (or cells) where one minute equals one nautical mile (nm), resulting in squares that represent approximately 100 nm^2. The grid and individual data points were spatially joined and each cell was given a number representing the sum of all the points that fell within it. The cells were color-coded depending upon the number of observations per cell, and a scale was generated using Jenks natural breaks (ESRI, 2007) to detect breaks in the data to reflect the number of points per cell. Natural breaks in the data points were generated in Arcview using algorithms that group similar values and maximize the differences between classes. The features are divided into classes whose boundaries are set where there are relatively large jumps in the data values. Depending on the species, the number of observations per cell ranged from zero to several thousand. Due to natural variability in abundance and sampling for each of the species and life stages, which is reflected by the variation in the number of observations per 100 nm^2, scales were tailored to each species.

The resulting scales generated by the cells could be interpreted in a number of different ways, and the resulting EFH boundary for each species and life stage may vary depending upon which cells are used to delineate the boundary. For instance, in alternative 2, NMFS considered using a threshold approach similar to the one used in the 2003 Amendment 1 to the HMS FMP where EFH was described based on the areas of highest number of data points for a particular species and life stage. In alternative 2, NMFS used different thresholds depending on the status of a particular stock and selected the top three highest count classes on a scale with six classes for blacktip sharks (which were not overfished) to delineate EFH. Conversely, for an overfished stock such as dusky sharks, NMFS used fewer observations per cell to delineate the EFH boundary (NMFS 2003; Chapter 10). The lower the number of data points or observations per cell that are used to delineate EFH, the more liberal the approach employed and the broader the resulting area. Once the threshold was established and the appropriate cells were identified, NMFS manually drew boundaries around the cells to create the new EFH boundaries. NMFS opted not to identify the 10 x 10 minute cells themselves as EFH because the blocks were discontinuous, sometimes fragmented, and did not appear to accurately reflect the continuous nature of HMS EFH. Although this approach may be appropriate for less mobile or sessile benthic species, the approach required a certain amount of subjectivity in determining which high count cells to include when manually drawing boundaries around cells. The process relies on the judgment of the person drawing the boundaries to decide which cells to include vs. exclude, particularly when high count cells did not adjoin one another. In addition, depending on the number of data points for the species, the resulting scales differed and lacked a consistent approach.

In alternative 3, NMFS considered a different approach based on generating boundaries around the distribution points themselves (without creating a grid and scale as described above in alternative 2). NMFS used an Arcview extension called Hawth's Analysis Kernel Density Estimator (or Hawth's analysis tool) to establish percent volume contours (or probability boundaries) as the basis for establishing new EFH boundaries. The area of probability is created using all data points for a particular species' life stage and taking into account the distance between points, thereby excluding the least dense points (outliers) from the resulting probability boundary. Hawth's analysis tool was used to create the 70, 80, 90, and 95 percent probability boundaries for Atlantic HMS. The online documentation (http://www.spatialecology.com/htools/bkde.php) explains the tool, which has been used in terrestrial applications to delineate home ranges of animals. A percent volume contour is not the same as a simple contour that is typically produced with tools like Spatial Analyst. A percent volume contour represents the boundary of the area that contains a certain percent of the volume of a probability density distribution. A simple contour (like the ones that are produced in Spatial Analyst) represent only the boundary of a specific value of the raster data, and does not in any way relate to the probability density distribution. For applications like animal home range delineation, the percent volume contour reflects the areas most frequently used by the species. The 95 percent volume contour would therefore, on average, contain 95 percent of the points that were used to generate the 95 percent probability boundary.

NMFS considered a range of probability boundaries (70, 80, 90, and 95) for updating EFH boundaries. All four of the probability boundaries are shown on maps in the electronic pdf version of this document and in the online EFH Evaluation Tool site (http://sharpfin.nmfs.noaa.gov/website/EFH_Mapper/HMS/map.aspx). Both the electronic pdf version and the online mapping site have options that allow the viewer to turn layers on and off, thereby providing the viewer with the ability to differentiate between the different probability boundaries. All four of the probability boundaries were not included on the maps in the hard copy version of the DEIS because it was difficult to see the preferred probability boundary due to the four overlapping probability boundaries and other layers. Thus, for ease of viewing, the hard copy maps only include the preferred 95 percent probability boundary. The 70 percent probability boundary contains approximately 70 percent of all the points that were used to generate the probability boundary, the 80 percent probability boundary includes approximately 80 percent of the points, and so on. This pattern holds true for data rich species with a large numbers of data points. For species with fewer data points (< 1,000), the relative number of points included in each probability boundary is higher. For example, the 70 percent probability boundary for a data poor species such as basking sharks may include 80 percent of the total points. The result is a more precautionary approach for delineating EFH for data poor species. The advantage of using probability boundaries is that they are reproducible, have a predictable outcome, and more accurately reflect key areas of distribution for species because the points are weighted proportionally to one another. NMFS selected the 95 percent probability boundary as the preferred boundary because it represented the most precautionary approach of the four probability boundaries, in many cases (but not all) was most similar to the existing EFH boundaries established in 1999, and tended to provide more continuous boundaries than some of the lower probability boundaries, which were based on fewer data points.

Generating the probability boundaries was the first step in creating the proposed EFH boundaries under Alternative 3. The resulting probability boundaries were then compared to existing EFH boundaries, bathymetric features or other known areas of important habitat, verified and corroborated to the extent possible with NMFS scientists and researchers familiar with the habitat requirements for a particular species, and then, if necessary, modified based on input from the scientists and analysis of the data. Where appropriate, NMFS used bathymetric features such as isobaths or the shoreline to delineate the edges of the probability boundaries. Depending on the species and life stage, if the probability boundary overlapped with the shoreline, NMFS clipped the resulting probability boundary along the shoreline. For other species that infrequently occupy nearshore waters, the edge of the probability boundary may have been clipped along a particular isobath. For example, if a species is known to primarily occur seaward of the 100m isobath, then the boundary was clipped along the 100m isobath, thus removing the probability boundary from areas shallower than the 100m isobath. Similarly, if a nursery area for a given species has been documented in a specific bay or estuary that may not have been included in the original 95 percent probability boundary, then that area was included. Conversely, if the 95 percent probability boundary resulted in inclusion of a bay or estuary for which there was no documented evidence of nursery or other essential habitat, then the area was excluded. Any additional changes or edits made to the boundaries are described in the EFH sections.

Since NMFS used the 95 percent probability boundary as the preferred boundary, only the 95 percent probability boundary was further edited to match the shoreline or other bathymetric features (and not the 70, 80, and 90 percent probability boundaries). The final, edited probability boundary is referred to as the 95 percent probability boundary 'preferred alternative.' For many of the species, NMFS produced both the 95 percent probability boundary and the 95 percent probability boundary 'preferred alternative.' The difference between the two is that the 95 percent probability boundary is the raw, unedited probability boundary that resulted from running Hawth's analysis tool, which may then have been further edited to match the EEZ, shoreline, or other bathymetric features, resulting in a 95 percent preferred alternative boundary. NMFS wanted reviewers to clearly see the difference between the 95 percent probability boundary generated by the Hawth's analysis tool and the 95 percent preferred boundary resulting from additional edits to the 95 percent probability boundary. This was considered particularly important for some pelagic species such as tunas, swordfish, billfish, and pelagic sharks whose range extends beyond the U.S. EEZ and for which data points outside the EEZ may have resulted in probability boundaries being generated inside and outside the EEZ. As described earlier, because the Magnuson-Stevens Act limits U.S. jurisdiction to areas within the U.S. EEZ, NMFS does not have regulatory jurisdiction to designate EFH beyond the U.S. EEZ, thus in cases where the probability boundary extended beyond the EEZ, the EEZ was used to delineate the seaward boundary. By including data points outside the EEZ in the analysis, NMFS took into account the migratory nature of HMS, the importance of habitat beyond the EEZ, and the potential influence of habitat outside the EEZ on the utilization of habitat inside the EEZ without actually identifying and describing areas beyond the EEZ as EFH.

The 95 percent probability boundary thus reflects all data points collected ocean-wide and not just data points inside the EEZ. As a result, for species that included data points outside the EEZ, NMFS generated all four probability boundaries based on all data points. All of the boundaries are shown on the EFH Evaluation Tool site, and viewers will notice that probability boundaries extend beyond the EEZ. These areas are not considered EFH, but rather are shown for comparative purposes and to clearly indicate how the proposed EFH boundary within the EEZ was created.

Layers that may have been used to delineate or modify probability boundaries include the EEZ, shoreline, and various isobaths. Where possible, NMFS used these parameters to delineate EFH boundaries, however, if none of the above parameters appeared to coincide with the edge of a probability boundary, NMFS may have manually delineated straight lines around the perimeter of the probability boundary. Any modifications made to the 95 percent probability boundaries are described in text.

In some cases, usually for data poor species, the probability boundaries included small(er) pockets of probability boundaries. In a few extreme cases, every known data point for a data poor species may have resulted in a 95 percent preferred probability boundary. Due to the highly mobile and migratory nature of the species, extremely small EFH areas may not necessarily reflect the true extent of EFH, may be an artifact of data poor species, and may need to be absorbed into larger areas, or conversely, excluded. In many cases, this may be handled on a species by species basis depending upon expert knowledge of a given species' habitat requirements. Options being considered are to incorporate smaller pockets into larger areas if they fall within a given distance of a larger probability boundary, excluding them if they are smaller than a given size or beyond a given distance of a larger probability boundary, leaving them as is, or manually creating new boundaries based on expert knowledge.

In the past, EFH descriptions were provided in text with specific geographic coordinates describing the boundaries. Because the probability boundaries do not have straight lines, but rather follow contour lines, isobaths, or the data points themselves, and are naturally smoothed and rounded, describing them in text would be difficult and impracticable. With new mapping capabilities and the ability to provide spatial files to the public via the internet, NMFS will no longer provide specific coordinates or detailed descriptions of EFH locations. Instead, NMFS will direct users to electronic versions of the maps or to the HMS EFH Evaluation Tool site, an internet-based mapping program to provide the EFH boundaries, rather than describing them in text. With the new tool, NMFS will have the capability to provide EFH spatial files to the public via the internet and will not have to provide text descriptions of the actual boundaries. Instead, the EFH descriptions in the DEIS will reference the spatial files and direct the public to the online tool to determine where EFH boundaries are.

For alternative 4, NMFS considered using all data points for a species to update EFH boundaries. Establishing EFH boundaries which encompass all available data points for a species could result in large EFH areas that do not necessarily reflect habitat which is essential. This approach would have created continuous boundaries between all available data points, potentially encompassing the entire EEZ for some species. NMFS did not further analyze this approach due to the wide geographic extent of resulting boundaries.

Similarly, for alternative 5, NMFS considered establishing EFH boundaries based on the entire known range of distribution for each species' life stage, rather than data points. As with alternative 4, this approach would have been very precautionary and would have resulted in extremely large EFH areas. NMFS did not further analyze this approach due to the wide geographic extent of resulting boundaries that did not necessarily reflect the most essential habitat areas.

4.1.3 Comparison of EFH Alternatives

For each of the alternatives, there are no ecological, social, or economic impacts that result from either changing or maintaining the existing EFH boundaries. In addition to the status quo, the alternatives represent a range of options from smaller, more refined areas to larger, more broadly delineated areas. The primary effect of changing EFH boundaries would be a change in the areas that are subject to consultation with NMFS under the EFH regulations. As such, if a proposed project is federally funded, authorized, or undertaken by a Federal agency or proposed to be undertaken by a Federal agency, which may affect EFH, then the agency is required to consult with NMFS. NMFS provides written recommendations on measures that would minimize, mitigate, or otherwise reduce the impacts of a proposed project on EFH. The action agency is then required to respond in writing on what measures were taken to minimize impacts.

Similarly, the analysis of fishing impacts to EFH is specifically required as part of the EFH designation process, and Chapter 6 of this document describes those fishing impacts. At this time, since no fishing impacts are occurring that would adversely affect EFH, no new measures currently are proposed to reduce fishing impacts (e.g., closures). As such, there are no measures being considered in this proposed action of designating EFH and HAPCs for Atlantic HMS that would result in immediate ecological, social or economic impacts on fishing. Should such required measures be identified in the future, NMFS would propose and appropriately analyze those measures at that time.

For alternative 1, the no action alternative, EFH and the areas subject to consultation would not change. For alternative 2, establishing new EFH boundaries based on the highest concentration of a particular species by selecting high count cells, EFH would be reduced in size for some species and potentially increased for others. Thus, the areas subject to consultation would vary by species. For alternative 3, establishing EFH based on the 95 percent probability boundary preferred alternative would decrease EFH for some species but potentially increase it for others. Thus, the areas subject to consultation would vary by species and areas. NMFS prefers alternative 3 because it provides an objective approach to identifying EFH, is transparent, and reproducible. Alternatives 4 and 5, establishing EFH based on all points or cells where species are present (Alt 4) or the entire range of species distribution (Alt 5) would result in very large areas identified as EFH, particularly if all the points are connected through continuous boundaries. NMFS did not prefer either of the last two alternatives because they would potentially encompass all areas where the species are present and not the areas that represent the most important habitat.

4.2 Habitat Areas of Particular Concern

As described in Chapter 2, the alternatives considered for identifying HAPCs are:

Alternative 1 No Action - maintain current HAPCs.

Alternative 2 *Designate a HAPC for spawning bluefin tuna in the Gulf of Mexico west of 85°W Longitude and south of 29°N Latitude while maintaining current HAPCs (Preferred Alternative).*

Alternative 3 Designate a HAPC for spawning bluefin tuna in the Gulf of Mexico based on the 95 percent probability boundary from bluefin tuna larval data collections.

Alternative 4 Designate a HAPC for spawning bluefin tuna based on the 95 percent probability boundary for adult bluefin tuna in the Gulf of Mexico.

Ecological, Social, and Economic Impacts

Similar to the reasons described for EFH, HAPCs are not expected to have any ecological, social, or economic impacts. A HAPC designation does not result in closures or other management measures designed to reduce fishing effort. Rather, a HAPC designation identifies an area as particularly important ecologically and may take into account the degree to which the habitat is sensitive to human-induced environmental degradation. If NMFS determines that human activities are having an effect on HAPCs, then NMFS could consider proposing measures to minimize impacts if they are determined to result from fishing activities, or develop conservation recommendations for non-fishing activities. NMFS has developed such recommendations for non-fishing activities as described in Chapter 6. Since HMS fishing gears are largely fished in the water column, they have little or no impact on EFH. The exception may be BLL gear whose impacts are further analyzed in Section 6.1.

Alternative 1, the no action alternative, would maintain existing HAPCs but would not designate any new HAPCs. Several HAPCs were identified for sandbar sharks in the 1999 HMS FMP for Atlantic Tunas, Swordfish, and Sharks, including off North Carolina, Chesapeake Bay, MD, Delaware Bay, DE, and Great Bay, NJ. The area off North Carolina was closed to shark BLL gear from January through July beginning in 2005 due to concerns about bycatch of juvenile sandbar and dusky sharks. Although the HAPC designation in the area was an important consideration, NMFS did not close the area solely due to habitat concerns. The HAPC designation provided additional information about the importance of the area as a shark nursery ground.

Alternative 2, the preferred alternative, would designate a HAPC for bluefin tuna in the central Gulf of Mexico west of 85ºW Longitude and south of 29º Latitude (Figure 4.1) while maintaining the current HAPCs for sandbar sharks along the Atlantic coast. The exact coordinates of the proposed HAPC are provided in Table 2.1.

A number of data sources were used to identify the potential HAPCs for bluefin tuna in the Gulf of Mexico, including NMFS SEFSC icthyoplankton surveys from 1992-2004, University of Mississippi ichthyoplankton surveys from 2000-2004 (Franks *et al.*, pers. comm.), POP, CTC, and TBF data (NMFS, SEFSC), as well as scientific literature from a number of studies on bluefin tuna spawning locations in the Gulf of Mexico (Block *et al.*, 2005; Rooker *et al*., 2007; Teo *et al.*, 2007). While it is difficult to pinpoint or predict the exact location of bluefin tuna spawning from year to year, and the location of spawning activity may vary depending on oceanographic conditions (Teo *et al.*, 2007), the data indicate widespread presence of both mature bluefin tuna >231 cm (Diaz and Turner, 2006) and bluefin tuna larvae throughout the proposed HAPC (Rooker *et al*., 2007; NMFS survey data). Since changes in sea surface temperatures and other oceanographic conditions in the Gulf of Mexico may change the timing and location of spawning, NMFS is proposing an area large enough to encompass inter-annual variability in oceanographic conditions and resulting spawning areas. The HAPC is designed to focus conservation efforts not only on adult bluefin tuna spawning in the Gulf of Mexico, but also on early life history stages such as eggs and larvae that may be particularly vulnerable to human induced environmental degradation.

Ichthyoplankton collections indicate that bluefin tuna larvae are found throughout large portions of the Gulf of Mexico, but that there is no single area that has substantially higher numbers of larvae (Figure 4.1) (Rooker *et al*., 2007). Similarly, PSAT tagging data from Block *et al.* (2005) indicated broad areas of the Gulf of Mexico that may be considered bluefin tuna spawning habitat. Teo *et al.* (2007) provided additional information from PSAT tags that appeared to refine the area where spawning most likely occurrs to the lower slopes of the northern and western Gulf of Mexico both inside and outside the U.S. EEZ, with a key spawning area located outside the EEZ (colored circles in Figure 4.1). Using a discrete choice model to draw correlations between oceanographic conditions (including sea surface temperature, current and wind speed, topography of the ocean floor, eddies, and surface chlorophyll concentrations) and bluefin tuna spawning behavior, Teo *et al*. (2007) estimated that optimal spawning conditions occur from April to June at temperatures ranging from 24° to 29°C over continental slope areas with moderate bathymetric gradients, with sea surface temperature being by far the most important oceanographic parameter that significantly affected the probability of bluefin tuna using an area for breeding. The areas of concentration indicate that bluefin tuna spawning grounds in the Gulf are located along the northern slope waters in depths between 2800 m and 3400 m from 85°W and 95°W (Teo *et al*., 2007) (Figure 4.1). The peak abundance of adult bluefin tuna (>231cm) appears to occur in May of each year (Figure 4.2). A similar peak for bluefin tuna <231cm also occurs in May of each year (Figure 4.3).

In the northern Gulf, larvae are often concentrated in frontal systems associated with the Loop Current, and areas of concentration often differ among surveys (Figure 4.4). Observed interannual variation in the catch is likely due to temporal variation in the spatial extent and shape of the Loop Current and associated features (eddies). As a result, an analysis of larval collections data tends to show high concentrations in a broad region of the northern Gulf, even though areas of concentration during annual surveys are often restricted and patchy (Rooker *et al.*, 2007).

Other correlations between bluefin tuna spawning and oceanographic parameters included low surface chlorophyll concentrations (0.10-0.16 mg m^{-3}) and areas with moderate eddy kinetic energy ranging from 251 to 355 cm^2 s^{-2} (Teo *et al*., 2007). In the breeding phase, the fish exhibit significantly shallower daily maximum depths, perform shallow oscillatory dives, and have movement paths that are significantly more residential and sinuous (Teo *et al*., 2007). The proportion of habitat usage in the Gulf was documented by Teo *et al*. (2007) and has been reproduced in Figure 4.1 (high, medium, and low proportion of habitat usage by breeding phase bluefin tuna) based on georeferencing the original figure provided in Teo *et al.* (2007). The proposed HAPC boundary in alternative 2 would include portions of the primary spawning habitat identified by Teo *et al.* (2007) that fall within the U.S. EEZ.

Alternative 3 would establish a HAPC for spawning bluefin tuna based on the 95 percent probability boundary derived from available ichthyoplankton and larval samples (Figure 4.4). NMFS used the same process to identify the probability boundary for bluefin tuna larvae that was used to generate the probability boundaries for EFH. NMFS used the 95 percent probability boundary (as opposed to the 70, 80, or 90) because it represented the most precautionary approach of the different probability analyses. NMFS also used the 95 percent probability boundary because there are fewer data points upon which to base the probability boundary (total of 45 sampling locations with the number of larvae per tow ranging from 0 to 135) and the 95 percent probability boundary provided the most continuous and connected boundary. The larval samples were taken at specific sampling locations and were not randomly distributed. As a result, the probability boundary appears rectangular in shape in certain areas and may not necessarily include the highest concentrations of bluefin tuna larvae that may occur in the Gulf. The data provide an overview of where larvae tend to be most common and may help to delineate important spawning areas. Alternative 3 encompassed virtually every ichthyoplankton sampling location in the Gulf of Mexico, and would largely fall within the HAPC proposed in Alternative 2.

Alternative 4 would establish a HAPC for spawning bluefin tuna based on the 95 percent probability boundary for adult bluefin tuna (Figure 4.5). NMFS used the 95 percent probability boundary because it is the most precautionary boundary for adult bluefin tuna (Section 4.1 Alternative 3) and because the HAPC should identify areas that are subsets of existing EFH rather than areas that are broader than the EFH boundaries themselves. Of the different probability boundaries that were considered, the 95 percent probability boundary represents a focused point of adult bluefin tuna distribution in the Gulf of Mexico that overlaps with portions of the larval distribution data, but would not necessarily include all areas that might be important bluefin tuna spawning habitat.

While correlations with a number of environmental variables have been drawn, there is currently no single indicator or environmental variable that will predict precisely when and where bluefin tuna spawning will occur. As a result, any proposed HAPC needs to be large enough to account for variability in spawning location. The HAPC in the current preferred alternative 2 is designed to encompass the areas of primary spawning which will vary from year to year depending on oceanographic conditions.

Although there are no direct environmental effects of designating a HAPC for spawning bluefin tuna in the Gulf of Mexico, it could help focus current and future conservation efforts in the area. For example, given the increased attention on domestic oil and gas production, many new leases are being issued in the Gulf of Mexico (see Non-Fishing Impacts Section 6.2). The Department of Interior's Minerals Management Service (MMS) data show that there are approximately 4,000 existing oil and gas structures and 33,000 miles of pipelines in the Gulf of Mexico (Figure 4.6), with plans for development of additional deep water oil production sites (Figure 6.15) and liquefied natural gas (LNG) sites in the Gulf of Mexico (Figure 6.17), many of which overlap with bluefin tuna spawning areas and the proposed HAPC designation. In addition there are plans for renewable energy projects off the U.S. Atlantic coast including the Florida Straits (see Non-Fishing Impacts Section 6.2). NMFS has provided conservation recommendations on a number of oil and gas development projects in the Gulf of Mexico in the past and would continue to do so in the future in order to mitigate potential adverse effects on EFH for a number of federally managed species that occur in the Gulf, including bluefin tuna. Having a HAPC designation for bluefin tuna would help identify and focus additional conservation efforts to minimize the impacts of oil and gas development projects on bluefin tuna spawning habitat.

4.3 Preferred Alternatives

To meet the purpose and need to update and revise existing HMS EFH and consider any new HAPCs or modifications to existing HAPCs, NMFS prefers EFH Alternative 3 and HAPC Alternative 2, as desribed and analyzed earlier in this Chapter. Chapters 5 and 6 provide subsequent information on these preferred alternatives to fulfill the requirements of the Magnuson-Stevens Act.

4.4 Other NEPA Considerations

The actions being considered in this amendment, to update EFH and designate a new HAPC, would not result in any unavoidable adverse impacts on the human environment. Since no management measures are being considered in this amendment that would alter the current use of the environment, there would likely be no changes in the short term use of the environment. Having EFH identified for HMS could potentially increase the long-term productivity of the environment if conservation recommendations for projects that are likely to affect EFH are implemented. There are no irreversible or irretrievable commitment of resources associated with this action.

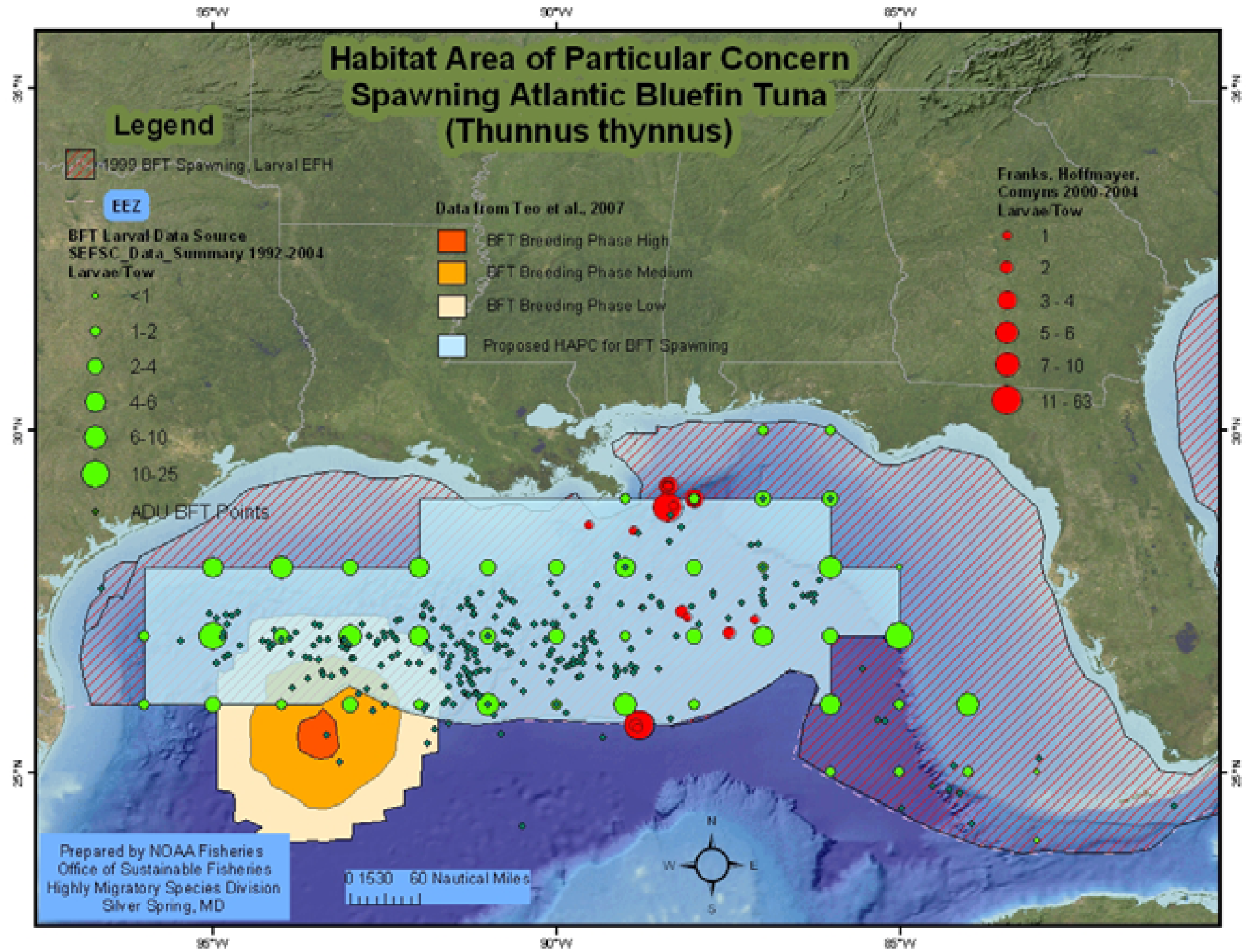

Figure 4.1 HAPC for spawning bluefin tuna in the Gulf of Mexico. The figure shows existing EFH boundaries for bluefin tuna spawning/larval EFH (hatched areas) and potential new HAPC boundaries (light blue area) based on alternative 2.

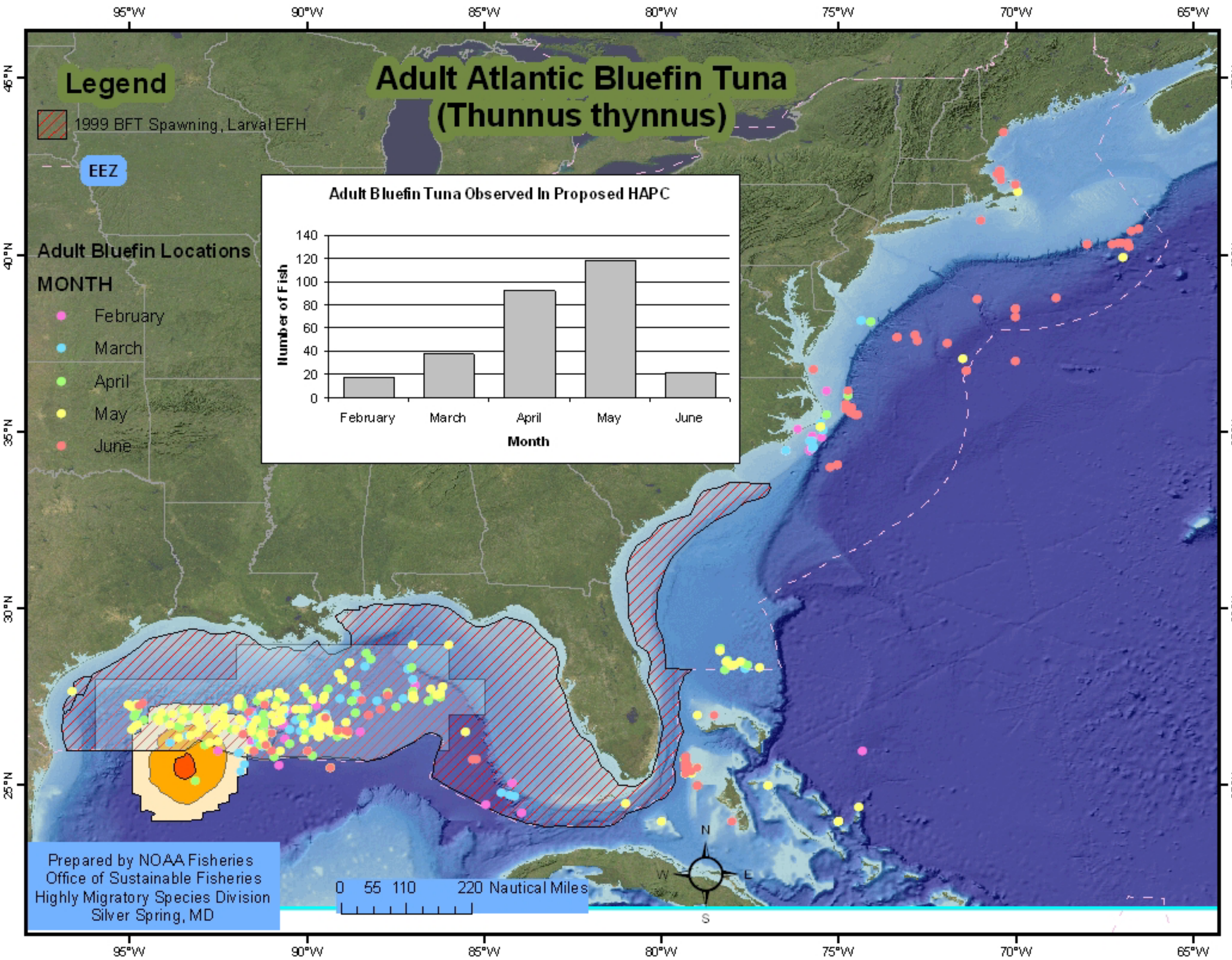

Figure 4.2 Monthly distribution data for adult bluefin tuna (≥ 231 cm) showing the temporal and spatial overlap within the proposed HAPC for alternative 2. Other boundaries are shown for reference.

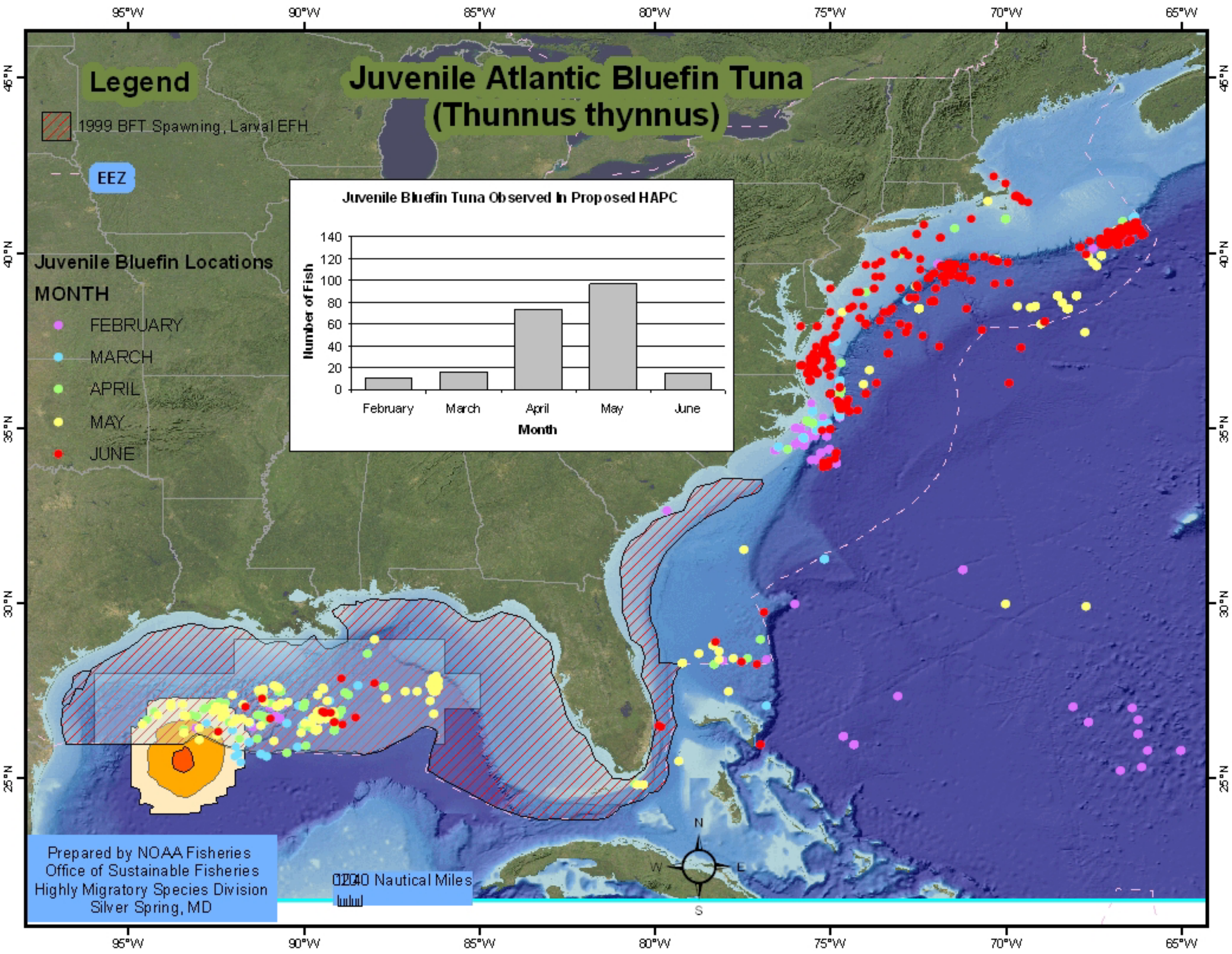

Figure 4.3 Monthly distribution data for bluefin tuna (< 231 cm) showing the temporal and spatial overlap within the proposed HAPC for alternative 2. Other boundaries are shown for reference.

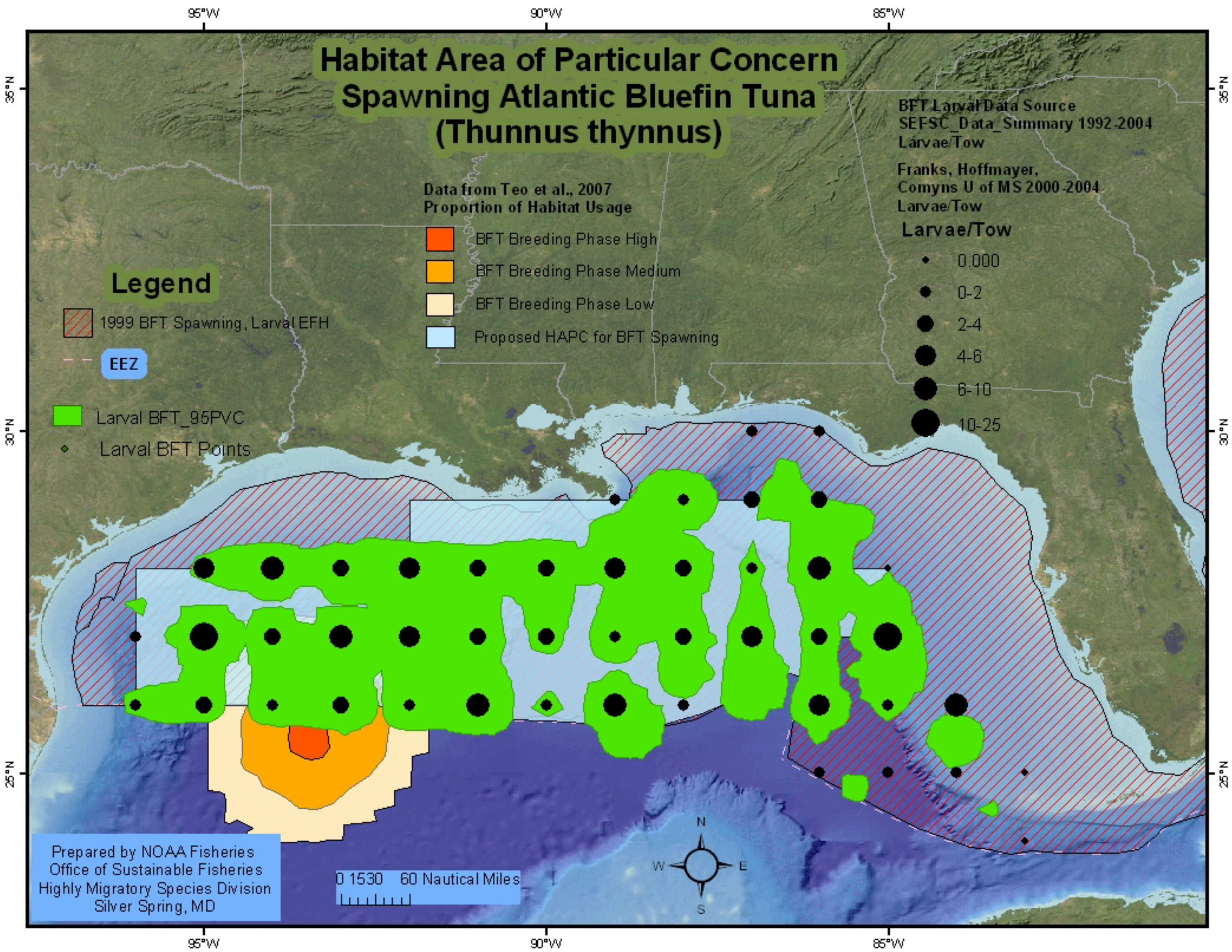

Figure 4.4 HAPC for spawning bluefin tuna (show in green) in the Gulf of Mexico based on the 95 probability boundary for bluefin tuna larvae as described in alternative 3. Other boundaries are shown for reference.

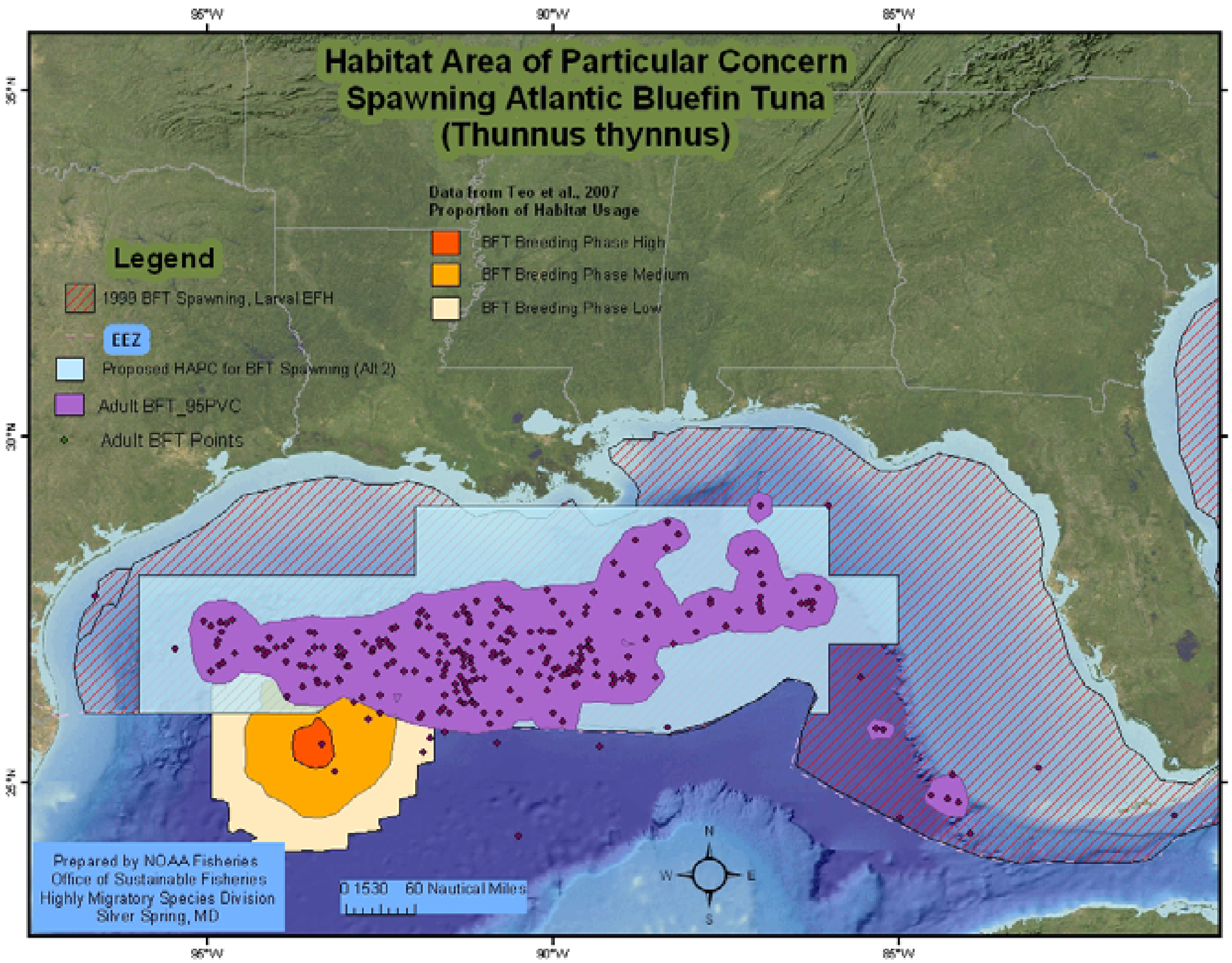

Figure 4.5 HAPC for spawning bluefin tuna (shown in purple) in the Gulf of Mexico based on the 95 percent probability boundary for adult bluefin tuna as described in alternative 4. Other boundaries are shown for reference.

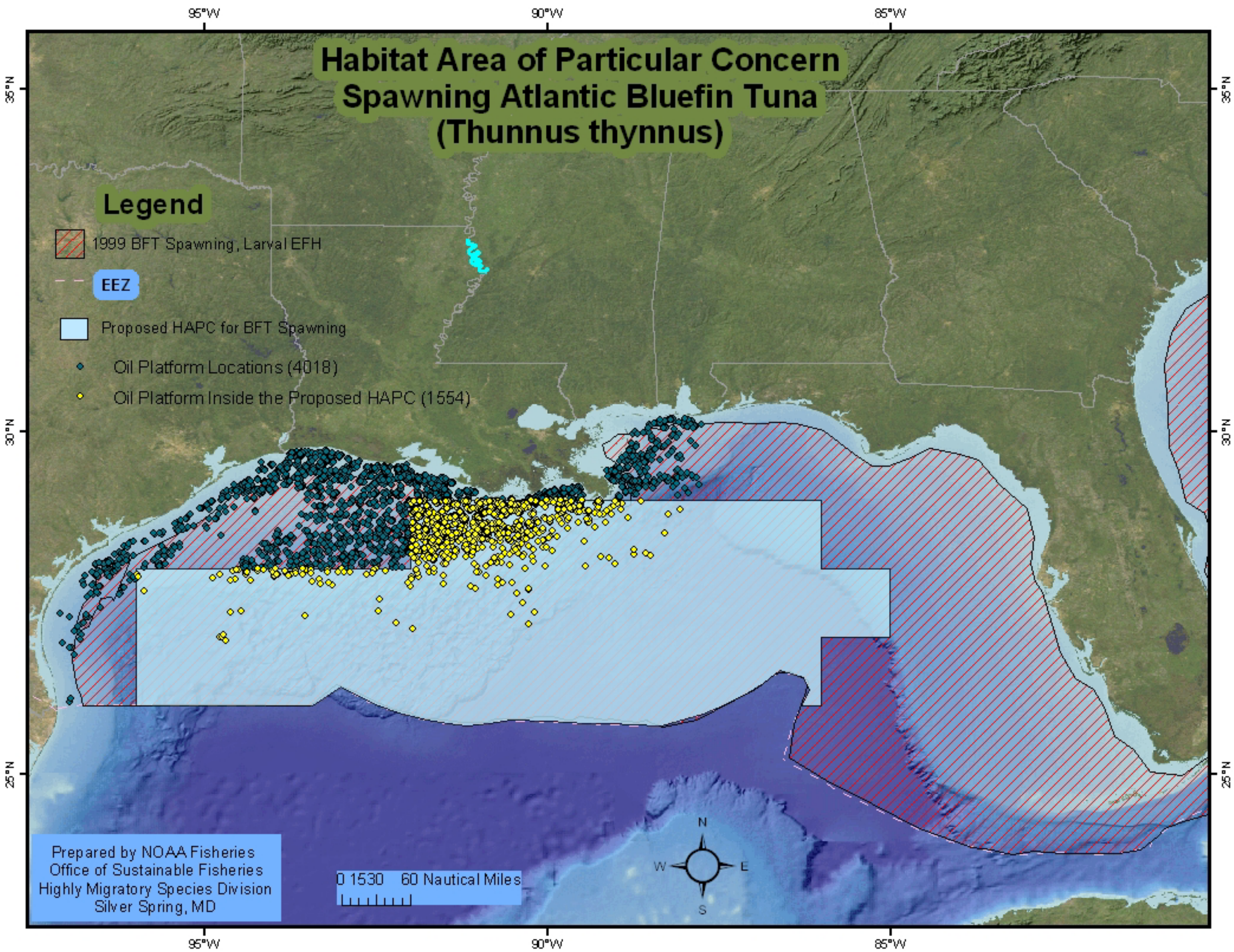

Figure 4.6 Oil and gas platforms in the Gulf of Mexico showing the overlap with proposed bluefin tuna HAPC. Source: MMS.

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5.0 LIFE HISTORY ACCOUNTS AND EFH DESCRIPTIONS AND MAPS

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5.0 ESSENTIAL FISH HABITAT

This section fulfills the requirements for EFH identification and designation in an FMP, as described in 50 CFR 600.759. Since this document serves as an integrated document for purposes of both the Magnuson-Stevens Act and the National Environmental Policy Act, it should be noted that this chapter describes EFH in accordance with Alternative 3 of the DEIS, which is identified as the agency's preferred alternative.

5.1 Life History Accounts and Essential Fish Habitat Descriptions

5.1.1 Tuna

5.1.1.1 Atlantic Albacore Tuna

Atlantic Albacore Tuna (*Thunnus alalunga*) Albacore tuna is a circumglobal species. Its life cycle is poorly known (Santiago and Arrizabalaga, 2005). In the west, Atlantic albacore tuna range from 40° to 45°N, to 40°S. It is an epipelagic, oceanic species generally found in surface waters with temperatures between 15.6° and 19.4°C, although larger individuals have a wider depth and temperature range (13.5° to 25.2°C). Albacore may dive into cold water (9.5°C) for short periods. However, they do not tolerate oxygen levels lower than two milliliter/liter (ml/l). Albacore tuna undergo extensive horizontal movements. Aggregations are composed of similarly sized individuals with groups comprised of the largest individuals making the longest journeys. Aggregations of albacore tuna may include other tuna species such as skipjack, yellowfin and bluefin tuna. North Atlantic and South Atlantic stocks are considered separate, with no evidence of mixing between the two (ICCAT, 1997; Collette and Nauen, 1983).

Predator-prey relationships: Albacore tuna forage from epipelagic to upper mesopelagic waters, down to a depth of 500 m (Consoli *et al*., 2008). A wide variety of fishes and invertebrates have been found in the few stomachs of albacore tuna that have been examined. As with other tuna, albacore probably exhibit opportunistic feeding behavior, with little reliance on specific prey items (Dragovich, 1969; Matthews *et al*., 1977). Consoli *et al.* (2008) assessed feeding habits in Mediterranean albacore tunawhere the results showed that the species is a top pelagic predator that consumes primarily medium sized fish and secondarily cephalopods. The diet consisted of a limited number of taxa and a constant size prey that did not vary over the course of the study, indicating a limited trophic niche width.

Life history: Albacore tuna spawn in the spring and summer in the western tropical Atlantic (ICCAT, 1997). They are assumed to spawn in waters around the Sargasso Sea and adjacent waters (Santiago and Arrizabalaga, 2005). Larvae have also been collected in the Mediterranean Sea and historically in the Black Sea (Vodyanitsky and Kazanova, 1954). The central Atlantic is the wintering area for albacore tuna, and the feeding migration of juveniles (up to age 5) to the productive waters in the northeastern Atlantic occurs in the summer while adults make the spawning migration. However, adults are also caught in feeding areas of the northeastern Atlantic, especially in September and October, and some juveniles are also caught in the western Atlantic (Santiago and Arrizabalaga, 2005).

Fisheries: For assessment purposes, three stocks of albacoretunaare assumed: North and South Atlantic stocks (separated at 5°N) and a Mediterranean stock (SCRS, 1997). In the North Atlantic albacore are taken by surface and longline fisheries. Surface fisheries target juveniles at 50 to 90 cm fork length (FL), and longlines catch sub-adult and adult fish at 60 to120 cm FL.

U.S. Fishery Status: North Atlantic albacore tuna is overfished with overfishing occurring; South Atlantic albacore tuna is not overfished and overfishing is not occurring.

Growth and mortality: The maximum size of albacore tuna has been reported at 127 cm FL (Collette and Nauen, 1983). For both sexes sexual maturity is reached at five years at 90 to 94 cm FL (Collette and Nauen, 1983; ICCAT, 1997). Mortality is higher for females (Collette and Nauen, 1983).

Essential Fish Habitat for Albacore Tuna:

- **Spawning, eggs, and larvae:** At this time, available information is insufficient for the identification of EFH for this life stage within the U.S. EEZ

- **Juveniles (<90 cm FL):** Offshore the U.S. east coast in the Mid-Atlantic Bight from north of Cape Hatteras to Cape Cod. Mid-east coast of Florida. Please refer to Figure 5.1 for detailed EFH map.

- **Adults (≥90 cm FL):** Central Gulf of Mexico, mid-east coast of Florida, and Puerto Rico. Atlantic east coast from North Carolina, south of Cape Hatteras to Cape Cod. Please refer to Figure 5.2 for detailed EFH map.

5.1.1.2 Atlantic Bigeye Tuna

Atlantic Bigeye Tuna (*Thunnus obesus*) Scientific knowledge of Atlantic bigeye tuna is limited. Its range is almost the entire Atlantic Ocean from 50°N to 45°S. It is rarely taken in the Gulf of Mexico, and some of the points currently included in the EFH maps may require further validation (J. Lamkin, pers. comm.). Although its distribution with depth in the water column varies, it is regularly found in deeper waters than are other tuna, descending to 300 to 500 m and then returning regularly to the surface layer (Musyl *et al*., 2003). Bigeye tuna can tolerate water with temperatures as low as 5°C and dissolved oxygen levels of less than 3.5 ml O_2 l^{-1} (Brill *et al*., 2005). Smaller fish are probably restricted to the tropics, while larger individuals migrate to temperate waters. There is probably one population in the Atlantic Ocean (ICCAT, 1997). Young bigeye tuna form schools near the sea surface, mixing with other tuna such as yellowfin and skipjack tuna (Collette and Nauen, 1983).

Predator-prey relationships: The diet of bigeye tuna includes fishes, cephalopods and crustaceans (Dragovich, 1969; Matthews *et al.*, 1977). Predators include large billfishes and toothed whales (Collette and Nauen, 1983).

Life history: Bigeye tuna probably spawn between 15°N and 15°S. A nursery area is known to exist in the Gulf of Guinea (Richards, 1969) off the coast of Africa where larvae have been collected below the 25°C isotherm (Richards and Simmons, 1971). Peak spawning here occurs in January and February, whereas in the northwestern tropical Atlantic spawning occurs in June and July (SCRS, 1978, 1979). The collection of larvae in U.S. waters has not been confirmed.

Fisheries: The bigeye tuna stock has been exploited using three major gear types - longline, baitboat, and purse seine - and by many countries throughout its range of distribution. ICCAT currently recognizes one stock for management purposes, based on time/area distribution of fish and movements of tagged fish. However, other possibilities such as distinct northern and southern stocks should not be disregarded (SCRS, 1997).

U.S. Fishery Status: Overfished and overfishing is occurring.

Growth and mortality: Growth rate for bigeye tuna is believed to be rapid. Sexual maturity is attained around three and a half years old, at approximately 115 cm FL (Fromentin and Fonteneau, 2001).

Habitat associations: Juvenile bigeye tuna form schools near the surface, mostly mixed with other tuna such as yellowfin and skipjack. These schools often associate with floating objects, whale sharks and sea mounts. These associations weaken as bigeye tuna mature (ICCAT, 2008a).

Essential Fish Habitat for Bigeye Tuna:

- **Spawning, eggs and larvae:** Information is insufficient for the identification of EFH for this life stage within the U.S. EEZ; although it cannot be identified as EFH under the Magnuson-Stevens Act because it is located outside the U.S. EEZ, the Gulf of Guinea, off the coast of Africa, is identified as important habitat for spawning adults, eggs and larvae. Matsumoto and Miyabe (2001) identified spawning sites offshore Dakar, Africa in the Atlantic Ocean just south of the Cape Verde islands.

- **Juveniles (<100 cm FL):** In the Gulf of Mexico south of Louisania and Mississippi, off the southern west coast of Florida, and south of the Florida Keys; as well as in the Atlantic off the Florida east coast through South Carolina. Continuous EFH areas from North Carolina, south of Cape Hatteras, to Cape Cod. Also off Puerto Rico and the Virgin Islands. Please refer to Figure 5.3 for detailed EFH map.

- **Adults (≥100 cm FL):** In the central Gulf of Mexcio and the mid-east coast of Florida. Atlantic east coast from Cape Hatteras to Cape Cod. Please refer to Figure 5.4 for detailed EFH map.

5.1.1.3 Atlantic Bluefin Tuna

Atlantic Bluefin Tuna (*Thunnus thynnus*) Atlantic bluefin tuna are managed as distinct western and eastern stocks separated by a management boundary at the 45°W meridian. In the western North Atlantic, bluefin tuna range from 45°N to 0° (Collette and Nauen, 1983).

However, they have recently been found up to 55°N in the western Atlantic (Vinnichenko, 1996). Bluefin tuna move seasonally from spring (April to June) spawning grounds in the Gulf of Mexico through the Straits of Florida to feeding grounds off the northeast U.S. coast (Mather *et al.*, 1995; Block *et al.*, 2005). It is believed that there is a single stock which ranges from Labrador and Newfoundland south into the Gulf of Mexico and the Caribbean, and also off Venezuela and Brazil. The Labrador Current may separate this western stock from that found in the eastern Atlantic (Tiews, 1963; Mather *et al.*, 1995; ICCAT, 1997).

The prevailing assumption is that mature western bluefin tuna follow an annual cycle of foraging in June through March off the eastern United States and Canadian coasts, followed by migration to the Gulf of Mexico to spawn in April and May (Mather *et al.*, 1995; Block *et al.*, 2005). Recent electronic tagging has confirmed two populations of Atlantic bluefin tuna that overlap on North Atlantic Ocean foraging grounds and sort to independent spawning areas located primarily in the Gulf of Mexico and Mediterranean Sea (Block *et al.*, 2005). After leaving the western spawning areas, bluefin tuna move to waters overlying the North American continental shelf, slope, and Gulf Stream waters, the South and mid-Atlantic Bight, the Gulf of Maine, and the Nova Scotia Shelf (Block *et al.*, 2005). Bluefin tuna were also documented moving to the central North Atlantic in the vicinity of 40°W, east of the Flemish Cap (Block *et al.*, 2005). Fish identified as western spawners can move to the eastern Atlantic and back, crossing the 45°W meridian several times over the course of one or more years. The overlap areas identified in the central and eastern Atlantic seem to be foraging areas for these western spawners (Block *et al.*, 2005). However, bluefin tuna smaller than 200 cm curved fork lrnght (CFL) did not enter identified spawning areas, and most of these fish remained west of 45°W throughout the year (Block *et al.*, 2005).

Additionally, electronically tagged fish in the western Atlantic showed transatlantic migrations to the Mediterranean Sea (Block *et al.*, 2005). These fish resided in the western Atlantic foraging grounds for 0.5 to 3 years before migrating to the Balearic Islands or the Tyrrhenian and/or Ionian seas (Block *et al.*, 2005). Western-tagged fish recaptured in the Mediterranean Sea seem to be returning to natal spawning areas in the Mediterranean after sharing feeding grounds in U.S. coastal waters (Rooker and Secor, 2004; Block *et al.*, 2005.).

Bluefin tuna distributions are probably constrained by the 12° C isotherm, although individuals can dive to 6° to 8°C waters to feed (Tiews, 1963). Year-to-year variations in movements have been noted (Mather *et al.*, 1995). While bluefin tuna are epipelagic and usually oceanic, they do come close to shore seasonally (Collette and Nauen, 1983). They often occur over the continental shelf and in embayments, especially during the summer months when they feed actively on herring, mackerel, and squids in the north Atlantic. Larger individuals move into higher latitudes than do smaller fish. Bluefin tuna are often found in mixed schools with skipjack tuna, these schools consisting of similarly sized individuals (Tiews, 1963).

Predator-prey relationships: Bluefin tuna larvae initially feed on zooplankton but switch to a piscivorous diet at a relatively small size. Small bluefin tuna larvae prey on other larval fishes and are subject to the same predators as these larvae, primarily larger fishes and gelatinous zooplankton (McGowan and Richards, 1989). Adults are opportunistic feeders, preying on a variety of schooling fish, cephalopods, and benthic invertebrates, including silver hake, Atlantic mackerel, Atlantic herring, krill, sandlance, and squid (Dragovich, 1969, 1970a;

Mathews *et al*., 1977; Estrada et. al., 2005). Predators of adult bluefin tuna include toothed whales, swordfish, sharks and other tuna (especially of smaller individuals) (Tiews, 1963; Chase, 2002).

Life history: Western North Atlantic bluefin tuna spawn from April to June in the Gulf of Mexico, Bahamas, and in the Florida Straits (Baglin, 1982; Richards, 1976, 1990; McGowan and Richards, 1989; Block *et. al*., 2005). Although individuals may spawn more than once a year, it had been assumed that there is a single annual spawning period. However, recent tagging data and the presence of small (<235 cm CFL) sexually mature females in the Gulf of Maine in June and July suggests that either individual bluefin tuna do not spawn on an annual cycle (Lutcavage *et al*., 1999; Block *et al*., 2005; Fromentin and Powers, 2005; Goldstein *et al*., 2007), or a component of the western stock is spawning somewhere other than the Gulf of Mexico, *e.g.* in the central North Atlantic or Gulf Stream edge (Mather *et al*., 1995; Lutcavage *et al*., 1999; Goldstein *et al*., 2007). Larvae have been confirmed from the Gulf of Mexico (Richards, 1991) and have been found as far up as the Carolinas, although their presence was associated with advection from the Florida Straits and not from offshore spawning (McGowan and Richards, 1989). Most of the larvae found were located around the 1,000 fathom curve in the northern Gulf of Mexico, with some sporadic collections off Texas. In the Florida Straits they are primarily collected along the western edge of the Florida Current, suggesting active transport from the Gulf of Mexico. This would also explain their occasional collection off the southeast United States.

Atlantic bluefin tuna have not been observed spawning (Richards, 1991); however recent work has identified putative breeding behaviors by bluefin tuna while in the Gulf of Mexico (Teo *et al*., 2007a; 2007b). Presumed Atlantic bluefin tuna breeding behaviors were associated with bathymetry, sea surface temperature, eddy kinetic energy, surface chlorophyll, and surface wind speed (Teo *et al*., 2007b). Presumed breeding bluefin tuna preferred continental slope waters with moderate sea surface temperatures, moderate eddy kinetic energy, low surface chlorophyll concentrations, and moderate wind speeds (Teo *et al*., 2007b).

It appears that larvae are generally retained in the Gulf until they grow into juveniles; in June, young-of-the-year begin movements in schools to juvenile habitats (McGowan and Richards, 1989) thought to be located over the continental shelf around 34°N and 41°W in the summer and further offshore in the winter. Also, they have been identified from the Dry Tortugas area in June and July (Richards, 1991; ICCAT, 1997). Juveniles migrate to nursery areas located between Cape Hatteras, North Caroliona and Cape Cod, Massachusetts (Mather *et al*., 1995).

Fisheries: Atlantic bluefin tuna are caught using a wide variety of gear types, including longlines, purse seines, traps, and various handgears. ICCAT recognizes two management units of Atlantic bluefin, one in the eastern and one in the western Atlantic; however, some mixing is probably occurring, as fish tagged in one location have been retrieved in the other (Block *et. al*., 2005). These management units are divided as follows: North of 10° N they are separated at 45°W; below the equator they are separated at 25° W, with an eastward shift between those parallels (SCRS, 1997). The effects of reduced stock size on distribution and habitat use is unknown at this time.

U.S. Fishery Status: Overfished, and overfishing is occurring.

Growth and mortality: Bluefin tuna can grow to more than 650 kg in weight and 300 cm in length, with no apparent difference between the growth rates of males and females (Mather *et al.*, 1995); however recent work by Neilson and Campana (2007) suggest that the growth curve most commonly used to assign ages for the western Atlantic stock may have shifted, which could result in growth curves needing to be adjusted for this species (Restrepo *et al*., 2007). Maximum age is estimated to be more than 20 years, with sexual maturity reached at approximately 196 cm (77 inches) FL and a weight of approximately 145 kg (320 lb). However, smaller mature females (185 cm CFL) have been observed in the Gulf of Maine in June and July (Goldstein *et al*., 2007). The size of 196 cm is believed to be reached in the western Atlantic at eight years, as opposed to five years in the easteern Atlantic. It is believed that the western Atlantic stock matures at age 8 to10 (Turner *et al*., 1991). The mean age of electronically tagged bluefin tuna in the spawning grounds of the Gulf of Mexico are ages 11 and above (≥ 241 cm CFL) (Block *et al*. 2005). In addition, recent analyses on longline data in the Gulf of Mexico estimate the age of 50 percent maturity to be 12 years (Diaz and Turner, 2007). However, the sizes of fish in the Gulf of Mexico in April and May may not accurately represent the spawning size range of the population as a whole (Goldstein *et al*., 2007). In addition, bluefin tuna in the western Atlantic mature more slowly than those in the eastern Atlantic and are believed to grow more slowly and reach a larger maximum size (SCRS, 1997). The rapid larval growth rate is estimated as one mm/day up to 15 mm, the size at transformation (McGowan and Richards, 1989).

Habitat associations: It is believed that there are probably certain features of the bluefin tuna larval habitat in the Gulf of Mexico which determine growth and survival rates, and that these features show variability from year to year, perhaps accounting for a significant portion of the fluctuation in yearly recruitment success (McGowan and Richards, 1989). The habitat requirements for larval success are not known, but larvae are collected within narrow ranges of temperature and salinity - approximately 26°C and 36 ppt. Along the coast of the southeastern United States onshore meanders of the Gulf Stream can produce upwelling of nutrient rich water along the shelf edge. In addition, compression of the isotherms on the edge of the Gulf Stream can form a stable region which, together with upwelling nutrients, provides an area favorable to maximum growth and retention of food for the larvae (McGowan and Richards, 1989). Size classes used for habitat analysis for bluefin tuna are based on the sizes at which they shift from a schooling behavior to a more solitary existence. Bluefin have traditionally been grouped by small schooling, large schooling, and giant. Future analyses should more fully evaluate habitat differences between the traditional size classes, if the data are available.

Essential Fish Habitat for Atlantic Bluefin Tuna:

- **Spawning, eggs, and larvae:** In the Gulf of Mexico out to the EEZ and in the Florida Straits north to waters off South Carolina as shown in Figure 5.5.

- **Juveniles (<145 cm TL):** In waters off North Carolina, south of Cape Hatteras, to Cape Cod. Please refer to Figure 5.6 for detailed EFH map.

- **Adults (≥145 cm TL):** In pelagic waters of the central Gulf of Mexcio and the mid-east coast of Florida. North Carolina from Cape Lookout to Cape Hatteras, and New England from Connecticut to the mid-coast of Maine. Please refer to Figure 5.7 for detailed EFH map.

5.1.1.4 Atlantic Skipjack Tuna

Atlantic Skipjack Tuna (*Katsuwonus pelamis*) Skipjack tuna are circumglobal in tropical and warm-temperate waters, generally limited by the 15°C isotherm. In the western Atlantic skipjack range as far north as Newfoundland (Vinnichenko, 1996) and as far south as Brazil (Collette and Nauen, 1983). Skipjack tuna are an epipelagic and oceanic species and may dive to a depth of 260 m during the day. Skipjack tuna is also a schooling species, forming aggregations associated with hydrographic fronts (Collette and Nauen, 1983). There has been no trans-Atlantic recovery of tags; eastern and western stocks are considered separate (ICCAT, 1997).

Predator-prey relationships: Skipjack tuna is an opportunistic species which preys upon fishes, cephalopods and crustaceans (Dragovich, 1969, 1970b; Dragovich and Potthoff, 1972; Collette and Nauen, 1983; ICCAT, 1997). Predators include other tuna and billfishes (Collette and Nauen, 1983). Skipjack tuna are believed to feed in surface waters, however they are caught as bycatch on longlines at greater depths. Stomach contents often include *Sargassum* or *Sargassum* associated species (Morgan *et al.*, 1985).

Life history: Skipjack tuna spawn opportunistically in equatorial waters throughout the year and in subtropical waters from spring to early fall (Collette and Nauen, 1983). Larvae have been collected off the east coast of Florida from October to December (Far Seas Fisheries Research Lab, 1978) and in the Gulf of Mexico and Florida Straits from June to October. However, most spawning takes place during summer months in the Caribbean, off Brazil (with the peak in January through March), in the Gulf of Mexico (April to May), and in the Gulf of Guinea (throughout the year) (Richards, 1969; SCRS, 1978/79).

Fisheries: This fishery is almost exclusively a surface gear fishery, although some skipjack tuna are taken as longline bycatch. Most skipjack tuna are taken in the east Atlantic and off the coast of Brazil, most recently with the use of floating objects to attract them. These floating objects have been identified to possibly affect migration patters and cause poor growth rates (ICCAT, 2008b). ICCAT assumes two management units for this species (eastern and western) due to the development of fisheries on both sides of the Atlantic and to the lack of transatlantic tag recoveries.

U.S. Fishery Status: Unknown.

Growth and mortality: Maximum size of the species is reported at 108 cm FL and a weight of 34.5 kg. Size at sexual maturity is 45 cm (18 inches) for males and 42 cm for females. This size is believed to correspond to about 1 to 1.5 years of age, although significant variability in interannual growth rates makes size-to-age relationships difficult to estimate (Collette and Nauen, 1983; ICCAT, 1997). Growth rate is variable and seasonal, with individuals from the tropical zone having a higher growth rate than those from the equatorial zone (SCRS, 1997). Life span is estimated to be eight to 12 years (Collette and Nauen, 1983).

Habitat associations: Aggregations of skipjack tuna are associated with convergences and other hydrographic discontinuities. Also, skipjack tuna associate with birds, drifting objects, whales, sharks and other tuna species (Colette and Nauen, 1983). The optimum temperature for the species is 27°C, with a range from 20° to 31°C (ICCAT, 1995).

Essential Fish Habitat for Skipjack Tuna:

- **Spawning, eggs, and larvae:** In offshore waters in the Gulf of Mexico to the EEZ and portions of the Florida Straits as shown in Figure 5.8. No changes to the 1999 boundary are proposed.

- **Juveniles/subadults (<45 cm FL):** In the Gulf of Mexico, south of Louisiania through the Florida Panhandle, and off Georgia and South Carolina. Continous EFH from the southern east coast of Florida through the Florida Keys. Patches off Georgia and South Carolina, Cape Hatteras to Maryland, and Delaware to Cape Cod. Please refer to Figure 5.9 for detailed EFH map.

- **Adults (≥45 cm FL):** In the central Gulf of Mexico, southern east coast of Florida through the Florida Keys, and Cape Hatteras to Cape Cod. EFH patches off South Carolina and the northern east coast of Florida. Please refer to Figure 5.10 for detailed EFH map.

5.1.1.5 Atlantic Yellowfin Tuna

Atlantic Yellowfin Tuna (*Thunnus albacres*) Atlantic yellowfin tuna are circumglobal in tropical and temperate waters. In the West Atlantic they range from 45°N to 40°S. Yellowfin tuna is an epipelagic, oceanic species, found in water temperatures between 18° and 31°C. It is a schooling species, with juveniles found in schools at the surface, mixing with skipjack and bigeye tuna. Larger fish are found in deeper water and also extend their ranges into higher latitudes. All individuals in the Atlantic probably comprise a single population, although movement patterns are not well known (Collette and Nauen, 1983; SCRS, 1997). There are possible movements of fish spawned in the Gulf of Guinea to more coastal waters off Africa, followed by movements toward the U.S. coast, at which time they reach a length of 60 to 80 cm (ICCAT, 1997). In the Gulf of Mexico yellowfin tuna occur beyond the 500-fathom isobath (Idyll and de Sylva, 1963).

Predator-prey relationships: Atlantic yellowfin tuna are opportunistic feeders. Stomachs have been found to contain a wide variety of fish and invertebrates (Dragovich, 1969, 1970b; Dragovich and Potthoff, 1972; Matthews *et al.*, 1977). Stomach contents of yellowfin from St. Lucia and the Caribbean contained squid and the larvae of stomatopods, crabs and squirrelfish (Idyll and de Sylva, 1963). Stomach contents often contain *Sargassum* or *Sargassum* associated fauna. Yellowfin tuna are believed to feed primarily in surface waters down to a depth of 100 m (Morgan *et al.*, 1985).

Life history: Spawning occurs throughout the year in the core areas of the species= distribution - between 15°N and 15°S - and also in the Gulf of Mexico and the Caribbean, occurring from May through November (ICCAT, 2008c). Spawning adults are typically significantly larger in body size in the Caribbean compaired to the Gulf of Mexico (Arocha *et al*., 2001). Yellowfin tuna are believed to be serial spawners, and larval distribution appears to be limited to water temperatures above 24°C and salinity greater than 33 ppt (Richards and Simmons, 1971). Larvae have been collected near the Yucatan peninsula and during September in the northern Gulf of Mexico along the Mississippi Delta (ICCAT, 1994).

Fisheries: Yellowfin tuna are caught by surface gears (purse seine, baitboat, troll, and handline) and with sub-surface gears (longline). A single stock is assumed for the Atlantic, based on transatlantic tag recaptures, time/area size frequency distribution, etc. (SCRS, 1997).

U.S. Fishery Status: Approaching an overfished condition.

Growth and mortality: The maximum size of yellowfin tuna is over 200 cm FL (Collette and Nauen, 1983). Sexual maturity is reached at about three years of age, at 110 cm FL, and a weight of 25 kg. Although it is not known if there is a differential growth rate between males and females (ICCAT, 1994), males are predominant in catches of larger sized fish (SCRS, 1997). Natural mortality is 0.8 for fish less than 65 cm in length, and 0.6 for fish greater than 65 cm. Mortality is higher for females of this size (ICCAT, 1994).

Habitat associations: Adult yellowfin tuna are confined to the upper 100 m of the water column due to their intolerance of oxygen concentrations of less than 2 ml/l (Collette and Nauen, 1983). In northern latitudes yellowfin can be further restricted to the surface depending on thermocline depth (Block *et al*., 1997). Association with floating objects has been observed, and in the Pacific larger individuals often school with porpoises (Collette and Nauen, 1983). Juveniles are found nearer to shore than are adults (SCRS, 1994). In the Gulf of Mexico adults usually occur 75 km or more offshore, while in the Caribbean they are found closer to shore. Although there appears to be a year-round population in the southern part of the Gulf of Mexico (Idyll and de Sylva, 1963), in June there appears to be some movement from the southern to the northern part of the Gulf of Mexico, resulting in greater catches in the northern part of the Gulf of Mexico from July to December.

Essential Fish Habitat for Yellowfin Tuna:

- **Spawning, eggs, and larvae:** In offshore waters in the Gulf of Mexico to the EEZ and portions of the Florida Straits as shown in Figure 5.11. No changes to the 1999 boundary are proposed.

- **Juveniles/subadults (<110 cm FL):** In the central Gulf of Mexico from Florida Panhandle to southern Texas. Mid-east coast of Florida and Georgia to Cape Cod. South of Puerto Rico. Please refer to Figure 5.12 for detailed EFH map.

- **Adults (≥110 cm FL):** In the central Gulf of Mexico from the Florida Panhandle to southern Texas. Mid-east coast of Florida and Georgia to Cape Cod. South of the Virgin Islands. Please refer to Figure 5.13 for detailed EFH map.

5.1.2 Swordfish

Swordfish (*Xiphias gladius*) Swordfish are circumglobal, ranging through tropical, temperate and sometimes cold water regions. Their latitudinal range is from 50°N to 40°, to 45°S in the western Atlantic, and 60°N to 45°, to 50°S in the eastern Atlantic (Nakamura, 1985). The swordfish population in the Atlantic is distinctly structured into North Atlantic and South Atlantic components. An investigation by Chow *et al*. (2007) indicated that not only gene flow but also individual migrations between the North and Mid-south Atlantic populations is consistently restricted, and that the swordfish are much less migratory than previously believed. ICCAT has managed the North and South Atlantic stocks on the basis of a separation at 5° N. However, Chow *et al*. (2007) also report that results of their genetic investigations suggest that the boundary between the populations may be located in the range of 10° to 20°N. The species moves from spawning grounds in warm waters to feeding grounds in colder waters. In the western north Atlantic two movement patterns are apparent: some fish move northeastward along the edge of the U.S. continental shelf in summer and return southwestward in autumn; another group moves from deep water westward toward the continental shelf in summer and back into deep water in autumn (Palko *et al.*, 1981). Swordfish are epipelagic to meso-pelagic, and are usually found in waters warmer than 13°C. Their optimum temperature range is believed to be 18° to 22°C but they will dive into 5° to10°C waters at depths of up to 650 m (Nakamura, 1985). Swordfish migrate diurnally, coming to the surface at night (Palko *et al.*, 1981). The species tolerates rapid temperature changes and dive into deep, cold waters, probably to search for prey, due to a specialized heating system to warm the eyes and brain, suggesting that the species is less likely to be restricted in its habitat by thermoclines (Chow *et al*., 2007). Carey (1990) observed different diel migrations in two groups of fish: swordfish in neritic (shallow, near-coastal) waters of the northwest Atlantic were found in bottom waters during the day and moved to offshore surface waters at night. Swordfish in oceanic waters migrated vertically from a daytime depth of 500 m to 90 m at night.

Predator-prey relationships: Adult swordfish are opportunistic feeders, having no specific prey requirements. They feed at the bottom as well as at the surface, in both shallow and deep waters. In waters greater than 200 m deep they feed primarily on pelagic fishes including small tunas, dolphinfishes, lancetfish (*Alepisaurus*), snake mackerel (*Gempylus*), flyingfishes, barracudas and squids such as *Ommastrephes*, *Loligo*, and *Illex*. In shallow water they prey upon neritic fishes, including mackerels, herrings, anchovies, sardines, sauries, and needlefishes. In deep water, swordfish may also take demersal fishes such as hakes, pomfrets (Bromidae), snake mackerels, cutlass fish (trichiurids), lightfishes (Gonostomatidae), hatchet fishes (Sternoptychidae), redfish, lanternfishes, and cuttlefishes (Nakamura, 1985).

In the Gulf of Mexico swordfish were found to feed primarily on cephalopods - 90 percent of stomach contents consisted of 13 species of teuthoid squids, most of which were *Illex*, and two species of octopus (Toll and Hess, 1981). Stillwell and Kohler (1985) found that 80 percent of the stomach contents of swordfish taken off the northeast coast of the United States consisted of cephalopods, of which short-finned squid (*Illex illecebrosus*) made up 26.4 percent. Adult swordfish in neritic waters will feed inshore near the bottom during the daytime and head seaward to feed on cephalopods at night. The movement of larger individuals into higher latitudes in the summer and fall may be in part to allow those individuals access to high concentrations of *Illex* (Arocha, 1997). Predators of adult swordfish are probably restricted to sperm whales (*Physeter catodon*), killer whales (*Orcinus orca*) and large sharks such as mako (*Isurus* spp).

Typically, swordfish larvae less than 9.0 mm in length consume small zooplankton, those 9.0 to 14.0 mm feed on mysids, phyllopods and amphipods, and at sizes greater than 21 mm they begin to feed on the larvae of other fishes. Govoni *et al.* (2003) report that the diet of larval swordfish is indicative of their vertical distribution in the water column: larvae <11 mm PSL eat primarily near-surface copepods, while larvae >11 mm PSL eat exclusively neustonic fish larvae. Juveniles feed on squids, fishes and some pelagic crustaceans (Palko *et al.*, 1981). Larvae are preyed upon by other fishes, and juveniles fall prey to predatory fishes, including sharks, tunas, billfishes, and adult swordfish (Palko *et al.*, 1981).

Life history: First spawning for North Atlantic swordfish occurs at four to five years of age (74 kg) in females. Fifty percent maturity in females is reached at 179 to 182 cm lower jaw fork length (LJFL), and in males at 112 to 129 cm LJFL (21 kg) at approximately 1.4 years of age (Arocha, 1997; Nakamura, 1985; Palko *et al.*, 1981). Most spawning takes place in waters with surface temperatures above 20° to 22°C, between 15°N and 35°N (Arocha, 1997; Palko *et al.*, 1981). In the western North Atlantic spawning occurs in distinct locations at different times of the year: south of the Sargasso Sea and in the upper Caribbean spawning occurs from December to March, while off the southeast coast of the United States it occurs from April through August (Arocha, 1997). Major spawning grounds are probably located in the Straits of Yucatan and the Straits of Florida (Grall *et al*., 1983; Govoni *et al*., 2003). Larvae have been found in largest abundance from the Straits of Florida to Cape Hatteras, North Carolina and around the Virgin Islands. Larvae are associated with surface temperatures between 24° and 29°C. The Gulf of Mexico is believed to serve as a nursery area (Palko *et al*., 1981). Govoni *et al.* (2003) report that spawning in the Gulf of Mexico seems to be focused in the vicinity of the northernmost arc of the Gulf Loop Current. Grall *et al.,* (1983) found larvae ten mm and larger to be abundant in the Caribbean, the Straits of Florida, and the Gulf Stream north of Florida from December to February. In the areas off the southeastern coast of the United States spawning is focused in the western Gulf Stream frontal zone (Govoni *et al*., 2003). In the western Gulf of Mexico, large larvae were found from March to May and from September to November; many larvae of all sizes were collected in the Caribbean and were also present year-round in the eastern Gulf of Mexico, the Straits of Florida and the Gulf Stream. Juvenile fish are frequently caught in the pelagic longline fishery in the Gulf of Mexico, the Atlantic coast of Florida, and near the Charleston Bump, regions that may serve as nurseries for North Atlantic swordfish (Cramer and Scott, 1998).

Fisheries: Swordfish in the Atlantic are taken by a directed longline fishery and as bycatch of the tuna longline fishery. There are also seasonal harpooning and driftnetting efforts off Nova Scotia (harpooning), off the northeast U.S. coast, and on the Grand Banks (driftnetting) (Arocha, 1997). The effect of this reduction in stock size on habitat use and species distributions is unknown. In January 1999, NMFS prohibited the use of driftnets for the swordfish fishery. In March 1999, NMFS instituted a program requiring all swordfish imported into the United States to have a certificate of eligibility specifying the origin of the fish. If the swordfish is from the Atlantic it must meet the 33-lb dw minimum size requirement of ICCAT.

U.S. Fishery Status: North Atlantic swordfish is not overfished, overfishing is not occurring, and the stock is in recovery (B/Bmsy = 0.99). South Atlantic swordfish is fully fished, overfishing may be occurring.

Growth and mortality: Swordfish reach a maximum length of 445 cm total length (TL) and a maximum weight of 540 kg. Males and females have different growth rates, with females longer and heavier at any given age (Nakamura, 1985). Natural mortality rate was estimated at 0.21 to 0.43 by Palko *et al.,* (1981), but ICCAT presently uses an estimate of 0.2 (Arocha, 1997). Berkeley and Houde (1981) found a higher growth rate for females than males over two years of age, and also found males to have a higher mortality rate than females.

Habitat associations: In the winter in the North Atlantic, swordfish are restricted to the warmer waters of the Gulf Stream, while in the summer their distribution covers a larger area. Distribution is size and temperature related, with few fish under 90 kg found in waters with temperatures less than 18°C. Larvae are restricted to a narrow surface temperature range, and are distributed throughout the Gulf of Mexico, in areas of the Caribbean, and in the Gulf Stream along the U.S. coast as far north as Cape Hatteras, North Carolina. Concentrations of adult swordfish seem to occur at ocean fronts between water masses associated with boundary currents, including the Gulf Stream and Loop Current of the Gulf of Mexico (Arocha, 1997; Govoni *et al.*, 2003).

***Essential Fish Habitat for Atlantic Swordfish*:**

- **Spawning, eggs, and larvae:** From off Cape Hatteras, North Carolina extending south around peninsular Florida through the Gulf of Mexico to the U.S./Mexico border from the 200 m isobath to the EEZ boundary; associated with the Loop Current boundaries in the Gulf and the western edge of the Gulf Stream in the Atlantic; also, all U.S. waters of the Caribbean from the 200 m isobath to the EEZ boundary (Figure 5.14). No change to the 1999 boundary are proposed.

- **Juveniles/subadults (<180 cm LJFL):** In the central Gulf of Mexico from southern Texas through the Florida Keys and Atlantic east coast from south Florida to Cape Cod. Puerto Rico and the Virgin Islands. Please refer to Figure 5.15 for detailed EFH map.

- **Adults (≥180 cm LJFL):** In the central Gulf of Mexico from southern Texas to the Florida Panhandle and western Florida Keys. Atlantic east coast from southern Florida to the mid-east coast of Florida, and Georgia to Cape Cod. Puerto Rico and the Virgin Islands. Please refer to Figure 5.16 for detailed EFH map.

5.1.3 Billfish

5.1.3.2 Blue Marlin

Blue Marlin (*Makaira nigricans*) Blue marlin inhabit the tropical and subtropical waters of the Atlantic, Pacific and Indian Oceans. Their geographic range is from 45°N to 35°S. In the Atlantic two seasonal concentrations occur: January to April in the southwest Atlantic from 5° to 30°S, and from June to October in the northwest Atlantic between 10° and 35° N. May, November and December are transitional months (Rivas, 1975). Blue marlin are generally solitary and do not occur in schools or in coastal waters (Nakamura, 1985). Since 2000, the ICCAT SCRS has considered a single, Atlantic-wide stock of blue marlin in stock assessments which is consistent with recent genetic stock structure analysis (ICCAT, 2001; Graves and McDowell, 2001; and Graves and McDowell 2003).

This species is epipelagic and oceanic, generally found in blue water with a temperature range of 22° to 31°C. Goodyear (2003) found that spatio-temporal heterogeneity in pelagic longline catch rates may be partly explained by seasonal changes in sea surface temperatures. Prince and Goodyear (2006) reported evidence of habitat compression in areas where there is a distinct band of cold, hypoxic water close to the surface in the eastern Atlantic and Pacific Oceans. This phenomenon restricts the acceptable habitat of billfish to shallower water in these areas, making them more vulnerable to surface gear, but also increases their access to prey items, possibly increasing growth rates. Research presented by the SCRS (2006) described data from a pop-up tagging study of eight blue marlin that were released in several locations in the tropical Atlantic Ocean, from off Dakar (shallow mixed layer) to off Brazil (deep mixed layer), that agreed with this hypothesis. They found that the diving depth was correlated with the depth of mixed layer, so that as the depth of mixed layer increased, the maximum depth of the dives also increased. The data indicated that blue marlin spent the majority of their time within the surface mixed layer and occasionally make short term dives to 800 m (Orbesen, Pers. Comm.).

Most of the blue marlin tagging and recovery efforts have been restricted to the western North Atlantic Ocean, with particularly intense activities off the U.S. Caribbean (including Puerto Rico and U.S. Virgin Islands) and the north-eastern coast of South America near La Guaira, Venezuela (Ortiz *et al*. 2003). Plots of minimum travel distance versus years-at large revealed no clear patterns that might indicate site fidelity and/or cyclic annual movements. Global plots of release-recovery vectors indicate that blue marlin are capable of trans-oceanic and trans-equatorial movements in the Atlantic and Pacific Oceans, as well as inter-oceanic movements (*i.e.*, from the Atlantic to the Indian Ocean and from the Pacific to the Indian Ocean). Strong seasonal movement patterns were evident in the Atlantic Ocean, from the U.S. Mid-Atlantic coast and Mexican Caribbean to Venezuela.

Orbesen *et al*. (in press) investigated blue marlin movements relative to the ICCAT management areas, as well as U.S. domestic data collection areas within the western North Atlantic basin, with mark-recapture data from 769 blue marlin. Linear displacement between release and recapture locations ranged from zero to 15,744 km (mean 575, median 119, SE 44) for blue marlin with the proportions of visits highest in the Caribbean area.

Predator-prey relationships: Blue marlin feed near the surface but also are known to feed in deeper waters than the other istiophorids. They feed primarily on tuna-like fishes, squid, and on a wide size range of other organisms, from 38 mm postlarval surgeonfish to 50 lb. bigeye tuna. Stomach contents have also included deep-sea fishes, such as chiasmodontids. Other important prey species vary by location and include dolphinfishes, especially bullet tuna (*Auxis* sp.) around the Bahamas, Puerto Rico, and Jamaica, and dolphinfishes and scombrids in the Gulf of Mexico. Octopods are also prey items (Rivas, 1975; Davies and Bortone, 1976; Nakamura, 1985). Predators of blue marlin are relatively unknown; although, evidence of shark predation on white marlin has been described (Kerstetter *et al*., 2004).

Reproduction and Early Life History: Blue marlin are sexually mature by 2 to 4 years of age (SCRS, 1997). Female blue marlin begin to mature at approximately 104 to 134 lb, while males mature at smaller weights, generally from 77 to 97 lb. Analysis of egg (ova) diameter frequency suggests that blue marlin, white marlin, and sailfish spawn more than once each spawning season (de Sylva and Breder, 1997). During the spawning season blue marlin release from one million to ten million small (1 to 2 mm), transparent pelagic planktonic eggs (Yeo, 1978). Martins *et al*. (2007) calculated batch fecundities for five mature females and found values ranging from 3,600,960 to 6,769,060 oocytes for five mature females ranging in size from 277 to 290 cm LJFL. Ovaries from a 324 lb female blue marlin from the northwest Atlantic were estimated to contain 10.9 million eggs, while ovaries of a 275 lb female were estimated to contain approximately 7 million eggs. Luckhurst *et al*. (2006) found that the largest female specimen (over 1,000 lbs) in their sample was in spawning condition, indicating that the largest females are still capable of reproducing and may not have reached senescence as had been proposed previously.

Although evidence indicates genetic mixing between the two geographic areas, de Sylva and Breder (1997) hypothesized that there may be two separate blue marlin spawning seasons; one in the North Atlantic with spawning from July to September (July to October according to de Sylva and Breder, 1997; May to November, according to Prince *et al.*, 1991) and one in the South Atlantic from February to March. May and June are peak spawning months for fish off Florida and the Bahamas, and there is a protracted spawning period off northwest Puerto Rico from May to November. Females taken off Cape Hatteras, North Carolina in June were found to have recently spawned (Rivas, 1975). Prince *et al*. (2005) found evidence of spawning blue marlin resulting from the presence of larvae off Punta Cana, Dominican Republic. One larval blue marlin (5.2 mm SL) was collected in pelagic waters off Miami, FL (Serafy *et al*., 2006). As reported by the SCRS (2006), Luckhurst *et al*. (2006) described evidence of spawning in blue marlin during July (from gonad index analyses and the ageing of a juvenile specimen) in the waters of Bermuda. This represents a northern extension (32°N) of the known spawning area in the northwest Atlantic for blue marlin. Preliminary information on blue marlin reproduction from between 7°N and 20°S presented in Martins *et al*. (2007) using gonad index showed higher values during June and August which corresponded seasonally with Luckhurst *et al*. (2006) above. Serafy *et al*. (2003) showed evidence of blue marlin spawning near Exuma Sound, Bahamas with highest larvae densities found especially where exchange with the Atlantic is greatest. Given age estimates and assuming passive surface transport, the larvae were likely spawned in waters that include Exuma Sound and may extend some 200 km southeast of its mouth. Blue marlin larvae were found in pelagic waters across the northern Gulf of Mexico in June and July of 2005 and 2006 (J. Rooker, Texas A&M University, Pers. Comm.). Blue marlin larvae were found in the north-central Gulf of Mexico in 2005 and 2006 (N. Brown-Peterson, University of Southern Mississippi, Pers. Comm.). A few larvae have been collected in the western Atlantic off Georgia, off Cat Cay, Bahamas, and in the Mid to North Atlantic (Ueyanagi *et al.*, 1970; Nakamura, 1985).

Fisheries: Blue marlin are targeted as a recreational fishery in the United States and Caribbean, and are also caught as bycatch of tropical tuna longline fisheries, which use shallow gear deployment. They are also caught by offshore longline fisheries which target swordfish, especially in the western Atlantic, as well as by directed artisanal fisheries in the Caribbean.

U.S. Fishery Status: Overfished, and overfishing is occurring.

Growth and mortality: Blue marlin are believed to be one of the fastest growing of all teleosts in the early stages of development, and weigh between 66 and 99 lb by age 1 (SCRS, 1997). Based on analyses of daily otolith ring counts, they reach 24 cm LJFL in about 40 days, and about 190 cm LJFL in 500 days, with a maximum growth rate of approximately 1.66 cm/day occurring at 39 cm LJFL (Prince *et al.*, 1991). Fish larger than 190 cm LJFL tend to add weight more than length, making the application of traditional growth curve models, in which length or weight are predicted as a function of age, difficult for fish in these larger size categories. Sponaugle *et al*. (2005) found differing early growth rates between locations after the first 5-6 days of life for fish from Exuma Sound, Bahamas and the Straits of Florida, which resulted in a 4-6 mm difference in standard length by day 15. The differences in growth appeared to be unrelated to water temperature. Females grow faster and reach much larger maximum sizes than males. Examination of sagitta (otolith) weight, body weight, and length/age characteristics indicate that sex-related size differences are related to differential growth between the sexes and not to differential mortality (Wilson *et al.*, 1991). Sexually dimorphic growth variation (weight only) in blue marlin appears to begin at 140 cm LJFL (Prince *et al.*, 1991). Somatic growth of male blue marlin slows significantly at about 220 lb, while females continue substantial growth throughout their lifetime (Wilson *et al.*, 1991). Male blue marlin usually do not exceed 350 lb, while females can exceed 1,200 lb.

Blue marlin are estimated to reach ages of at least 20 to 30 years, based on analysis of dorsal spines (Hill *et al.*, 1990). Although spine ageing techniques for blue marlin have not been validated and vascularization of the spine core causes problems with accurate ring counts (SCRS 2006), longevity estimates are supported by tagging data. The maximum time at liberty recorded of a tagged individual was 4,591 days (12.6 years) for a blue marlin (Orbesen *et al*, in press). Sagitta otolith weight is suggested to be proportional to age, indicating that both sexes are equally long-lived, based on the maximum otolith weight observed for each sex (Wilson *et al.*, 1991). Data about the age and growth of marlin are still lacking, hindering the ability to incorporate age-structure based on observations into Atlantic marlin stock assessments (SCRS 2006).

Habitat associations: Adults are found primarily in the tropics within the 24EC isotherm, and make seasonal movements related to changes in sea surface temperatures. In the northern Gulf of Mexico they are associated with the Loop Current and are found in blue waters of low productivity rather than in more productive green waters. Off Puerto Rico the largest numbers of blue marlin are caught during August, September and October. Equal numbers of both sexes occur off northwest Puerto Rico in July and August, with larger males found there in May and smaller males in September (Rivas, 1975). Very large individuals, probably females, are found off the southern coast of Jamaica in the summer and off the northern coast in winter, where males are caught in December and January.

Essential Fish Habitat for Blue Marlin:

- **Spawning, eggs, and larvae:** Off Florida. Please refer to Figure 5.17 for detailed EFH map. No changes to the 1999 boundary are proposed.

- **Juveniles/Subadults (20-189 cm LJFL):** In the central Gulf of Mexico from southern Texas to the Florida Panhandle through the Florida Keys to southern Cape Cod. Puerto Rico and the Virgin Islands. Please refer to Figure 5.18 for detailed EFH map.

- **Adults (≥190 cm LJFL):** In the central Gulf of Mexcio, from southern Texas to the Florida Panhandle, through the Florida Keys to southern Cape Cod. Puerto Rico and the Virgin Islands. Please refer to Figure 5.19 for detailed EFH map.

5.1.3.3 White Marlin

White Marlin (*Tetrapturus albidus*) White marlin is an oceanic, epipelagic species that occurs in the Atlantic Ocean, Gulf of Mexico, and Caribbean waters. It inhabits almost the entire Atlantic from 45ºN to 45°S in the western Atlantic and 45EN to 35ES in the eastern Atlantic. The geographical range for white marlin is restricted to the tropical and temperate waters of the Atlantic Ocean and adjacent seas. This differs from the blue marlin (*Makaira nigricans*) and sailfish (*Istiophorus platypterus*), that range throughout both the Atlantic and Indo-Pacific regions. In higher latitudes, such as between New Jersey and Virginia, they are found commonly in shallow coastal waters (de Sylva and Davis, 1963). White marlin are found at the higher latitudes of their range only in the warmer months. Large post-spawning aggregations of white marlin are reported off the Mid-Atlantic States during the summer period (Earle, 1940; deSylva and Davis, 1963; Baglin, 1977). Although they are generally solitary, they sometimes are found in small, usually same-age groups.

Taxonomic investigations have occurred recently for white marlin and its congeners. Collette *et al*. (2006) presented genetic evidence to propose a taxonomic reclassification of white marlin and Indo-Pacific striped marlin, *Tetrapturus audux* into a separate genus, *Kajikia*. Validity of the roundscale spearfish (*T. georgii*) has recently been reported by Shivji *et al*. (2006) using genetic and morphometric analyses. Roundscale spearfish are not hybrids, but rather a clearly different genetic lineage to sympatric billfish species. To an untrained observer, the roundscale spearfish and white marlin are morphologically similar. Characteristics that differentiate the roundscale spearfish from the white marlin include: mid-lateral scales that are rounded anteriorly; a greater distance between the anus and insertion of the first anal fin; branchiostegal rays extending to posterior edge of the operculum; and, unique mitochondrial ND4L-ND4 nucleotide sequences. It is likely that most roundscale spearfish captures have been classified as white marlin. The proportion of roundscale spearfish in the white marlin population is unknown. Further, it is unknown whether the proportion has changed over time. It took >100 years to observe sufficient specimens to clearly identify the species, so it is not likely to be abundant. No information is available describing interspecific competition, and potential geographic overlap, between the roundscale spearfish and white marlin; although, a genetic re-analysis of specimens identified as "white marlin," landed in New Jersey recreational fishing tournaments over the last few years, confirmed 17.5 percent were actually roundscale spearfish (J. Graves, VIMS, unpubl. data). This has raised the possibility that the abundance of white marlin may be overestimated. The POP data suggests the roundscale spearfish is widely distributed in the western North Atlantic, and abundant in the Sargasso Sea area during the winter period (Beerkircher *et al*., in press). Further, POP observers have reported roundscale spearfish in mid-July off the Grand Banks at 43°42´N, 47°37´W (L. Beerkircher, SEFSC, Pers. Comm.).

The so-called "hatchet marlin" (*Tetrapturus* sp.), another putative congener, exhibits truncated dorsal and anal fins. Genetic analysis reveals this condition can occur in both roundscale spearfish and white marlin; thus, the shortened fins suggest a phenotype variable only, not a separate species (J. Graves, VIMS, pers. com).

Conventional mark-recapture data collected by the Cooperative Tagging Center (CTC) constituent-based tagging program (NOAA/NMFS/SEFSC) has revealed spatial and temporal characteristics of white marlin movement (Ortiz *et al*., 2003). From 1954 through 2005, a total of 47,662 white marlin were marked and released in the Atlantic basin, resulting in 961 recaptures (2.01 percent; Orbesen *et al*., In Review]). The majority of releases took place in the months of July through September, in the western North Atlantic off the eastern coast of the United States; and, to a lesser extent, off Venezuela, the Gulf of Mexico, and the western central Atlantic. The longest distance traveled was 6,523 km (4,053 miles), while the maximum number of days at-liberty was 5,488 (15 yrs). Trans-Atlantic crossing have been recorded for several individuals. However, only two reports of trans-equatorial crossings have been documented (Orbesen *et al*., In Review]). Recaptures indicate a substantial number of individuals moving between the Mid-Atlantic coast of the United States and the northeast coast of South America.

Horodysky *et al*. (2007) examined vertical movement and habitat use of 47 pop-up satellite archival tags (PSAT) monitored white marlin released from recreational and commercial vessels (Horodysky and Graves, 2005; Kerstetter and Graves, 2006). During periods at-liberty ranging from five to seven days, these white marlin spent nearly half their time near the surface (< 10 m). All made frequent short duration dives to depths averaging 51 m, suggesting that a great deal of foraging effort takes place well below the surface waters. Horodysky *et al*. (2007) go on to suggest this behavior may explain the relatively high catch rates of white marlin on some deep-set pelagic longline gears. In a study supporting this suggestion, Junior *et al*. (2004) reported no obvious depth layer preference for white marlin captured with pelagic longline gear off northeastern Brazil in depths ranging from 50 to 230 m (164-754 feet). An analysis of high resolution (≤ 60 seconds) archival data from two white marlin PSATs showed time engaged in vertical movement ranged from 29.4 percent to 54.4 percent, with most of this activity taking place during daylight hours (Hoolihan *et al*., unpubl. data). Maximum depths recorded for these individuals were 188 m and 260 m. While dive events were frequent, the majority of time (55.9 and 86.1 perccent) was spent at depths less than 75 m. Prince and Goodyear (2006) used PSAT data from sailfish and blue marlin to show how vertical movement could be restricted by a hypoxic barrier formed during upwelling. One implication of this condition is that billfish movements are constrained to near-surface depths where adequate levels of dissolved oxygen are available. Another is that their susceptibility to capture by surface fishing gears would increase. Given the same conditions, white marlin could be expected to behave similarly.

Predator–prey relationships: The most important prey items of adult white marlin, at least in the Gulf of Mexico, are squid, dolphinfishes (*Coryphaena*) and hardtail jack (*Caranx crysos*), followed by mackerels, flyingfishes, and bonitos. Other food items found inconsistently and to a lesser degree include cutlassfishes, puffers, herrings, barracudas, moonfishes, triggerfishes, remoras, hammerhead sharks, and crabs. Along the central Atlantic coast food items include round herring (*Etrumerus teres*) and squid *(Loligo pealei*). Carangids and other fishes are consumed as well (Nakamura, 1985). Davies and Bortone (1976) found the most frequent stomach contents in 53 specimens from the northeastern Gulf of Mexico, off Florida, and off Mississippi to include little tunny (*Euthynnus* sp.), bullet tuna (*Auxis* sp.), squid, and moonfish (*Vomer setapinnis*). They also found white marlin to feed on barracuda and puffer fish. Atlantic pomfret (*Brama brama*) and squid (*Ornithoteuthis antillarum*) were the most abundant food items sampled from stomachs of white marlin collected off the coast of Brazil in the southwestern Atlantic Ocean (Junior *et al*., 2004). The only predators of adult white marlin may be sharks and possibly killer whales (Mather *et al.*, 1975).

Reproduction and Early Life History: Female white marlin are about 20 kg (44 lb) in mass and 130 cm (51.2 inches) in length at sexual maturity. Spawning activity occurs during the spring (March through June) in northwestern Atlantic tropical and sub-tropical waters marked by relatively high surface temperatures (20° to 29°C) and salinities (> 35 ppt). White marlin move to higher latitudes during summer, when waters warm. White marlin sampled during the summer at these higher latitudes (Mid-Atlantic States) were in a post-spawning state (deSylva and Davis, 1963). Arocha *et al*. (2006) reported females exhibiting high gonad index values (associated with mature gonads) present in the western North Atlantic from April to July between 18°N and 22°N. Spawning seems to take place further offshore than sailfish, although white marlin larvae are not found as far offshore as blue marlin. Females may spawn up to four times per spawning season (deSylva and Breder, 1997). It is believed there are at least five spawning areas in the western North Atlantic: northeast of Little Bahama Bank off the Abaco Islands; northwest of Grand Bahama Island; southwest of Bermuda; the Mona Passage, east of the Dominican Republic; and the Gulf of Mexico. Prince *et al*. (2005) collected eight white marlin larvae in neuston tows in April/May off the coast of Punta Cana, Dominican Republic indicating that there had been recent spawning activity in this general area. More recently, nine white marlin larvae were collected during May-June near the Bahamas in the Florida Straits (D. Richardson, RSMAS, unpubl. data). Lastly, white marlin larvae (n = 15) have been genetically identified from the Gulf of Mexico, confirming spawning activity in that region (J. Rooker, Texas A&M University, Unpubl. Data).

Fisheries: White marlin are targeted as a recreational fishery in the United States and Caribbean, and are also caught as bycatch of tropical tuna longline fisheries which use shallow gear deployment. They are also caught by offshore longline fisheries which target swordfish, especially in the western Atlantic, as well as by directed artisanal fisheries in the Caribbean.

U.S. Fishery Status: Overfished, overfishing is occurring. White marlin underwent a status review under the Endangered Species Act (ESA) in 2002 that found that listing the species as threatened or endangered was "not warranted" (September 9, 2002; 67 FR 57204). Subsequent to the 2002 finding, a settlement agreement was reached between NMFS, the Center for Biological Diversity (CBD), and the Turtle Island Restoration Network (TIRN) wherein it was agreed that NMFS would revisit the status of the white marlin following the 2006 stock assessment by ICCAT. In December 2006, NMFS announced that a status review of the Atlantic white marlin was initiated (December 21, 2006; 71 FR 76639). NMFS conducted a white marlin status review in 2007 and found that listing the species as threatened or endangered was "not warranted" (January 4, 2008; 73 FR 843).

Growth and mortality: Adult white marlin grow to over 280 cm TL and 82 kg (184 lbs). Size at harvest generally ranges from 20 to 30 kg (44-66 lb). White marlin exhibit sexually dimorphic growth patterns; females grow larger than males (Mather *et al.*, 1975; Nakamura, 1985). They grow quickly and can reach an age of at least 18 years, based on tag recapture data (SCRS, 2004).

Habitat associations: The world's largest sport fishery for the species occurs in the summer from Cape Hatteras, North Carolina to Cape Cod, Massachusetts especially between Oregon Inlet, North C and Atlantic City, NJ. Successful fishing occurs up to 80 miles offshore at submarine canyons, Carolina extending from Norfolk Canyon in the Mid-Atlantic to Block Canyon off eastern Long Island (Mather, *et al.*, 1975). Concentrations are associated with rip currents and weed lines (fronts), and with bottom features such as steep dropoffs, submarine canyons and shoals (Nakamura, 1985). The spring peak season for white marlin sport fishing occurs in the Straits of Florida, southeast Florida, the Bahamas, and off the north coasts of Puerto Rico and the Virgin Islands. In the Gulf of Mexico summer concentrations are found off the Mississippi River Delta, at DeSoto Canyon, and at the edge of the continental shelf off Port Aransas, Texas, with a peak off the Delta in July, and in the vicinity of DeSoto Canyon in August. In the Gulf of Mexico adults appear to be associated with blue waters of low productivity, being found with less frequency in more productive green waters. While this is also true of the blue marlin, there appears to be a contrast in the factors controlling blue and white marlin abundances, as higher numbers of blue marlin are caught when catches of white marlin are low and vice versa (Rivas, 1975; Nakamura, 1985). It is believed that white marlin prefer slightly cooler temperatures than blue marlin. Spawning occurs in early summer, in subtropical, deep oceanic waters with high surface temperatures and salinities (20° to 29EC and over 35 ppt). Spawning concentrations occur off the Bahamas, Cuba, and the Greater Antilles, probably beyond the U.S. EEZ, although the locations are unconfirmed. Concentrations of white marlin in the northern Gulf of Mexico and from Cape Hatteras to Cape Cod are probably related to feeding rather than spawning (Mather *et al.*, 1975).

Essential Fish Habitat for White Marlin:

- **Spawning, eggs, and larvae:** At this time the available information is insufficient to identify EFH for this life stage.

- **Juvenile (20-158 cm LJFL):** In the central Gulf of Mexico from southern Texas to the Florida Panhandle. Florida Keys to mid-east coast of Florida, and Georgia to Cape Cod. Please refer to Figure 5.20 for detailed EFH map.

- **Adults (≥159 cm LJFL):** In the central Gulf of Mexico from southern Texas to the Florida Panhandle. Florida Keys to the mid-east coast of Florida, and South Carolina to Cape Cod. Puerto Rico and the Virgin Islands. Please refer to Figure 5.21 for detailed EFH map.

5.1.3.4 Sailfish

<u>Sailfish (*Istiophorus platypterus*)</u> Sailfish have a circumtropical distribution (Post, 1998). They range from 40EN to 40ES in the western Atlantic and 50EN to 32ES in the eastern Atlantic. Sailfish are epipelagic and coastal to oceanic, and are usually found above the thermocline at a temperature range of 21° to 28EC, but may dive into deeper, colder water. Taxonomic investigations have occurred recently for sailfish and its congeners. Collette *et al*. (2006) presented genetic evidence to propose a taxonomic reclassification of some genera and recommended continued placement of sailfish in its own genus, Istiophorus.

During the winter sailfish are restricted to the warmer parts of their range and move farther from the tropics during the summer (Beardsley *et al.*, 1975; Nakamura, 1985). The summer distribution of sailfish does not extend as far north as for marlins. Tag-and-recapture efforts have recovered specimens only as far north as Cape Hatteras, NC, but there have been reported interactions further north than Cape Hattaras. No transatlantic or transequatorial movements have been documented using tag-recapture methods (Bayley and Prince, 1993).

Predator-prey relationships: Early larvae feed on copepods, but shift to eating fish when they reach 6.0 mm in size. The diet of adult sailfish caught around Florida consists mainly of pelagic fishes such as little thunny (*Euthynnus alletteratus*), halfbeaks (*Hemiramphus* spp.), cutlassfish (*Trichiurus lepturus*), rudderfish (*Strongylura notatus*), jacks (*Caranx ruber*), pinfish (*Lagodon rhomboides*), and squids, including *Argonauta argo* and *Ommastrephes bartrami* (Nakamura, 1985). Sailfish are opportunistic feeders, and there is unexpected evidence that they may feed on demersal species such as sea robin (Triglidae), cephalopods, and gastropods found in deep water. Sailfish in the western Gulf of Mexico have been found to contain a large proportion of shrimp in their stomachs (Beardsley *et al.*, 1975; Nakamura, 1985). Davies and Bortone (1976) report that the stomach contents of 11 sailfish from the Gulf of Mexico most frequently contained little thunny, bullet tuna (*Auxis* sp.), squid, and Atlantic moonfish (*Vomer setapinnis*). Adult sailfish are probably not preyed upon often, but predators include killer whales (*Orcinus orca*), bottlenose dolphin (*Tursiops turncatus*), and sharks (Beardsley *et al.*, 1975).

Reproduction and Early Life History: Spawning has been reported to occur in shallow waters (30 to 40 ft) around Florida, from the Keys to the region off Palm Beach on the east coast. Spawning also occurs in the Gulf of Mexico as shown by the presence of hydrated eggs in ovaries of fish collected off Texas (Bumguardner *et al*., 2007). Additionally, spawning is assumed to occur, based on the presence of larvae, in the northern Gulf of Mexico from May to September (Jay Rooker, Texas A&M University at Galveston, Pers. Comm.). Spawning is also assumed to occur, based on presence of larvae, offshore beyond the 100 m isobath from Cuba to the Carolinas, from April to September. Sailfish larvae have been found in Exuma Sound in the Bahamas during summer months suggesting that spawning may occur in the Sound and/or up to 200 km southeast of the mouth of the Sound (Serafy *et al*., 2003). Sailfish larvae (3.5 to12mm SL) have been found in pelagic waters off Miami, FL in August (Serafy *et al*., 2006). Sexual maturity occurs in the third year, with females at a weight of 13 to18 kg and males at 10 kg (de Sylva and Breder, 1997). Sailfish are multiple spawners, with spawning activity moving northward in the western Atlantic as the summer progresses. Larvae are found in Gulf Stream waters in the western Atlantic, and in offshore waters throughout the Gulf of Mexico from March to October (Beardsley *et al.*, 1975; Nakamura, 1985; de Sylva and Breder, 1997).

Fisheries: Sailfish are primarily caught in directed sport fisheries and as bycatch of the commercial longline fisheries for tunas and swordfish. Historically, nearly all sailfish and longbill spearfish from commercial catches have been reported as Atlantic sailfish; however, nearly all of these represent longbill spearfish (and perhaps other spearfish), and it is probable that very few sailfish are taken commercially in offshore waters of the Atlantic. Thus, it is impossible to determine historical trends in sailfish catches since at least two species have been combined.

U.S. Fishery Status: Unknown.

Growth and mortality: Analysis of daily growth rings in Atlantic sailfish sagittae otoliths estimated ages at 3 to18 days for fish that were 2.8 to15.2 mm SL (Luthy *et al*., 2005). Most sailfish examined that have been caught off Florida are under three years of age. Mortality is estimated to be high in this area, as most of the population consists of only two year classes (Beardsley *et al.*, 1975). Sailfish are probably the slowest growing of the Atlantic istiophorids. Sexual dimorphic growth is found in sailfish, but it is not as extreme as with blue marlin (SCRS, 1997). An individual sailfish was recaptured after 6,568 days (17.9 years) at liberty. The maximum age can be 13 to15 or more years. Growth rate in older individuals is very slow - 0.59 kg/yr (Prince *et al.*, 1986).

Habitat associations: In the winte,r sailfish can be found in small schools around the Florida Keys and off eastern Florida, in the Caribbean, and in offshore waters throughout the Gulf of Mexico. In the summer they appear to diffuse along the U.S. coast as far north as the coast of Maine, although there is a population off the east coast of Florida all year long. During the summer some of these fish move north along the inside edge of the Gulf Stream. After the arrival of northerlies in the winter they regroup off the east coast of Florida. Sailfish appear to spend most of their time above the thermocline, which occurs at depths of 10 to 20 m to 200 to 250 m, depending on location. The 28EC isotherm appears to be the optimal temperature for this species. Sailfish are mainly oceanic but migrate into shallow coastal waters. Larvae are associated with the warm waters of the Gulf Stream (Beardsley *et al.*, 1975; Nakamura, 1985; Post, 1998).

Essential Fish Habitat for Sailfish:

- **Spawning, eggs, and larvae:** Off the southwest coast of Florida to Key West, FL, associated with waters of the Gulf Stream and Florida Straits from 5 mi offshore out to the EEZ boundary (Figure 5.22)**.** No changes to the 1999 boundary are proposed.

- **Juveniles/Subadults (20-142 cm LJFL):** In the central Gulf of Mexico, and off southern Texas and the Florida Panhandle. Atlantic east coast from the Florida Keys to mid-coast of South Carolina, the Outer Banks of North Carolina and Maryland. Eastern Puerto Rico and Virgin Islands. Please refer to Figure 5.23 for detailed EFH map.

- **Adults (≥143 cm LJFL):** In the central Gulf of Mexico, and off southern Texas and the Florida Panhandle. Atlantic east coast from the Florida Keys to northern Florida, off of Georgia, and Cape Hatteras. Also around the Virgin Islands. Please refer to Figure 5.24 for detailed EFH map.

5.1.3.5 Longbill Spearfish

Longbill Spearfish (*Tetrapturus pfluegeri*) Only relatively recently (1963) has the longbill spearfish been reported as a new (distinct) species. It is known, but rare, from off the east coast of Florida, the Bahamas and the Gulf of Mexico, and from Georges Bank to Puerto Rico. More recently it has been observed to be more widely distributed, mostly in the western Atlantic. The range for this species is from 40EN to 35ES. It is an epipelagic, oceanic species, usually inhabiting waters above the thermocline (Robins, 1975; Nakamura, 1985). The species is generally found in offshore waters.

Taxonomic investigations have occurred recently for billfishes. Collette *et al*. (2006) presented genetic evidence to propose a taxonomic reclassification of some billfishes; however, in their suggestions, longbill spearfish remain in the genus *Tetrapturus*.

Validity of the roundscale spearfish (*Tetrapturus georgii*) has recently been reported by Shivji *et al*. (2006) using genetic and morphometric analyses. Roundscale spearfish are not hybrids, but rather a clearly different genetic lineage to sympatric billfish species. Due to its similar morphometric characteristics, it is likely that most roundscale spearfish captures have been classified as white marlin and more information on roundscale spearfish may be found in the white marlin discussion elsewhere in this section.

Predator-prey relationships: The diet of the longbill spearfish consists of pelagic fishes and squids. However, little data for diet specific to fish in the north Atlantic is available.

Life history: Spawning is thought to occur in widespread areas in the tropical and subtropical Atlantic (Nakamura, 1985) in the winter from November to May (de Sylva and Breder, 1997). There are a few records of larvae caught near the Mid-Atlantic Ridge from December to February, and in the Caribbean (Ueyanagi *et al.*, 1970; de Sylva and Breder, 1997)

Fisheries: Longbill spearfish is not a target species, and retention is prohibited in the U.S. EEZ. It is taken as bycatch of the tuna and swordfish longline fisheries; however, retention is prohibited.

U.S. Fishery Status: Unknown.

Growth and mortality: The maximum weight of females at first maturity is approximately 45 kg (de Sylva and Breder, 1997).

Habitat associations: The species ranges farther offshore than sailfish. Nothing is known about its habitat associations.

Essential Fish Habitat for Longbill Spearfish:

- **Spawning, eggs, and larvae:** At this time available information is insufficient to describe and identify EFH for this life stage.

- **Juvenile/Subadult (20-182 cm LJFL):** In the central Gulf of Mexico through eastern Louisiana to the Florida Panhandle. Flordia Keys to the mid-east coast of Florida. EFH patches scattered from northern Florida to Cape Cod, with concentrations from North Carolina to Delaware, and Pureto Rico and the Virgin Islands. Please refer to Figure 5.25 for detailed EFH map.

- **Adults (≥183 cm LJFL):** In the central Gulf of Mexico, and in the Atlantic off North Carolina and Delaware. Please refer to Figure 5.26 for detailed EFH map.

5.1.4 Large Coastal Sharks

5.1.4.2 Basking Sharks

Basking shark (*Cetorhinus maximus*) The basking shark is the second largest fish in the world, its size exceeded only by the whale shark. Like the whale shark, it is a filter-feeding plankton eater. Basking sharks feed by forward swimming with a widely opened mouth to filter particulate prey from the water column. As water passes across the gills, it is filtered by long bristle-like rakers on the gill arches, a strategy known as ram filter-feeding. *Cetorhinus maximus* is considered to be the only shark species that is an obligate ram filter-feeder (Diamond, 1985). It is a migratory species of the subpolar and cold temperate seas throughout the world, spending the summer in high latitudes and moving into warmer water in winter (Castro, 1983). In spite of its size and local abundance in summer, its habits are very poorly known. Basking sharks are thought to actively select areas along thermal fronts containing high densities of zooplankton, mainly large calanoid copepods. It is believed that they track seasonal zooplankton aggregations closely (Sims and Quayle, 1998; Sims, 1999; Sims *et al*., 2003) and follow annual changes in zooplankton distribution (Sims and Reid, 2002). These shifts may explain the disappearance of basking sharks from areas where they were formerly abundant; alternatively, local basking shark declines have been thought to be due to excessive fishing pressure (Southall *et al*., 2005).

In the northwest and east Atlantic basking sharks occur in coastal regions from April to October, usually with a peak in sightings from May until August (Kenney *et al*., 1985; Southall *et al*., 2005). The temporal and spatial distribution of basking sharks in both the northwest and east Atlantic are thought to be influenced by seasonal water stratifications, temperature, and prey abundance (Owen, 1984, Sims and Merrett, 1997; Sims and Quayle, 1998; Sims, 1999; Sims *et al*., 2003; Skomal *et al*., 2004; Cotton *et al*., 2005). Few winter observations and the discovery of several sharks lacking gillrakers lead Parker and Boeseman (1954) to propose that during winter months basking sharks move offshore into deepwater, become inactive, and remain resting on the bottom in a hibernative state. However, recent tagging and metabolic studies have shown that basking sharks did not hibernate during the winter; rather they make extensive migrations, often to deeper waters, utilizing productive continental-shelf and shelf-edge habitats. In addition, animals did not exhibit long migrations into open-ocean regions away from waters (Sims, 1999; Sims *et al*., 2003; Skomal *et al*., 2004).

Distribution data for the basking shark is incomplete largely because the species is not commonly taken by fisheries. In addition, to date, a stock assessment has not been conducted on basking sharks; however, tagging data suggest separate eastern and western stocks (Kohler *et al*., 1998). Aerial surveys of the U.S. continental shelf waters off New England in the northwest Atlantic (Hudson Canyon to the Gulf of Maine) estimated the abundance of basking sharks to be between 6,671 to 14,295 individuals in these waters (Owen, 1984; Kenney *et al*., 1985). Recent genetic work suggests comparatively low genetic diversity and no significant differentiation among ocean basins with a low effective population size (N_e) for a globally distributed species (Hoelzel *et al*., 2006).

While feeding, individual basking sharks are usually observed at the surface from spring to autumn, although some individuals form loose aggregations as they feed in the same discrete patch of zooplankton (Sims *et al*., 2000). In the northwest Atlantic, aggregations of basking sharks were observed from the south and southeast of Long Island, east of Cape Cod, and along the coast of Maine (Kenney *et al*., 1985). In particular, large aggregations were observed approximately 75 km south of Martha's Vineyard and 90 km south of Moriche's Inlet, Long Island (Kenney *et al*., 1985).

Reproductive potential: Little is known about basking shark reproductive processes. Males are believed to reach maturity between 460 and 610 cm (Bigelow and Schroeder, 1948), at an estimated age of four to five years (Parker and Stott, 1965). However, these age estimates have not been validated. Female length at maturity has been suggested as 700 cm by Matthews (1950) and Parker and Scott (1965), and 810-980 cm by Compagno (1984). Aggregations of basking sharks thought to exhibit group courtship behaviors have been observed. These aggregations tend to be associated with persistent thermal fronts within areas of high prey density, which have been hypothesized to be important areas for courtship and breeding of basking sharks (Sims *et al*., 2000). Wilson (2004) noted courtship behaviors in aggregations of basking sharks in the southern Gulf of Maine and near the Great South Channel, approximately 95 km southeast of Cape Cod, Massachusetts. Harvey-Clark *et al*. (1999) found aggregations exhibiting similar behaviors off the coast of Nova Scotia, Canada. Similarly, Sims *et al*. (2000) observed putative annual courtship behaviors from 1996–1999 off southwest England. However, no mating has been observed and is presumed to occur at depth (Sims *et al*., 2000; Wilson, 2004). It is believed that female basking sharks give birth to young measuring about 180 cm total length (TL), probably in high latitudes. There are no modern reports on the size of litters or data on reproductive cycles, however, Matthews (1950) observed basking sharks in breeding condition in late spring and early summer off the west coast of Scotland. Sampling was not conducted later in the summer to verify the extent of the breeding season.

Impact of fisheries: Fishing for the basking shark is prohibited in U.S. waters, although basking sharks are common off the east coast in winter. The basking shark is listed as 'Vulnerable' in the International Union for the Conservation of Nature Red List of Threatened Species (IUCN, 2002) and in Appendix II of CITES (UNEP-WCMC, 2003).

***Essential Fish Habitat for Basking Shark*:**

Note: At this time, insufficient data is available to differentiate EFH between the juvenile and adult size classes, therefore, EFH is the same for those life stages.

- **Neonate/YOY (≤182 cm TL):** At this time, available information is insufficient for the identification of EFH for this life stage.

- **Juveniles (183 to 809 cm TL):** Atlantic east coast from the northern Outer Banks of North Carolina to the Gulf of Maine. Please refer to Figure 5.27 for detailed EFH map.

- **Adults (≥810 cm TL):** EFH designation for adults and juveniles have been combined and are the same. Please refer to Figure 5.27 for detailed EFH map.

5.1.4.3 Hammerhead Sharks

5.1.4.3.1 Great Hammerhead Shark

Great hammerhead (*Sphyrna mokarran*) This shark is found both in open oceans and shallow coastal waters. One of the largest sharks, the great hammerhead is circumtropical in warm waters (Castro, 1983). It is usually a solitary fish, unlike the more common scalloped hammerhead which often forms very large schools. Great hammerhead sharks have been observed using their laterally expanded head in prey-handling (Strong *et al*., 1990; Chapman and Gruber, 2002). Hammerheads are known for their unique head morphology. This morphology is thought to aid in a greater lateral search area, which may increase the probability of prey encounter, and enhanced maneuverability, which may aid in prey capture (Kajiura and Holland, 2002).

Reproductive potential: In Australian waters males mature at about 210 to 258 cm TL and females mature usually at 210 to 220 cm TL (Stevens and Lyle, 1989). Pups measure about 67 cm TL at birth (Stevens and Lyle, 1989) and litters consist of 20 to 40 pups (Castro, 1983). The gestation period lasts about 11 months (Stevens and Lyle, 1989). The reproductive cycle is biennial (Stevens and Lyle, 1989). In U.S. waters, the great hammerhead utilizes shallow inshore waters along Florida's Gulf coast as nursery areas throughout the warm months (Hueter and Tyminski, 2007). The location of their pupping grounds in this area is uncertain, as no neonates have been documented by the Mote Center for Shark Research (Hueter and Tyminski, 2007). The presence of young-of-the-year great hammerheads (N = 25, TL = 64–89 cm) in June and July indicates that pupping occurs in late spring and early summer, perhaps off the beaches in areas not sampled by the Mote CSR or farther offshore along Florida's Gulf coast (Hueter and Tyminski, 2007). Young-of-the-year great hammerheads can been found in the Yankeetown, Tampa Bay, and Charlotte Harbor areas throughout the summer at temperatures of 23.9 to 31.5°C, salinities of 20.8 to 34.2 ppt, dissolved oxygen of 5.3 to 7.6 mg/l, and depths of 1.8 to 5.5 m, but are seldom seen after October (Hueter and Tyminski, 2007). The first-year animals return to the nursery grounds the following March and April (Hueter and Tyminski, 2007). Older juvenile great hammerheads (TL = 92–279 cm) often are found close to shore along Florida's Gulf coast in the Florida Keys and the bays and estuaries of the Yankeetown, Tampa Bay, Charlotte Harbor, and Ten Thousand Islands areas (Hueter and Tyminski, 2007). Longline surveys of Texas coastal waters also have revealed offshore secondary nurseries for this species (Hueter and Tyminski, 2007).

Impact of fisheries: Great hammerheads are caught in coastal longline shark fisheries as well as in pelagic tuna and swordfish longline fisheries. Its fins bring the highest prices in the shark fin market. The great hammerhead is vulnerable to overfishing because of its biennial reproductive cycle and because it is caught both in directed fisheries and as bycatch in tuna and swordfish fisheries.

***Essential Fish Habitat for Great Hammerhead*:**

Note: At this time, insufficient data is available to differentiate EFH by size classes, therefore, EFH is the same for all life stages.

- **Neonate/YOY (≤74 cm TL):** Coastal areas throughout the west coast of Florida and scattered in the Gulf of Mexico from Alabama to Texas. Atlantic east coast from the Florida Keys to New Jersey. Eastern Puerto Rico. Please refer to Figure 5.28 for detailed EFH map.

- **Juveniles (71 to 209 cm TL):** EFH for all life stages have been combined and are considered the same. Please refer to Figure 5.28 for detailed EFH map.

- **Adults (≥210 cm TL):** EFH for all life stages have been combined and are considered the same. Please refer to Figure 5.28 for detailed EFH map.

5.1.4.3.2 Scalloped Hammerhead Shark

Scalloped hammerhead (*Sphyrna lewini*) This is a very common, large, schooling hammerhead of warm waters. It is the most common hammerhead in the tropics and is readily available in abundance to inshore artisanal and small commercial fisheries as well as offshore operations (Compagno, 1984). It migrates seasonally north-south along the eastern United States. Scalloped hammerhead sharks are widely distributed, but they are also dependent on discrete coastal nursery areas (Duncan *et al*., 2006). Tagging data indicate that scalloped hammerhead sharks use offshore oceanic habitat, but do not regularly roam across large distances (Kohler and Turner, 2001). Rather, individuals appear to disperse readily across continuous habitat (continental shelves) (Duncan *et al*., 2006). Hammerheads are known for their unique head morphology. This morphology is thought to aid in a greater lateral search area, which may increase the probability of prey encounter, and enhanced maneuverability, which may aid in prey capture (Kajiura and Holland, 2002). In addition, recent morphological and genetic research suggests a cryptic species of scalloped hammerhead shark found in the north-west Atlantic from coastal North Carolina to Florida (Abercrombie *et al*., 2005; Quattro *et al*., 2006); a recent phylogeny for hammerhead sharks was done by Cavalcanti (2007).

Reproductive potential: There is sexual segregation of males and females with females found more often in deeper water and a tendency to move into offshore waters at a smaller size than males (Klimley 1987; Branstetter, 1987b; Stevens and Lyle, 1989). Males in the Atlantic and Gulf of Mexico mature at about 180 to 234 cm FL or 9 to10 years of age (Branstetter, 1987b; Hazin *et al*., 2001; Piercy *et al*., 2007), while those in the Indian Ocean mature at 140 to 165 cm TL (Bass *et al.*, 1973). Branstetter (1987b) found that males grow to a maximum size of 272 to 300 cm, corresponding to 22 to 30 years of age. Females mature around 241 cm FL or 15 years of age (Branstetter, 1987b; Hazin *et al*., 2001; Piercy *et al*., 2007), with a maximum size of 305 to 310 cm, corresponding to 35 yrs of age (Branstetter, 1987b). Peircy *et al*. (2007) found that the northwest Atlantic Ocean and Gulf of Mexico populations grow more slowly and have smaller asymptotic sizes than previously reported studies for this species in the Pacific Ocean. Branstetter (1987b) reported growth through the first winter around 15 cm, and an annual growth rate of 10 to15cm for the next few years for scalloped hammerhead in the Gulf of Mexico; however, Piercy *et al*. (2007) found faster growth for this species in the Gulf of Mexico. Scalloped hammerheads can have large litters (>30 pups) with pups ranging in size from 38 and 56.2 cm TL (Clarke 1971; Compagno 1984; Branstetter, 1987b; Chen *et al*., 1988; Castro, 1983). However, there is variation in liter size based on geographic region (Lessa *et al*, 1998). In the northwestern Gulf of Mexico, back-calculated size at parturition for this species ranged from 45 to 60 cm TL with a mean of 50.3 cm TL (Branstetter, 1987b). Clarke (1971) reported a 39.5 cm TL scalloped hammerhead from Hawaiian waters. Castro (1993b) recorded a 34.7 cm TL neonate from Bulls Bay, South Carolina. During this study, three free swimming individuals were collected measuring less than 40 cm TL, with the smallest measuring 38.5 cm TL.

The reproductive cycle is annual (Castro, 1993b), and the gestation period is nine to ten months (Stevens and Lyle, 1989) but may be as long as 12 months (Branstetter, 1987b). Castro (1993b) found nurseries in the shallow coastal waters of South Carolina. Subsequent studies have identified the importance of coastal South Carolina waters as primary and secondary nursery areas for scalloped hammerheads (Abel *et al*., 2007; Ulrich *et al*., 2007). Abel *et al*. (2007) collected juvenile scalloped hammerhead sharks (47 to 58 cm TL) in Winyah Bay, South Carolina, and suggested that this area may be an important secondary nursery area for this species. Ulrich *et al*. (2007) collected neonate and juvenile scalloped hammerhead sharks in both estuarine and nearshore waters off South Carolina. Sizes ranged from 27.4 to 101.4 cm FL, and scalloped hammerheads occurred over a temperature range of 18 to 31°C and a salinity range of 20 to37 ppt (Ulrich *et al*., 2007). Scalloped hammerheads were present in South Carolina coastal waters from mid-April, when water temperatures had increased to approximately 18°C, through mid-November, when water temperatures decreased to 18°C (Ulrich *et al*., 2007). They were observed in estuarine waters from mid-May through early September in a narrow temperature range from 25° to 26°C (Ulrich *et al*., 2007). Scalloped hammerheads were collected in nearshore waters in November as they were presumably migrating out of South Carolina waters (Ulrich *et al*., 2007). Neonates dominated the catch (67.31 percent), with the majority occurring from mid-May through the beginning of November (Ulrich *et al*., 2007). Of the 173 neonates caught only three were captured in nearshore waters, two of these being in October and November when these sharks were likely migrating out of South Carolina waters (Ulrich *et al*., 2007). The mean size of neonates with an open or partially healed umbilicus was 33.1 cm FL, which is in agreement with Castro's (1993b) estimates of size at parturition. The ratio of male to female neonate scalloped hammerheads was not different than 1:1 (Ulrich *et al*., 2007).

Adams and Paperno (2007) also collected neonates from late May to early June in an area identified as nursery habitat in waters adjacent to Cape Canaveral and directly southwest of Canaveral Bight off the east coast of Florida. Water temperatures ranged from 26.1° to 28.8°C and water depths ranged from 3.8 to 9.7 m during the sampling period. The stomach contents of neonates examined in this area included fresh, partially digested, and well-digested small fishes (*e.g*., menhaden *Brevoortia* spp.) and shrimp (Adams and Paperno, 2007). The presence of fresh and partially digested prey items in stomachs of scalloped hammerheads examined during this study indicated that individuals from this population were actively feeding in nearshore Cape Canaveral waters (Adams and Paperno, 2007). The extensive sand-shell plain of Southeast Shoal, the deeper waters of Canaveral Bight, and the shelf transition zone directly south of Canaveral Bight may provide important feeding areas for this species (Adams and Paperno, 2007). The shallow waters and unique habitat of Southeast Shoal also may afford neonates an increased level of protection from large predators compared to adjacent deepwater habitats (Adams and Paperno, 2007).

Young scalloped hammerheads are relatively uncommon in Gulf nearshore waters of peninsular Florida. Neonates of this species (TL = 46 to 53 cm) are observed along the beaches of the lower Texas coast in late spring and early summer and also are occasionally seen in the Yankeetown, Tampa Bay, and Charlotte Harbor areas at that time in temperatures of 23.2° to 30.2°C, salinities of 27.6 to 36.3 ppt, and DO of 5.1 to 5.5 ml/l (Hueter and Tyminski, 2007). Young-of-the-year scalloped hammerheads are present in bays and nearshore nurseries during the summer months in the Florida areas of Yankeetown, Tampa Bay, and Charlotte Harbor as well as along the beaches of the lower Texas coast (Hueter and Tyminski, 2007). These first-year sharks typically move out of these areas by late October (Hueter and Tyminski, 2007). Older juvenile scalloped hammerheads (TL = 102–120 cm) occasionally are seen in the Tampa Bay area (Hueter and Tyminski, 2007). Nursery habitat for scalloped hammerhead sharks has also been identified in Mississippi Sound and Mobile Bay off the coasts of Mississippi and Alabama (Parsons and Hoffmayer, 2007). Secondary nurseries for this species extend into deeper coastal waters particularly off Texas, where they have been captured during longline surveys and on rod-and-reel around offshore oil rigs at depths of at least 53 m (Hueter and Tyminski, 2007).

Juvenile scalloped hammerhead sharks reside within nursery habitats for extended periods of time (at least on year post parturition) (Duncan and Holland, 2006). In addition, juveniles of the cryptic species of scalloped hammerheads were found in relative high abundance in South Carolina estuaries, and its rarity in other areas (*i.e.*, Gulf of Mexico) suggests that South Carolina bays are among the more important nursery grounds for the cryptic species (Quattro *et al*., 2006).

Impact of fisheries: Because the scalloped hammerhead forms very large schools in coastal areas, it is targeted by many fisheries for its high priced fins. Scalloped hammerhead and silky sharks make up >80 percent of the shark bycatch in the winter swordfish/tuna longline fishery of the northwestern Gulf of Mexico. Neonate scalloped hammerheads are also taken in shrimp trawls in coastal waters of the Gulf of Mexico (Branstetter, 1987b). The scalloped hammerhead is considered vulnerable to overfishing because its schooling habit makes it extremely vulnerable to gillnet fisheries and because scalloped hammerheads are actively pursued in many fisheries throughout the world. Fishery-dependent data from 1986 to 2000 from the U.S. pelagic longline fleet shows a decreasing trend in the abundance of hammerhead sharks, most of which are comprised of scalloped hammerhead sharks (Baum *et al*., 2003); however, critical evaluation of these results indicate that this estimate may be exaggerated based on incomplete analyses and dataset limitations (Burgess *et al*., 2005). Due to limited dispersal by this species, it is suggested that depleted populations will not recover quickly through immigration; rather, recovery would be slow through reproduction (Duncan *et al*., 2006).

*Essential Fish Habitat for Scalloped Hammerhead***:**

- **Neonate/YOY (≤60 cm TL):** Coastal areas in the Gulf of Mexico from Texas to the southern west coast of Florida. Atlantic east coast from the mid-east coast of Florida to the mid South Carolina Coast, and southern North Carolina. Please refer to Figure 5.29 for detailed EFH map.

- **Juveniles (61 to 179 cm TL):** Coastal areas in the Gulf of Mexico from the southern to mid-coast of Texas, eastern Lousainia to the southern west coast of Florida, and the Florida Keys. Atlantic east coast of Florida through New Jersey. Please refer to Figure 5.30 for detailed EFH map.

- **Adults (≥180 cm TL):** Coastal areas in the Gulf of Mexico along the southern Texas coast, and eastern Lousainia through the Florida Keys. Atlantic east coast of Florida to Long Island, NY. Please refer to Figure 5.31 for detailed EFH map.

5.1.4.3.3 Smooth Hammerhead Shark

Smooth hammerhead (*Sphyrna zygaena*) This is an uncommon hammerhead of temperate waters. Fisheries data for hammerheads includes this species and the scalloped and great hammerheads; however, there is little data specific to the species.

*Essential Fish Habitat for Smooth Hammerhead***:**

- **Neonate/YOY (≤72 cm TL):** Atlantic east coast in and around Delaware Bay. Please refer to Figure 5.32 for detailed EFH map.

- **Juveniles (73 to 219 cm TL):** Atlantic east coast from Florida through South Carolina, Cape Hatteras to southern Cape Cod. Please refer to Figure 5.33 for detailed EFH map.

- **Adults (≥284 cm TL):** At this time, available information is insufficient for the identification of EFH for this life stage.

5.1.4.4 Mackerel Sharks

5.1.4.4.1 White Shark

White shark (*Carcharodon carcharias*) The white shark is the largest of the lamnid, or mackerel, sharks. It is a poorly known apex predator that occurs in coastal and offshore waters and is most common in cold and warm temperate seas (Compagno, 1984). Its presence is usually sporadic throughout its range, although there are a few localities (*e.g.*, off California, Australia, South Africa, and New England) where it is seasonally common. In the western North Atlantic, it is found from Newfoundland to the Gulf of Mexico (Casey and Pratt, 1985). The number of white sharks reported along the east coast of the United States was lowest in the most northern and southern parts of the range, *i.e.*, the Gulf of St. Lawrence region and the Gulf of Mexico-southeast U.S. regions, respectively. The highest number of occurrences was recorded from the

Mid-Atlantic Bight (Casey and Pratt, 1985). Seasonally, white sharks were reported from January through September in the Gulf of Mexico; in every month but August off the southeastern United States; from April through December in the Mid-Atlantic Bight; from June through November in the Gulf of Maine; and during July and August in the Gulf of St. Lawrence-Newfoundland region (Casey and Pratt, 1985). White shark sightings are common off New England during the summer (Casey and Pratt, 1985). The seasonal occurrence of the white shark is at least partly influenced by surface temperature. Miles (1971) suggests that the world distribution of white sharks is restricted to water temperatures between 12° and 25°C. Squire (1967) reported white sharks during all months of the year in Monterey Bay, where mean monthly temperatures ranged from 10.2° to 14.4°C. Most of the available evidence indicates that the white shark is a temperate species despite the apparent tolerance by the adults to a wide range of temperatures (Casey and Pratt, 1985). Water temperatures reported in 73 cases of white shark occurrence in Casey and Pratt's study, ranged from 11° to 24°C with 75 percent of the occurrences where surface temperatures were between 15°C and 22°C (Casey and Pratt, 1985). They suggest that the 15°C isotherm is a rough indication of the seasonal white shark distribution in the northern latitudes (Casey and Pratt, 1985).

If temperature is a major factor influencing the distribution of the white shark, it appears that larger individuals tolerate a wider range of temperatures and occupy a broader geographical range (Casey and Pratt, 1985). Although white sharks over 300 cm TL have been reported in every region, individuals less than 200 cm TL are common only in the Mid-Atlantic Bight (Casey and Pratt, 1985). From all available evidence, the white shark is more abundant on the continental shelf between Cape Hatteras and Cape Cod (35°00'N, 43°00'N) than in any other region in the western North Atlantic (Casey and Pratt, 1985). More young white sharks have been caught there than in any area of comparable size in the world (Casey and Pratt, 1985), with the smallest specimen measuring 109 cm fork length caught in Vineyard Sound off Massachusetts (Skomal, 2007). The occurrence of small and intermediate size white sharks in continental shelf waters of the Mid-Atlantic Bight up through coastal waters of Massachusetts suggests this area serves as a nursery area for juveniles (Casey and Pratt, 1985; Skomal, 2007). In addition, on eight occasions pairs of large white sharks have been observed swimming close together (Casey and Pratt, 1985). Although adult white sharks of both sexes occur in the Mid-Atlantic Bight, sexes of these pairs were not determined (Casey and Pratt, 1985). The occurrence of adults of both sexes in the same region and the presence of large individuals swimming together may be evidence of mating activity in the Mid-Atlantic Bight (Casey and Pratt, 1985).

White sharks are born between 108 and 136 cm FL (120-150 cm TL; Francis 1996) and are known to reach 599 cm FL (640 cm TL; Castro 1983, Compagno 1984). Bigelow and Schroeder (1958) estimated the size at maturity to be about 396 to 426 cm, which may be a conservative estimate (Casey and Pratt, 1985). Casey and Pratt (1985) provided a length-weight curve indicating the white shark is very robust, with its weight increasing an average of 456 kg (207 lb) for every 30 cm (1 ft) of length between 415-549 cm (15 and 18 ft).

Off the California coast, large adults prey on seals and sea lions and are sometimes found around their rookeries. The white shark is also a scavenger of large dead whales. Recent isotopic analysis showed an isotopic signature based on diet that changed with increasing size, indicating a change in diet over time; one shift was from yolk to fish after white sharks were born and another switch occurred at a total length of 341 cm, representing a known diet shift from fish to marine mammals (Estrada *et al*., 2006). This is consistent with other work that has shown that after birth, juvenile white sharks are known to be piscivorous, and white sharks > 300 cm long shift from a diet principally of fish to marine mammals (Klimley 1985, McCosker 1985). Morphological work on white sharks has shown special adaptations in their caudal fins and liver size that allow small individuals to effectively hunt fast-swimming fish, whereas larger white sharks have increased buoyancy to patrol wide-ranging areas while minimizing energy costs in search of preferred large mammalian prey (Lingham-Soliar, 2005b). White sharks also have a highly stiffened dorsal fin and a highly modified caudal peduncle and caudal fin that allows for fast swimming (Lingham-Soliar, 2005a; 2005c).

Recent PSAT tagging of white sharks off of South Africa have shown that both male and female white sharks make coastal migrations as well as transoceanic return migrations. Based on this tagging data and genetic data, it is believed that while female white sharks may exhibit natal homing behavior, they also can make long, transoceanic migrations (Bonfil *et al*., 2005). However, previous genetic work by Pardini *et al*., 2001 suggested that male sharks show transoceanic dispersal, while females exhibit more non-roving behaviors. Tagging work by Boustany *et al*. (2002) also indicate that adult white sharks' ranges are more pelagic than was previously thought, comprising of an inshore continental-shelf phase as well as extensive oceanic travel that includes extensive dives. Juvenile white sharks use the entire water column when the animal is over the continental shelf (Dewar *et al*., 2004). In addition, foraging juveniles may occur in the mixed layer and near the surface at night, however, daytime dive patterns suggest that diurnal feeding occurs at or near the bottom (Dewar *et al*., 2004). These tagging data have also indicated that juvenile white sharks may be able to tolerate colder waters than previously thought; however, vertical movement patterns may indicate some thermal constraints on the behavior of juveniles (Dewar *et al*., 2004). Adult white sharks, however, do not seem to be constrained to the mixed layer and spend large portions of time below the thermocline when offshore (Boustany *et al*., 2002).

Reproductive potential: Very little is known of its reproductive processes because few gravid females have been examined by biologists in modern times. Two specimens contained seven embryos. Recent observations show that white sharks carry seven to ten embryos that are born at 120 to 150 cm TL (Francis, 1996; Uchida *et al*., 1996). Another pregnant female white shark was captured by a tunny boat in the Gulf of Gabes (southern Tunisia, central Mediterranean), on February 26, 2004 (Saidi *et al*., 2005). She had four developing embryos, three females and one male, ranging in size between 132 and 135 cm total length and weighed between 27.65 and 31.50 kg (Saidi *et al*., 2005). The embryos exhibited a distended abdomen due to yolk accumulation (Saidi *et al*., 2005). This confirms that the species is oophagous (Saidi *et al*., 2005). The types of habitats and locations of nursery areas are unknown. It is likely that the nurseries will be found in the warmer parts of the range in deep water.

The lengths of the reproductive and gestation cycles are unknown. White sharks are believed to mature between 370 and 430 cm at an estimated age of nine to ten years (Cailliet *et al.,* 1985). Cailliet *et al.,* (1985) estimated growth rates of 25.0 to 30.0 cm/year for juveniles and 21.8 cm/year for older specimens, and gave the following von Bertalanffy parameters: n = 21, L4 = 763.7 cm, K = 0.058, to = -3.53. They estimated that a 610 cm TL specimen would be 13 to 14 years old. Mollet and Cailliet (2002) used a life history table model and the Leslie-matrix demographic model to predict annual population growth of white sharks. With population parameter estimates as defined in their paper, they estimated the potential annual population growth as 8.2 percent, with a fishing mortality of 0.0787 $year^{-1}$ across all age classes producing a stationary population ($\lambda = 1.0$). Population growth was most affected by juvenile survival and adult survival (Mollet and Cailliet, 2002), and mean generation time was estimated to be 23.1 years.

Impact of fisheries: The white shark is a prized game fish because of its size. It is occasionally caught in commercial longlines or in near-shore drift gillnets, but it must be released in a manner which maximizes its survival. Its jaws and teeth are often seen in specialized markets where they bring high prices. Preliminary observations (Strong *et al.,* 1992) show that populations may be small, highly localized, and very vulnerable to overexploitation. The white shark has been adopted as a symbol of a threatened species by some conservation organizations, and has received protected status in South Africa, Australia, and the State of California. In 1997, the Unites States implemented a catch-and-release only recreational fishery for the white shark, while prohibiting possession of the species. There are no published population assessments, or even anecdotal reports, indicating any population decreases of the white shark. Nevertheless, it is a scarce apex predator and a long-lived species of a limited reproductive potential that is vulnerable to longlines.

***Essential Fish Habitat for White Shark*:**

- **Neonate/YOY (≤166 cm TL):** Along the mid- and southern west coast of Florida in the Gulf of Mexico, and along the mid- and northern east coast of Florida, South Carolina, and North Carolina in the Atlantic. Maryland to Cape Cod. Please refer to Figure 5.34 for detailed EFH map.

- **Juveniles (167 to 479 cm TL):** EFH for all life stages have been combined and are considered the same. Please refer to Figure 5.34 for detailed EFH map.

- **Adults (≥480 cm TL):** EFH for all life stages have been combined and are considered the same. Please refer to Figure 5.34 for detailed EFH map.

5.1.4.5 Nurse Sharks

Nurse shark (*Ginglymostoma cirratum*) The nurse shark inhabits littoral waters in both sides of the tropical and subtropical Atlantic, ranging from tropical West Africa and the Cape Verde Islands in the east, and from Cape Hatteras, North Carolina to Brazil in the west. It is also found in the east Pacific, ranging from the Gulf of California to Panama and Ecuador (Bigelow and Schroeder, 1948). It is a shallow water species, often found lying motionless on the bottom under coral reefs or rocks. It often congregates in large numbers in shallow water (Castro, 1983; Pratt and Carrier, 2001). Generally, nurse sharks are not usually far ranging in their movements and most individuals spend their entire life cycle within a few hundred square kilometers (Carrier and Luer, 1990; Kohler *et al*., 1998).

Reproductive potential: Males reach maturity at about 150 to 170 cm TL (Pikitch *et al*., 2005). Litters consist of 20 to 30 pups, the young measuring about 30 cm total length at birth.

The gestation period is about five to six months and reproduction is biennial (Castro, 2000). The age at maturity is unknown, but the nurse shark is a long-lived species. Clark (1963) reported an aquarium specimen living up to 24 years in captivity.

Its nurseries are in shallow turtle grass (*Thalassia*) beds and shallow coral reefs (Castro, 2000; Pratt and Carrier 2001). Juveniles are also found around mangrove islands in south Florida. Primary nurseries for the nurse shark on the west coast of Florida have not been well documented, perhaps due in part to this species' small size at birth and ability to avoid entanglement in collection gear (Hueter and Tyminski, 2007). No neonates or young of the year have been captured in any Mote CSR-directed field collections (Hueter and Tyminski, 2007). Older juveniles (*N* = 314, TL = 49–212 cm), which have been caught on Mote CSR longline and drumline gear, are commonly observed from April to November in the areas of Tampa Bay, Charlotte Harbor, Ten Thousand Islands, and the Florida Keys in temperatures of 17.5° to 32.9°C, salinities of 21.8 to 38.9 ppt, DO of 1.7 to 11.5 mg/l, and depths of 0.3 to 12.2 m (Hueter and Tyminski, 2007). In addition, juvenile nurse sharks (62.0–121.9 cm TL) were collected in northern Cape Canaveral (latitude 28°40'N) to south of the Jupiter Island area (latitude 27°04'N) in water depths of 3 to 11 m (Adams and Paperno, 2007) and in Winyah Bay, South Carolina (Abel *et al*., 2007). Large numbers of nurse sharks often congregate in shallow waters off the Florida Keys and the Bahamas at mating time in June and July (Fowler, 1906; Gudger, 1912; Pratt and Carrier, 2001). A small area has been set up for protection of mating sharks at Fort Jefferson in the Dry Tortugas as nurse shark mating has been observed in this area (Pratt and Carrrier, 2001). Pikitch *et al*. (2005) documented juvenile, neonate, and pregnant female nurse sharks in Glovers Reef off Belize, indicating this is an important nursery area for these sharks.

Work by Wiley and Simpendorfer (2007) caught juvenile and adult nurse sharks (10 to 215 cm) in the marine areas of the Everglades National Park. Here, nurse sharks seem to avoid salinities < 30 ppt and were found in salinities > 30 ppt. Most nurse sharks were caught in waters between 25° to 29°C and in depths greater than 2.25 m (Wiley and Simpendorfer, 2007).

Impact of fisheries: In North America and the Caribbean the nurse shark has often been pursued for its hide, which is said to be more valuable than that of any other shark (Springer, 1950a). The fins have no value, and the meat is of questionable value (Springer, 1979). The U.S. commercial bottom longline fleet catches few nurse sharks. Based on acoustic tagging of nurse sharks, Chapman *et al*. (2005) determined that effective no-take marine reserves need to be large (boundaries of at least tens of kilometers) and need to encompass not only diverse habitats (ocean reefs, seagrass flats, lagoons) but also the areas that connect them (*i.e*., major channels).

***Essential Fish Habitat for Nurse Shark*:**

- **Neonate/YOY (≤36 cm TL):** Insufficient data to determine EFH for this lifestage.
- **Juvenile (52 to 230 cm TL):** Coastal areas in the Gulf of Mexico from the Florida Panhandle to the Florida Keys. Atlantic east coast of Florida to southern Georgia. Southeast coast of Puerto Rico. Please refer to Figure 5.35 for detailed EFH map.

- **Adults (≥231 cm TL):** Coastal areas in the Gulf of Mexico from the Florida Panhandle to the Florida Keys. Atlantic east coast of Florida. Southeast coast of Peurto Rico. Please refer to Figure 5.36 for detailed EFH map.

5.1.4.6 Requiem Sharks

5.1.4.6.1 Bignose Shark

Bignose shark (*Carcharhinus altimus*) The bignose shark is a poorly known, bottom dwelling shark of the deeper waters of the continental shelves. It is found in tropical and subtropical waters throughout the world (Castro, 1983). There is evidence that bignose sharks undergo diurnal vertical migration. Bignose sharks have been documented near the bottom in 90-500 m by day. At night, at least some individuals move into shallower water or up into the pelagic zone (Anderson and Stevens, 1996).

Reproductive potential: The smallest mature specimens recorded by Springer (1960) were a 213 cm TL male and a 221 cm TL female. Springer (1950c) reported litters of seven to eight pups, while Stevens and McLoughlin (1991) noted from three to 15 pups. Birth size is probably around 70 cm TL based on the largest embryos (65 to 70 cm TL) reported by Fourmanoir (1961) and free swimming specimens with fresh umbilical scars seen by Bass *et al.,* (1973). Based on 29 individuals (3 mature, 2 almost mature), 50 percent maturity for females is 192.5 cm FL (L. Natanson, NEFSC, unpubl. data). Based on 12 individuals (2 mature) 50 percent maturity for males is 179 cm FL (Natanson, unpubl. data). The lengths of the gestation period and of the breeding cycle have not been reported. The location of the nurseries is unknown.

Impact of fisheries: Springer (1950c) stated that the bignose shark appeared to be the most common large shark of the edges of the continental shelves in the West Indian region, and that the species made up a substantial portion of the catch in the Florida shark fishery of the1940s. In some areas bignose sharks are mistaken for sandbar sharks.

***Essential Fish Habitat for Bignose Shark*:**

Note: At this time, insufficient data is available to differentiate EFH between the juvenile and adult size classes; therefore, EFH is the same for those life stages.

- **Neonate/YOY (≤84 cm TL):** Insufficient data to determine EFH for this lifestage.

- **Juveniles (85 to 225 cm TL):** From Louisiana through the west coast Florida to the Florida Keys in the Gulf of Mexico, and the east coast of Florida and South Carolina in the Atlantic. Continuous EFH from North Carolina to New Jersey. Please refer to Figure 5.37 for detailed EFH map.

- **Adults (≥226 cm TL):** EFH for juvenile and adult life stages have been combined and are considered the same. Please see Figure 5.37 for detailed EFH map.

5.1.4.6.2 Blacktip Shark

Blacktip shark (*Carcharhinus limbatus*) The blacktip shark is circumtropical in shallow coastal waters and offshore surface waters of the continental shelves. In the southeastern United States it ranges from Virginia to Florida and the Gulf of Mexico. Upon examining a large number of museum specimens, Garrick (1982) believed it to be a single worldwide species. However, Dudley and Cliff (1993), working off South Africa, and Castro (1996), working on blacktip sharks off the southeastern United States, showed that there were significant differences among the various populations. For example, the median size for blacktip sharks in the Atlantic is 126.6 cm fork length, whereas the median size in the Gulf region is 117.3 cm fork length. In addition, researchers investigated the genetic population structure of blacktip sharks in the Atlantic and Gulf of Mexico and found genetic differences between Atlantic and Gulf of Mexico populations (Keeney *et al*., 2003; Keeney *et al*., 2005). Considering the documented long-distance movements of blacktip sharks (Kohler *et al*., 1998), the magnitude and geographical scale of genetic differentiation indicates a strong tendency for female blacktip sharks to exhibit a high degree of site-fidelity (philopatry) for Gulf or Atlantic natal nurseries (Keeney *et al*., 2003; Keeney *et al*., 2005).

The blacktip shark is a fast moving shark that is often seen at the surface, frequently leaping and spinning out of the water. It often forms large schools that migrate seasonally north-south along the coast and exhibit a strong diel pattern in their aggregations thought to be related to predator avoidance or improved feeding efficiency (Heupel and Simpendorfer, 2005a). This species is much sought after in the eastern United States because of the quality of its flesh. The blacktip and the sandbar shark are the two primary species in the U.S. commercial fisheries. In the markets of the United States "blacktip" has become synonymous with good quality shark; therefore, many other species are also sold under that name.

Reproductive potential: Off the southeastern United States males mature at between 142 and 145 cm total length and females at about 156 cm TL (Castro, 1996). According to Branstetter and McEachran (1986), in the western North Atlantic males mature at 139 to 145 cm total length at four to five years and females at 153 cm total length at six to seven years. A similar pattern is evident in the Atlantic and Gulf of Mexico, with larger size at maturity in the Atlantic than in the Gulf region. However, these ages are unvalidated and based on a small sample. Branstetter and McEachran (1986) estimated the maximum age at ten years, and gave the von Bertalanffy parameters for combined sexes as: L_4 = 171, K= 0.284, t_o= -1.5.

The young are born at 55 to 60 cm total length in late May and early June in shallow coastal nurseries from Georgia to the Carolinas (Castro, 1996), and in bay systems in the Gulf of Mexico (Carlson, 2002; Parsons, 2002), and the Texas coast (Jones and Grace, 2002). Litters range from one to eight pups (Bigelow and Schroeder, 1948) with a mean of four. The gestation cycle lasts about a year; the reproductive cycle is biennial (Castro, 1996).

In general, nursery areas are thought to be used for two main reasons: predator avoidance and food abundance (Branstetter 1990; Castro 1993b; Simpfendorfer and Milward 1993). However, work by Heupel and Hueter (2002) found that prey abundance is not the main factor directing the movement patterns and habitat choice of juvenile blacktip sharks within one nursery area on the west coast of Florida. Rather, predator avoidance may be more important in the use of the nursery grounds by these young animals than prey abundance (Heupel and Hueter 2002). Mortality in this nursery was shown to be the highest for neonates within the first 15 weeks of life; Heupel and Simpendorfer (2002) showed that 61 and 91 perecnt of neonates died within in this time period due to natural and fishing mortality. In addition, examination of home range size within nursery areas showed a population-wide increase in home range size over time (Heupel *et al*., 2004). Therefore, Heupel and Simpendorfer (2005b) argued that larger reserve areas would be needed to protect nursery grounds and provide better protection for young sharks when they were most vulnerable within the nursery area.

According to Castro (1993b), the nurseries are on the seaward side of coastal islands of the Carolinas, at depths of two to four meters. Carlson (2002) found neonates in depths of 2.1 to 6.0 m under a variety of habitat conditions. Castro (1993b) found neonates over muddy bottoms off Georgia and the Carolinas, while Hueter found them over seagrass beds off west Florida (Mote Laboratory CSR, unpubl. data). Gurshin (2007) found the summer population of blacktip sharks around the Sapelo Island National Estuarine Research Reserve appeared to consist primarily of young-of-the-year and small juveniles, suggesting that the estuary system of Sapelo Island, Georgia served as primary and secondary nursery habitats.

Juvenile blackip sharks have also been found in Winyah Bay and North Inlet, South Carolina, and this area has been suggested as a secondary nursery habitat for this species (Abel *et al*., 2007). Blacktip sharks were captured in South Carolina waters from May until early November and ranged in size from 44.7 to approximately 185.0 cm FL (Abel *et al*., 2007). Blacktip sharks occurred at temperatures between 19°C and 31°C and over a salinity range of 13 to37 ppt, although 98 percent were captured at salinities between 25 and 37 ppt (Abel *et al*., 2007). Both adult female and male blacktip sharks were observed between June and November in nearshore waters and from May to early October in estuarine waters (Abel *et al*., 2007). A total of 190 neonate and young-of-the-year blacktip sharks were collected during the study (Abel *et al*., 2007). With the exception of one individual, neonates and young of the year were captured exclusively in estuarine waters between May and early September, indicating the importance of the estuaries as primary nurseries for this species (Abel *et al*., 2007). Neonate blacktip sharks with umbilical remains ranged in size from 44.7 to 59.3 cm FL (mean = 51.2 cm FL), which was slightly larger than the size range at parturition reported by Castro (1996) (Abel *et al*., 2007). Parturition occurred over an approximately 1-month period during May and June (Abel *et al*., 2007). By mid-September young-of-the-year had migrated into nearshore waters (Abel *et al*., 2007). Juvenile blacktip sharks, ranging in size from 72.5 to 111.3 cm FL, were caught in both estuarine and nearshore waters, indicating that this species utilizes both of these areas as secondary nurseries (Abel *et al*., 2007). Juveniles were first seen in nearshore waters in mid-May (Abel *et al*., 2007). By the end of May juveniles were collected in both nearshore and estuarine waters (Abel *et al*., 2007). Juvenile blacktip sharks were not captured in estuaries after the beginning of September and presumably migrated out of South Carolina nearshore waters by the beginning of October (Abel *et al*., 2007). Juvenile blacktip sharks (63 to88.5 cm TL) were also collected along the eastern seaboard from northern Cape Canaveral (latitude 28°40'N) south to the Jupiter Island area (latitude 27°04'N) in water depths of 3 to 11 m (Adams and Paperno, 2007).

On the west coast of Florida, Yankeetown has proven to be the most productive blacktip shark primary nursery followed by Charlotte Harbor, Tampa Bay, Ten Thousand Islands, and the Florida Keys (Hueter and Tyminski, 2007). Neonate blacktip sharks (N = 1,933, TL = 42–74 cm) have been documented in all five of these Florida areas, and significant pupping takes place along the Texas coast as well (Hueter and Tyminski, 2007). Blacktip shark pupping begins as early as mid-April and can continue until as late as the first week of September, with the peak occurring in June (Hueter and Tyminski, 2007). Steiner *et al*. (2007) found blacktip sharks were most abundant in the Ten Thousand Islands area between May and August, with clear peaks in June and July. Specimens still showing an umbilical scar in the Ten Thousand Islands area were reported from the beginning of May through the beginning of August (Steiner *et al*., 2007). Immature blacktip sharks were occasionally caught in the estuary, but they usually stayed around the Gulf front islands. Overall, blacktip sharks caught in the Ten Thousand Islands were estimated to be a couple of days old (umbilical scar still open) to 5+ years (Steiner *et al*, 2007).

Young-of-the-year blacktip sharks remain in the nurseries throughout the warm months and begin their fall migration in October and November when water temperatures drop to around 20°C. Heupel (2007) concluded that temperature drops were the primary cue that juvenile blacktip sharks used to time their emigration from nursery areas. However, young-of-the-year and juvenile blacktip sharks have been found in the warm water effluents of Tampa Bay and Yankeetown power plants during the winter months (Hueter and Tyminski, 2007). Tag/recapture data suggest that first-year blacktip sharks leaving the north-central Florida nurseries (Yankeetown area) in the fall migrate south as far as the Marquesas Islands west of the Florida Keys (a minimum distance of 519 km; Hueter *et al*. 2005) (Hueter and Tyminski, 2007). In preparation for winter, adult blacktip sharks of Florida migrate to wintering grounds off southern Florida and the Keys (Steiner *et al*., 2007). Young-of-the-year blacktip sharks begin their northward spring migration back to the primary nursery areas as early as late February but more typically in March and April, and thus these areas function additionally as secondary nurseries for one-year-old as well as older juvenile blacktip sharks (Hueter and Tyminski, 2007). Older juvenile year-classes return to these nursery areas beginning in March and remain there throughout the summer before undergoing their fall migration in October and November (Hueter and Tyminski, 2007). These juveniles often move well into the estuaries and are found in salinities as low as 17 ppt (Hueter and Tyminski, 2007).

Mote CSR collaborative studies indicate that immature blacktip sharks also are commonly found associated with nearshore oil rigs during the warm months along the upper Texas coast as well as coastal areas of Mississippi and Louisiana (Hueter and Tyminski, 2007; Parsons and Hoffmayer, 2007; Neer *et al*., 2007). Neer *et al*. (2007) has shown that central Louisiana's nearshore coastal waters appear to be important pupping and nursery areas for blacktip sharks with males ranging from 45.6 to 109.5 cm FL and females ranging fro 43.9 to 110.8 cm FL. Blacktip sharks regularly frequent Terrebonne/Timbalier Bay system in central Louisiana in June and July (Neer *et al*., 2007). Temperature ranged from 22.2°C to 32.4°C, while salinity ranged from 11.0 to 37.3 ppt over the sampling period, and dissolved oxygen ranged from 2.89 to 9.61 mg/l, with more blacktips being found in warmer, more saline waters (Neer *et al*., 2007). Parsons and Hoffmayer (2007) collected juvenile blacktip sharks in Mississippi Sound and Mobile Bay off the coasts of Mississippi and Alabama. Young-of-year and juvenile blacktip shark collections made in these areas water between 3.1 and 8.2 m in mean depth, 27.1°C and 30.6°C mean temperature, 18 and 20 parts per thousand (ppt) mean salinity, 5.5 and 7.3 ppm mean dissolved oxygen, 10.7 and 20.3 cm/s mean current speed, and 80 to 130 cm mean Secchi depth (Parsons and Hoffmayer, 2007). Large numbers of young-of-the-year blacktips were collected north of Dauphin Island, in the lower reaches of the Mobile Bay, Fort Morgan, Sand Island, north of Horn Island, and near the mouth of Bay St. Louis, with high catch-per-unit-effort occurring in May and June and the highest in July when waters were about 29° to 33°C (Parsons and Hoffmayer, 2007).

Impact of fisheries: The blacktip shark is caught in many diverse fisheries throughout the world. Off the southeastern United States it is caught in commercial longlines set in shallow coastal waters, but it is also pursued as a gamefish. There are localized gillnet fisheries in Federal waters off Florida that target blacktips during their migrations, when the schools are close to shore in clear waters. Aircraft are often used to direct net boats to the migrating schools, often resulting in the trapping of large schools. The species is pursued commercially throughout its range and is targeted because it is often found in shallow coastal waters. Their habit of migrating in large schools along shorelines could make this species extremely vulnerable to organized drift gillnet fisheries.

Essential Fish Habitat for Blacktip Shark

- **Neonate/YOY (≤75 cm TL):** Coastal areas in the Gulf of Mexico from Texas through the Florida Keys. Please refer to Figure 5.38 for detailed EFH map.

- **Juvenile (76 to 136 cm TL):** Coastal areas in the Gulf of Mexico from Texas through the Florida Keys. In the Atlantic from the mid-east coast of Florida to the mid-coast of South Carolina, southern North Carolina and areas around Cape Lookout. Please refer to Figure 5.39 for detailed EFH map.

- **Adult (≥137 cm TL):** Coastal areas in the Gulf of Mexico from Texas through the Florida Keys. In the Atlantic from the mid-east coast of Florida to the mid-coast of South Carolina, southern North Carolina and areas around Cape Lookout. Please refer to Figure 5.40 for detailed EFH map.

5.1.4.6.3 Bull Shark

Bull shark (*Carcharhinus leucas*) The bull shark is a large, shallow water shark that is cosmopolitan in warm seas and estuaries (Castro, 1983). It often enters fresh water, and may penetrate hundreds of kilometers upstream; bull sharks are the only shark species that is known to be physiologically capable of spending extended periods in freshwater (Thorson *et al*., 1973).

Reproductive potential: Males mature 210 to 220 cm TL or 14 to 15 years of age, while females mature >225 cm TL or 18+ years of age (Branstetter and Stiles, 1987). Growth parameters have been estimated by Branstetter and Stiles (1987) as L_∞ = 285 cm TL, K= 0.076, t_0= -3.0 yr. Recent work by Neer *et al*. (2005) estimated von Bertalanffy growth model parameters as L_∞ = 300.7 cm FL, K= 0.042, t_0= -6.84 yr and estimated the theoretical longevity of bull sharks as 38.6 yrs. Bull sharks have been documented to have a wide range in size-at-birth from 62 cm FL off South Africa, 63.5 to 68 cm FL for bull sharks in Brazilian waters, 51 to 67.6 cm FL for a animals collected off Florida, and 55.5 cm to 66 cm for pups collected off Louisiana (Sadowsky, 1971; Clark and von Schmidt, 1965; Cliff and Dudley, 1991). However, simulations incorporating variability in size-at-birth produced similar von Bertalanffy growth model results as those using a fixed size-at-birth (Neer *et al*., 2005). Jensen (1976) stated that litters ranged from one to ten pups and that the average size was 5.5 pups. The gestation period is estimated at ten to eleven months (Clark and von Schmidt, 1965). The length of the reproductive cycle has not been published, but it is probably biennial. In the United States the nursery areas are in low salinity estuaries of the Gulf of Mexico Coast (Castro, 1983) and the coastal lagoons of the east coast of Florida (Snelson *et al.,* 1984).

On the east coast of Florida, juvenile bull sharks ranging from 75.4 to 146 cm TL were collected from northern Cape Canaveral (latitude 28°40'N) south to the Jupiter Island area (latitude 27°04'N) in water depths of 3 to 11 m (Adams and Paperno, 2007). On the west coast of Florida, young bull sharks are relatively common during the warm months along Florida's Gulf coast and have been documented by the Mote CSR in the areas of Yankeetown, Tampa Bay, Charlotte Harbor, Ten Thousand Islands, and the Keys as well as in Texas coastal waters (Hueter and Tyminski, 2007). The primary nurseries for this species are typically in lower salinity estuaries and river mouths (as low as 0.9 ppt) (Hueter and Tyminski, 2007). Neonate bull sharks have been found in Yankeetown, Tampa Bay, Charlotte Harbor, Ten Thousand Islands, and Texas between the months of May and August (Hueter and Tyminski, 2007). Young-of-the-year bull sharks are found in these same areas throughout the warm months and remain in these primary nurseries until as late as November or until water temperatures fall to about 21°C (Hueter and Tyminski, 2007). However, first-year bull sharks have been documented in Florida estuaries at temperatures as low as 16.4°C, returning to these nursery areas the following spring as early as March. Thus, these same Florida areas (Yankeetown, Tampa Bay, Charlotte Harbor, Ten Thousand Islands, and the Keys) may also function as secondary nurseries for the bull shark (Hueter and Tyminski, 2007). Older juveniles return to these nursery areas in the spring as early as April and remain in the bays throughout the summer before undertaking their fall migration in October and November (Hueter and Tyminski, 2007). Texas bull sharks show a similar temporal pattern (Hueter and Tyminski, 2007); although older juvenile bull sharks utilize estuarine nursery areas (1.7 to 41.1 ppt), they do not appear to venture as far into freshwater as the neonates and young-of-the-year (Hueter and Tyminski, 2007). Additionally, young-of-the-year and older juvenile bull sharks have been found in the warm water effluents of Tampa Bay and Yankeetown power plants during the winter months (Hueter and Tyminski, 2007). Presumably, these sharks become entrapped within these warm water plumes when the temperature of the surrounding water falls below the sharks' tolerance level, but definitive data are lacking (Hueter and Tyminski, 2007). Steiner *et al*. (2007) found sharks did not travel far between capture and recapture locations, indicating a relatively low rate of movement of the bull sharks within the estuary. In addition, adult female bull sharks may enter the Ten Thousand Islands estuary to give birth (Steiner *et al*., 2007).

Other work by Simpendorfer *et al*. (2005) found neonate and young-of-the-year animals in the Caloosahatchee River, San Carlos Bay, and Pine Island Sound on the west coast of Florida. In this river system, small individuals were found in the Caloosahatchee River and larger individuals were found in the Pine Island Sound area; size class segregation was thought to minimize intra-specific predation. Cliff and Dudley (1991) reported a shift in diet as size increases, increasing from teleosts to elasmobranches, which include feeding on juveniles of their own and other species such as juvenile blacktip sharks (Oguri 1964; Tuma 1976; Cliff and Dudley 1991). Different size classes were also shown to prefer different salinity and temperature regimes where <1 year old individuals were most common in salinities between 7 and 17.5 ppt and were found in the highest temperatures (Simpendorfer *et al*. 2005). Work by Wiley and Simpendorfer (2007) also documented neonate and juvenile bull sharks within the Everglades

National Park (73 to 210 cm TL), suggesting that this may be a nursery ground for this species. In particular, sizes <150 cm were found in the Whitewater Bay region, but larger size classes of bull sharks occurred in coastal marine areas of the Everglades (Wiley and Simpendorfer, 2007). In the Everglades National Park, bull sharks were found in salinities < 25 ppt, but seemed to avoid salinities > 30 ppt, with most bull sharks being caught between 15 and 29 ppt. Bull sharks were also caught in water temperatures of 30 °C and higher and waters between 1.2 and 2.2 m in depth (Wiley and Simpendorfer, 2007).

Louisiana's coastal and inland estuarine waters are also important primary and secondary nursery areas for bull sharks. Blackburn *et al*. (2007) found bull sharks ranging from 44 to 136.2 cm FL collected in the interior of Lake Pontchartrain, the Pearl River system, Little Lake/Barataria Bay and its inland waters, the Terrebonne/Timbalier Bay system, and the Atchafalaya/Vermilion Bay system in the coastal waters off Louisiana. Neonates (sharks with FL ≤ 82.3 cm) and juveniles (sharks with FL ≥ 82.4 cm) were collected in all six estuarine environments, with most neonate and juvenile bull sharks being collected from Lake/Barataria Bay (Blackburn *et al*., 2007). The seasonal distribution of bull sharks in Louisiana appears most concentrated in the spring and summer months (Blackburn *et al*., 2007). Bull sharks were collected from March to September in salinities ranging from 0.0 to 32.1 ppt, water temperatures ranging from 15.0°C to 37.0°C, and turbidity ranging from 10 to 200 cm (Blackburn *et al*., 2007). Immature bull sharks have also been found in Mississippi Sound and Mobile Bay off the coasts of Mississippi and Alabama at salinities of 14 to 17.1 ppt (Parsons and Hoffmayer, 2007).

Impact of fisheries: The bull shark is a common coastal species that is fished in both artisanal and industrial/modern fisheries. Clark and von Schmidt (1965) found it to be the most common shark caught in their survey of the sharks of the central Gulf coast of Florida, accounting for 18 percent of the shark catch. Dodrill (1977) reported it to be the seventh most commonly taken shark at Melbourne Beach, Florida, composing 8.6 percent of all longline landings. Thorson (1976) recorded a marked decline of the Lake Nicaragua-Rio, San Juan population from 1963 to1974, resulting from a small-scale, but sustained commercial fishing operation. This fishery intensified in 1968, and by 1972 bull sharks in the area had become so scarce that Thorson (1976) predicted that any other developments would eliminate the bull shark from Lake Nicaragua. Russell (1993) indicated that the bull shark constituted three percent of the shark catch in the directed shark fishery in the U.S. Gulf of Mexico. Castillo (1992) referred to the species in Mexico as intensely exploited in both coasts." The bull shark is vulnerable to overfishing because of its slow growth, limited reproductive potential, and because it is pursued in numerous fisheries.

***Essential Fish Habitat for Bull Shark*:**

- **Neonate/YOY (≤95 cm TL):** Gulf of Mexico coastal areas along the Texas, and EFH patches off of Mississippi, the Florida Panhandle, and west coast of Florida; as well as the Atlantic mid-east coast of Florida. Please refer to Figure 5.41 for detailed EFH map.

- **Juveniles (96 to 219 cm TL):** Gulf of Mexico coastal areas along the Texas coast, eastern Louisiana to the Florida Panhandle, and the west coast of Florida through the

Florida Keys. Atlantic coastal areas from the mid-east coast of Florida to South Carolina. Please refer to Figure 5.42 for detailed EFH map.

- **Adults (≥220 cm TL):** Gulf of Mexico along the southern and mid-coast of Texas to western Louisiana, eastern Louisania to the Florida Keys. East coast of Florida to South Carolina in the Atlantic. Please refer to Figure 5.43 for detailed EFH map.

5.1.4.6.4 Caribbean Reef Shark

Caribbean reef shark *(Carcharhinus perezi)* Caribbean reef sharks ranges from North Carolina, Bermuda, and the east coast of Florida to southern Brazil, including the northern Gulf of Mexico and the Antilles (Garrick, 1982; Compagno, 1984; Jensen *et al*., 1995). This is a poorly known, bottom-dwelling species that inhabits shallow coastal waters, usually around coral reefs (Castro, 1983).

Reproductive potential: Males mature at about 150 to 170 cm TL (Pikitch *et al*., 2005) and females at about 200 cm TL. Pups are born at about 70 cm TL, litters consisting of four to six pups. The reproductive cycle is biennial (Castro, unpub.). The nurseries have not been described. However, Pikitch *et al*. (2005) have documented small individuals at Glover's Reef Marine Reserve in Belize where equal numbers of males and females are present from May to July suggesting that Glover's Reef could also be a mating ground for these species (Pikitch *et al*., 2005). Garla *et al*. (2006) found neonate and young-of-the-year Caribbean reef sharks at Fernando de Noronha Archipelago and Atol das Rocas off Brazil (Garla *et al*., 2006). Garla *et al*. (2006) found that parturition takes place at Atol das Rocas and Fernando de Noronha at the end of the dry season (February to possibly late April) and that immature Caribbean reef sharks are present within Fernando de Noronha Archipelago's insular shelf throughout most, if not all, of the year. Caribbean reef sharks have been found at the Flower Garden Banks in the northwestern Gulf of Mexico, and it has been suggested that this area may function as essential fish habitat for Caribbean reef sharks (Childs, 2000).

Based on acoustic tagging of Caribbean reef sharks at Glover's Reef Marine Reserve in Belize, Chapman *et al*. (2005) determined that effective no-take marine reserves need to be large (boundaries of at least tens of kilometers) and need to encompass not only diverse habitats (ocean reefs, seagrass flats, lagoons) but also the areas that connect them (*e.g.*, major channels). In addition, Chapman *et al*. (2005) documented for the first time that Caribbean reef sharks cross the pelagic zone between reefs, which underscores the need for reserve networks and regulation of pelagic fisheries in the conservation of this species.

***Essential Fish Habitat for Caribbean Reef Shark*:**

Note: At this time, insufficient data is available to differentiate EFH by size classes, therefore, EFH is the same for all life stages.

- **Neonate/YOY (≤66 cm TL):** Gulf of Mexico coastal areas along the mid- and southern west coast of Florida, and the Florida Keys. Atlantic coastal areas from the southern to mid-Florida coast. Puerto Rico and the Virgin Islands. Please refer to Figure 5.44 for detailed EFH map.

- **Juveniles (67 to 199 cm TL):** EFH have been combined for all life stages and are considered the same. Please refer to Figure 5.44 for detailed EFH map.

- **Adults (≥200 cm TL):** EFH have been combined for all life stages and are considered the same. Please refer to Figure 5.44 for detailed EFH map.

5.1.4.6.5 Dusky Shark

Dusky shark (*Carcharhinus obscurus*). The dusky shark is common in warm and temperate continental waters throughout the Atlantic, Pacific and Indian Oceans. It is a migratory species which moves north-south with the seasons. This is one of the larger species found from inshore waters to the outer reaches of continental shelves. It used to be important as a commercial species and a game fish, but is currently prohibited.

Reproductive potential: Males mature at 290 cm total length and reach at least 340 cm total length, while females mature at about 300 cm total length and reach up to 365 cm total length. Dusky sharks are one of the slowest growing requiem sharks. This species matures at approximately 19 to21 years and may live up to 45 years (Natanson *et al.* 1995). Litters consist of six to14 pups, which measure 85 to 90 cm TL at birth (Castro, 1983). The gestation period is believed to be about 16 months (Clark and von Schmidt, 1965), but this has not been confirmed. Natanson (1990) gave the following parameters for males L_{max}= 351 cm FL (420 cm total length), K= .047, t_o = !5.83; and females at L_{max}= 316 cm total length (378 cm total length), K= .061, t_o=-4.83. The growth rate is believed to be about ten cm/yr for the young and five cm/yr for the adults. Age and growth information can also be found in Natanson *et al.* (1995).

Dusky sharks exhibit viviparity (give birth to live young) and neonates often inhabit nursery areas in coastal waters. For example, Castro (1993b) reported that dusky sharks gave birth in Bulls Bay, South Carolina in April and May, while Musick and Colvocoresses (1986) stated that the species gives birth in the Chesapeake Bay, Maryland in June and July. Grubbs and Musick (2002) also noted that young dusky sharks use nearshore waters in Virginia as nursery areas, but that they rarely enter estuaries.

Impact of fisheries: The dusky shark has historically played an important role in the coastal shark fisheries. It is valued for its flesh as well as its fins which are sold overseas for use in shark fin soup. This species is often taken as bycatch in both the bottom and pelagic longline fisheries, making it highly vulnerable to overfishing. This species is currently prohibited and is a candidate for listing under the Endangered Species Act.

***Essential Fish Habitat for Dusky Shark*:**

Note: At this time, insufficient data is available to differentiate EFH between the juvenile and adult size classes, therefore, EFH is the same for those life stages.

- **Neonate/YOY (≤121 cm TL):** EFH patches in the Gulf of Mexico off southern Texas, Mississippi, the Florida Panhandle, mid-west coast of Florida, and Florida Keys. Atlantic east coast of Florida, and South Carolina to southern Cape Cod. Please refer to Figure 5.45 for detailed EFH map.

- **Juvenile (122 to 299 cm TL):** EFH patches in the central Gulf of Mexico, southern Texas, the Florida Panhandle, mid-west coast of Florida, and Florida Keys. Atlantic east coast of Florida, and South Carolina to southern Cape Cod. Please refer to Figure 5.46 for detailed EFH map.

- **Adult (≥300 cm TL):** EFH for juvenile and adult life stages have been combined and are considered the same. Please refer to Figure 5.46 for detailed EFH map.

5.1.4.6.6 Galapagos Shark

Galapagos shark (*Carcharhinus galapagensis*) The Galapagos shark is circumtropical in the open ocean and around oceanic islands (Castro, 1983). It is very similar to the dusky shark and is often mistaken for it, although the dusky shark prefers continental shores (Castro, 1983). The Galapagos shark is very seldom seen in U.S. waters. However, a few Galapagos sharks are undoubtedly caught off the east coast every year, which have probably been misidentified as dusky sharks.

Reproductive potential: Males reach maturity between 205 and 239 cm TL and females between 215 and 245 cm TL (Wetherbee *et al.*, 1996). This species is viviparous (Dulvy and Reynolds, 1997), and pups are born at slightly over 80 cm TL. Litters may range from four to16 pups with the average litter size being 8.7. Juveniles typically inhabit waters shallower than 82 feet (25 m), as these areas act as nursery grounds affording protection from cannibalism (Bester, 2005b). Although the gestation cycle is estimated to last about a year (Wetherbee *et al.*, 1996), the length of the reproductive cycle for this species is not known.

Impact of fisheries: The Galapagos shark is of little economic importance, however, the flesh of this species is considered to be of excellent quality for human consumption (Bester, 2005b).

***Essential Fish Habitat for Galapagos Shark*:**

- **Neonate/YOY (≤97 cm TL):** At this time, available information is insufficient for the identification of EFH for this life stage.

- **Juveniles (98-214 cm TL):** At this time, available information is insufficient for the identification of EFH for this life stage.

- **Adults (≥215 cm TL):** At this time, available information is insufficient for the identification of EFH for this life stage.

5.1.4.6.7 Lemon Shark

Lemon shark (*Negaprion brevirostris*) The lemon shark is common in the American tropics, inhabiting shallow coastal areas, especially around coral reefs. During migration, this species can be found in oceanic waters but tends to stay along the continental and insular shelves (Morgan, 2008). Lemon sharks are reported to use coastal mangroves as nursery habitats, although this is not well documented in the literature. There is evidence that two separate populations exist within the western Atlantic Ocean: one in the Caribbean and one in the Gulf of Mexico. The primary population in continental U.S. waters is found off south Florida, although adults stray north to the Carolinas and Virginia in the summer. Additional life history information can be found in Sundstrom *et al.* (2001) and Barker *et al.* (2005).

Reproductive potential: Lemon sharks are viviparous, *i.e*. they give birth to live free-swimming young. Adults typically mature around 228 cm TL (Springer, 1950b), at approximately 11.6 years for males and 12.7 years for females (Brown and Gruber, 1988). This species is described as slow growing and long-lived (at least 20 years of age) with the von Bertalanffy parameters: L_4 =317.65, K= .057, and t_o= -2.302 (Brown and Gruber, 1988). Lemon shark reproductive cycles are biennial (Castro, 1993b), mating occurs in shallow water during the spring months (Morgan, 2008), and gestation lasts ten (Springer, 1950b) to 12 months (Clark and von Schmidt, 1965). Litters typically consist of five to 17 pups, which measure about 64 cm TL at birth (Springer, 1950b; Clark and von Schmidt, 1965). The shallow waters around mangrove islands (Springer 1950b) off tropical Florida and the Bahamas have been shown to serve as nursery areas for this species. Lemon shark neonates have also been found in Tampa Bay, Florida during the month of May, at temperatures of 22.0° to 25.4°C, salinities of 26.8 to 32.6 ppt, and DO of 5.9 to 9.6 ml/l, while juveniles can be found over a wider area off western Florida and in a wider range of temperatures and salinities (Hueter and Tyminski, 2007).

Impact of fisheries: The lemon shark is targeted commercially and recreationally throughout its range. Lemon shark meat and fins are used for human consumption. Fins are marketed for shark-fin soup base, liver oil for vitamins, the carcass for fish meal, and the hides for leather (FishBase, 2008). Anecdotal evidence indicates that lemon sharks are vulnerable to local depletions.

***Essential Fish Habitat for Lemon Shark*:**

- **Neonate/YOY (≤86cm TL):** Gulf of Mexico coastal areas along the Texas mid-coast, mid-west coast of Florida, and the Florida Keys. Puerto Rico and Virgin Islands. Please refer to Figure 5.47 for detailed EFH map.

- **Juveniles (87 to 239 cm TL):** Gulf of Mexico coastal areas along Texas, eastern Louisiana, and the Florida Panhandle throught the Florida Keys. Atlantic east coast of Florida. Puerto Rico and Virgin Islands. Please refer to Figure 5.48 for detailed EFH map.

- **Adults (≥240 cm TL):** Gulf of Mexico coastal areas along the west coast of Florida through the Florida Keys. Southern and northern east coast of Florida in the Atlantic. Please refer to Figure 5.49 for detailed EFH map.

5.1.4.6.8 Narrowtooth Shark

Narrowtooth shark (*Carcharhinus brachyurus*) This is a coastal-pelagic species of widespread distribution in warm temperate waters throughout the world. In general, it is a temperate shark, absent or rare in tropical waters (Bass *et al.*, 1973). Although the species has been reported for the California coast by Kato *et al*. (1967) as *C. remotus*, and for the southwest

Atlantic, few data exist for the western north Atlantic. The narrowtooth shark commonly occupies a variety of habitats from freshwater and brackish areas of large rivers to shallow bays and estuaries. It has been found from the surf line to depths of up to 328 feet (100 m), but is believed to range deeper (Press, 2008).

Reproductive potential: Males mature between 200 and 220 cm TL, and females mature below 247 cm TL. The young are born at about 60 to 70 cm TL. Six pregnant females averaged 16 embryos, with a range of 13 to 20 pups per litter (Bass *et al.,* 1973). Walter and Ebert (1991) calculated age at sexual maturity at 13 to 19 years for males and 19 to 20 years for females. They commonly reach maturity at 205.7 to 236.2 cm TL and 226.1 to 243.8 cm TL for males and females, respectively (Press, 2008). Gestation is believed to last a year (Cliff and Dudley, 1992). The length of the reproductive cycle is not known, but it is probably biennial as it is for most large carcharhinid sharks. The maximum size for a narrowtooth shark is reported to be 292.1 cm TL. The age at maturity is 13 years old for males, and 20 years old for females and the maximum age is unknown.

The narrowtooth shark has a viviparous mode of reproduction, which means that embryos develop inside the uteri of the mother and are born live. It is believed that reproduction in narrowtooth sharks occurs biennially. According to the limited data that is available on the biology of this species, parturition in South Africa most likely occurs in June or July and litters range from 13 to 24 pups with an average of 15. Other studies have combined data from several locations and suggest varying parturition times from June to February. Gestation is estimated to last 12 months with the young approximately 59 to70 cm TL at birth. The narrowtooth shark utilizes inshore bays and coasts as nursery areas (Press, 2008).

Impact of fisheries: Because it appears to be a very slow growing carcharhinid (based on the unvalidated ages by Walter and Ebert (1991), the narrowtooth shark is probably vulnerable to overfishing.

***Essential Fish Habitat for Narrowtooth Shark*:**

- **Neonate:** At this time, available information is insufficient for the identification of EFH for this life stage.
- **Juveniles:** At this time, available information is insufficient for the identification of EFH for this life stage.
- **Adults:** At this time, available information is insufficient for the identification of EFH for this life stage.

5.1.4.6.9 Night Shark

Night shark (*Carcharhinus signatus*) This carcharhinid shark inhabits the waters of the western north Atlantic from Delaware to Brazil and the west coast of Africa. It is a tropical species that seldom strays northward. The night shark is typically found near outer continental shelves of subtropical waters at depths greater than 275 to 366 m during the day and about 183 m at night (Castro, 1983).

Reproductive potential: There is little information on night shark reproductive processes. Litters usually consist of 12 to 18 pups which measure 68 to 72 cm TL at birth (Castro, 1983). Length at maturity has been reported for females as 150 cm FL (178 cm TL) (Compagno, 1984). The nurseries remain undescribed. Hazin *et al.* (2000) and Santana and Lessa (2004) provide additional information on reproduction and age and growth, respectively. Back-calculated size at birth was 66.8 cm and maturity was reached at 180 to190 cm (age 8) for males and 200 to 205 cm (age ten) for females. Age composition, estimated from an age-length key, indicated that juveniles predominate in commercial catches, representing 74.3 percent of the catch. A growth rate of 25.4 cm/yr was estimated from birth to the first band (*i.e.*, juveniles grow 38 percent of their birth length during the first year), and a growth rate of 8.55 cm/yr was estimated for eight to ten year-old adults (Santana and Lessa, 2004).

Impact of fisheries: The night shark was abundant along the southeast coast of the United States and the northwest coast of Cuba before the development of the swordfish fishery of the 1970s. Although not targeted, night sharks make up a segment of the shark bycatch in the pelagic longline fishery. Historically, night sharks comprised a significant proportion of the artisanal Cuban shark fishery but today they are rarely caught. Although information from some fisheries has shown a decline in catches of night sharks, it is unclear whether this decline is due to changes in fishing tactics, market, or species identification. Despite the uncertainty in the decline, the night shark is currently listed as a species of concern (*i.e.*, candidate species) to the Endangered Species Act due to alleged declines in abundance resulting from fishing effort, *i.e.*, overutilization (Carlson *et al.*, 2008). Martinez (1947) stated that the Cuban shark fishery relied heavily on the night shark, which constituted 60 to 75 percent of the total shark catch, and that the average annual catch for 1937 to 1941 was 12,000 sharks. Guitart Manday (1975) documented a precipitous decline in night shark catches off the Cuban northwest coast during the years 1971 to 1973. Berkeley and Campos (1988) stated that this species represented 26.1 percent of all sharks caught in swordfish fisheries studied by them along the east coast of Florida from 1981 to 1983. Anecdotal evidence from commercial swordfish fishermen also indicates that in the late 1970s it was not unusual to have 50 to 80 dead night sharks, usually large gravid females, in every set from Florida to the Carolinas. During the 1970s, sports fishermen in south Florida often resorted to catching night sharks when other more desirable species (marlins) were not biting. The photographic record of sport fishing trophies landed shows that large night sharks were caught daily and landed at the Miami docks in the 1970s. Today, the species is rare along the southeast coast of the United States. The World Conservation Union (IUCN) currently lists night sharks globally as vulnerable based on population declines throughout its western Atlantic Ocean range due to target and bycatch exploitation by fisheries (Carlson *et al*., 2008).

***Essential Fish Habitat for Night Shark*:**

Note: At this time, insufficient data is available to differentiate EFH by size classes, therefore, EFH is the same for all life stages.

- **Neonate/YOY (≤72 cm TL):** In the Gulf of Mexico off Texas, Louisania, and the Florida Panhandle to the Florida Keys. Southern and mid-east coast of Florida and South Carolina to Delware in the Atlantic. Please refer to Figure 5.50 for detailed EFH map.

- **Juveniles (73 to 204 cm TL):** EFH have been combined for all life stages and are considered the same. Please refer to Figure 5.50 for detailed EFH map.

- **Adults (≥205 cm TL):** EFH have been combined for all life stages and are considered the same. Please refer to Figure 5.50 for detailed EFH map.

5.1.4.6.10 Sandbar Shark

Sandbar shark (*Carcharhinus plumbeus*) The sandbar shark is cosmopolitan in subtropical and warm temperate waters. It is a common species found in many coastal habitats. The North Atlantic population of sandbar sharks ranges from Cape Cod to the western Gulf of Mexico, and migrates seasonally, segregating by sex during much of the year (Conrath and Musick, 2007). It is a bottom-dwelling species most common in 20 to 55 m of water, but occasionally found at depths of about 200 m.

Reproductive potential: The sandbar shark is a slow growing species. Both sexes reach maturity at about 147 cm total length or approximately 5 feet (Merson, 1998). Estimates of age at maturity range from 15 to 16 years (Sminkey and Musick, 1995) to 29 to 30 years (Casey and Natanson, 1992), although 15 to 16 years is the commonly accepted age of maturity. The von Bertalanffy growth parameters were proposed for combined sexes are L_4= 186 cm FL (224 cm total length; 168 cm PCL), K= 0.046, t_o= -6.45 by Casey and Natanson (1992); and re-evaluated by Sminkey and Musick (1995) as L_4= 164 cm PCL (219 cm total length; 182 cm Fl), K= 0.089, and t_o= -3.8. Young are born at about 60 cm total length (smaller in the northern parts of the North American range) from March to July. Litters consist of one to 14 pups, with nine being the average (Springer, 1960). The gestation period lasts about a year and reproduction is biennial (Musick *et al.,* 1993). Hoff (1990) used an age at maturity of 15 years, a life span of 35 years, and a two-year reproductive cycle to calculate that each female may reproduce only ten times.

In the United States, sandbar shark nursery areas are typically in shallow coastal waters from Cape Canaveral, Florida (Springer, 1960), to Martha's Vineyard, Massachusetts. Delaware Bay, Delaware (McCandless *et al.*, 2002; 2007), Chesapeake Bay, Maryland (Grubbs and Musick, 2007), Great Bay, New Jersey (Merson and Pratt, 2002, 2007) and the waters off Cape Hatteras, North Carolina (Jensen *et al.*, 2002; Conrath and Muskick, 2007) are important primary and secondary nurseries. Primary nurseries are where parturition occurs and where neonate and young-of-the-year sharks are present, whereas secondary nurseries are generally utilized by older sharks following departure from primary nursery areas (Merson and Pratt 2001, 2007; McCandless *et al*., 2007). Size and sex data from surveys in waters of Nantucket Sound, Massachusetts indicate that this region also provides secondary nursery habitat for this species. Temperatures during periods when sandbar sharks were caught typically ranged from 20° to 24°C and depths from 2.4 to 6.4 m (Skomal, 2007). Neonates have been captured in Delaware Bay in late June. Young-of-the-year were present in Delaware Bay until early October when the temperature fell below 21°C. Grubbs and Musick (2007) reported that the principal nursery in Chesapeake Bay is limited to the southeastern portion of the estuary, where salinity is great than 20.5 ppt and depth is greater than 5.5 m. Another nursery may exist along the west coast of Florida and along the northeast Gulf of Mexico. Hueter and Tyminski (2002) found neonates off

Yankeetown, Florida from April to July, in temperatures of 25.0° to 29.0°C and salinities of 20.4 to 25.9 ppt. Neonate sandbar sharks were found in an area between Indian Pass and St. Andrew Sound, Florida in June when the temperature had reached 25°C (Carlson, 2002).

Impact of fisheries: The sandbar shark is one of the most important commercial species in the shark fishery of the southeastern United States, along with blacktip sharks. It is a preferred species because of the high quality of its flesh and large fins. Commercial longline fishermen pursue sandbar stocks in their north-south migrations along the coast; their catches can be as much as 80 to 90 percent sandbar sharks in some areas.

U.S. Fishery Status: Stock assessments in 2006 indicated that the stock was overfished with overfishing occurring. As a result, in 2008 NMFS implemented Amendment 2 to the Consolidated HMS FMP, which greatly reduced fishing mortality on sandbar sharks. Currently the only directed fishing that is authorized on sandbar sharks is under the auspices of the shark research fishery. Sandbar sharks were also prohibited from retention in the recreational fishery beginning in 2008. It is considered highly vulnerable to overfishing because of its slow maturation and heavy fishing pressure, as evidenced in the catch-per-unit-effort (CPUE) declines in U.S. fisheries.

***Essential Fish Habitat for Sandbar Shark*:**

- **Neonate/YOY (≤78 cm total length):** Atlantic coastal areas along northeastern Florida to South Carolina, and Cape Lookout to Long Island, New York. Please refer to Figure 5.51 for detailed EFH map.

- **Juvenile (79 to 190 cm total length):** Eastern Louisiana to the Florida Keys in the Gulf of Mexico, and the east coast of Florida to southern New England in the Atlantic. Please refer to Figure 5.52 for detailed EFH map.

- **Adult (≥191 cm total length):** Eastern Louisiana to the Florida Keys in the Gulf of Mexico, and the east coast of Florida to southern New England in the Atlantic. Please refer to Figure 5.53 for detailed EFH map.

- **Habitat Areas of Particular Concern (HAPC):** Important nursery and pupping grounds have been identified in shallow areas and at the mouth of Great Bay, New Jersey, in lower and middle Delaware Bay, Deleware, lower Chesapeake Bay, Maryland, and near the Outer Banks, North Carolina, and in areas of Pamlico Sound and adjacent to Hatteras and Ocracoke Islands, North Carolina, and offshore of those islands (Figure 5.54).

5.1.4.6.11 Silky Shark

Silky shark (*Carcharhinus falciformis*) The silky shark inhabits warm, tropical, and subtropical waters throughout the world. Primarily, the silky is an offshore, epipelagic shark, but juveniles venture inshore during the summer. In the western Atlantic, it ranges from Massachusetts to Brazil including the Gulf of Mexico and Caribbean Sea (Knickle, 2008).

Tagging data indicate movement of silky sharks between the Gulf of Mexico and the U.S. Atlantic coast (Kohler *et al*., 1998).

Reproductive potential: Data on the silky shark are variable. There is a strong possibility that different populations may vary in their reproductive potential. Litters range from six to 14 pups, which measure 75 to 80 cm TL at birth (Castro, 1983). According to Bonfil *et al.* (1993), the silky shark in the Campeche Bank, Mexico, has a 12-month gestation period, giving birth to ten to 14 pups, with an average of 76 cm TL during late spring and early summer, possibly every two years. Males mature at 225 cm TL (about ten years) and females at 232 to 245 cm TL (>12 yrs of age). The von Bertanffy parameters estimated by Bonfil *et al.* (1993) are: L_4 = 311 cm TL, K= 0.101, and t_o= -2.718 yr. Maximum ages were 20+ years for males and 22+ years for females (Bonfil *et al.,* 1993). Springer (1967) describes reefs on the outer continental shelf as nursery areas. Bonfil *et al,* (1993) mentions the Campeche Bank as a prime nursery area in the Atlantic. Data suggest a size at first sexual maturity for the silky shark in the equatorial Atlantic of about 230 cm, for females, and from 210 to 230 cm, for males. The monthly distribution of female sexual stages do not show any clear trend, suggesting that, at least close to the equator, the species might not have a clear seasonal cycle of gestation. Litter size ranged from 4 to 15, with a sex ratio of embryos equal to 1:1.4 male: female (Hazin *et al*., 2007)

Impact of Fisheries: The silky shark is caught frequently in swordfish and tuna fisheries. Berkeley and Campos (1988) found it to constitute 27.2 percent of all sharks caught in swordfish vessels off the east coast of Florida from 1981 to 1983. Bonfil *et al,* (1993) considered that the life-history characteristics of slow growth, late maturation, and limited offspring may make it vulnerable to overfishing. In all probability, local stocks of this species cannot support sustained heavy fishing pressure. Silky sharks were prohibited from retention in the recreational fishery beginning in 2008.

***Essential Fish Habitat for Silky Shark*:**

Note: At this time, insufficient data is available to differentiate EFH by size classes, therefore, EFH is the same for all life stages.

- **Neonate/YOY (≤92 cm TL):** In the Gulf of Mexico from the southern coast of Texas across the central Gulf, and from eastern Louisiana to the Florida Keys. Atlantic east coast from Florida to New Jersey. Please see Figure 5.55 for detailed EFH map.

- **Juveniles (93 to 244 cm TL):** EFH for all life stages have been combined and are considered the same. Please refer to Figure 5.55 for detailed EFH map.

- **Adults (≥245 cm TL):** EFH for all life stages have been combined and are considered the same. Please refer to Figure 5.55 for detailed EFH map.

5.1.4.6.12 Spinner Shark

Spinner shark (*Carcharhinus brevipinna*) The spinner shark is a common, coastal-pelagic, warm-temperate and tropical shark of the continental and insular shelves (Compagno, 1984). It is a common inhabitant of inshore waters less than 30 m deep, but ranges offshore to at least 150 m deep (Aubrey and Snelson, 2007). The spinner shark is often seen in schools, leaping out of the water while spinning. It is a migratory species, but its patterns are poorly known. Off the eastern United States it ranges from Virginia to Florida and in the Gulf of Mexico.

Predator-prey Relationships: A study on shark foraging ecology conducted by Bethea *et al.* (2004) in Apalachicola Bay, Florida, showed that young-of-the-year and juvenile spinner sharks fed mainly on teleosts, with Clupeids (mostly *Brevoortia* spp.) the dominant prey.

Reproductive potential: Males mature at 130 cm TL or four to five years, females mature at 150 to 155 cm TL or seven to eight years (Branstetter, 1987a). According to Branstetter (1987a), males reach maximum size at ten to 15 years and females at 15 to 20 years. However, he added the caveat that as sharks near their maximum size, their growth is slower, therefore, their maximum ages may be much greater. Branstetter (1987a) gave von Bertalanffy parameters for both sexes were: L_4 = 214 cm, K= 0.212, t_o = -1.94 yr. The ages have not been validated. According to Garrick (1982), the species reaches a maximum size of 278 cm TL. The spinner shark has a biennial reproductive cycle (Castro, 1993c), young born at 60 to 75 cm TL in late May and early June. The litters usually consist of six to 12 pups (Castro, 1983). In the Carolinas, the nursery areas are in shallow coastal waters (Castro, 1993c); however, the extent of the nursery areas is unknown. Hueter and Tyminski (2007) found juveniles along the west coast of Florida in temperatures of 21.9° to 30.1°C, salinities of 21.0 to 36.2 ppt, and DO 3.5 to 5.0 ml/l. The primary pupping grounds for the species in Florida is not clearly defined (Hueter and Tyminski, 2007). However, Apalachicola Bay, Florida has been identified as a nursery area for spinner sharks (Bethea *et al.*, 2004). Adult sharks move into this system in late May to early June to give birth. Young-of-the-year are present in the area by the end of June and remain until fall when they migrate offshore. Aubrey and Snelson (2007) reported spinner shark nursery areas in shallow inshore waters of the central east coast of Florida between Cape Canaveral and Cocoa Beach. These were sandy bottom areas where sea surface temperatures ranged from 24.5° to 30.5°C and mean salinity was 36 ppt. This area approximates the relatively unprotected littoral and surf zones and adjacent bays and nurseries that have been previously reported for spinner sharks. However, this is the first nursery area identified for the spinner shark on the east coast of Florida, and only one of two on the east coast of the United States, (the other being in the Carolinas) (Aubrey and Snelson, 2007). Other nursery areas for the spinner shark have been found along the beaches and in the bays of Texas during the summer months, and juvenile spinner sharks also have been found in the coastal waters of Mississippi and Louisiana and along the beaches of Tampa Bay in Florida. Larger juveniles have been captured off Sarasota and Tampa Bay (Hueter and Tyminski, 2007). Additional life history information on the spinner shark can be found in Allen and Wintner (2002), Capape *et al.* (2003), Bethea *et al.* (2004), Carlson and Baremore (2005), and Joung *et al.* (2005).

Impact of fisheries: The spinner shark is similar in reproductive potential and habits to the blacktip shark, and its vulnerability to fisheries is probably very similar to that of the blacktip. In fact, the blacktip-spinner complex is a commonly used category that combines the landings of these two species because of species similarities and difficulties in distinguishing the two species.

***Essential Fish Habitat for Spinner Shark*:**

- **Neonate/YOY (≤70 cm TL):** Coastal areas in the Gulf of Mexico along Texas, eastern Louisania, the Florida Panhandle, Florida west coast, and the Florida Keys; and in Atlantic coastal areas along the east coast of Florida to southern North Carolina. Please refer to Figure 5.56 for detailed EFH map.

- **Juveniles (71 to 179 cm TL):** Gulf of Mexico coastal areas from Texas to the Florida Panhandle, and the west coast of Florida to the Florida Keys. Atlantic east coast of Florida to the mid-coast of Georgia, and the mid-coast of South Carolina through North Carolina, with EFH patches off Virginia and Maryland. Please refer to Figure 5.57 for detailed EFH map.

- **Adults (≥180 cm TL):** Off of southern Texas and and Louisania, and from eastern Louisiana through the Florida Keys in the Gulf of Mexico. Atlantic east coast of Florida to southern Georgia, and off South Carolina and the Outer Banks. Please refer to Figure 5.58 for detailed EFH map.

5.1.4.6.13 Tiger Shark

Tiger shark (*Galeocerdo cuvier*). The tiger shark inhabits warm waters in both deep oceanic and shallow coastal regions (Castro, 1983). In the western North Atlantic Ocean, tiger sharks occur in coastal and offshore waters from approximately 40° to 0°N, and have been documented to make transoceanic migrations (Driggers *et al.*, 2008). In the North Atlantic they are rarely encountered north of the Mid-Atlantic Bight (Skomal, 2007). A study by Heithaus *et al.*, (2002) on tiger sharks in Australia showed they preferred shallow seagrass habitats, and this was influenced by prey availability, which is greater in shallow waters. The tiger shark is one of the larger species of sharks, reaching over 550 cm TL and over 900 kg. Its characteristic tiger-like markings and unique teeth make it one of the easiest sharks to identify. It is one of the most dangerous sharks and is believed to be responsible for many attacks on humans (Castro, 1983).

Reproductive potential: Tiger sharks mature at about 290 cm TL (Castro, 1983; Simpfendorfer, 1992). The pups measure 68 to 85 cm TL at birth. Reproduction is viviparous. Litters are large, usually consisting of 35 to 55 pups (Castro, 1983). According to Branstetter *et al.* (1987), males mature in seven years and females in ten years, and the oldest males and females were 15 and 16 years of age. The ages have not been validated. Branstetter *et al.* (1987) gave the growth parameters for an Atlantic sample as L_4 = 440 cm TL, K= 0.107, and t_o= -1.13 years, and for a Gulf of Mexico sample as L_4 = 388 cm TL, K= 0.184, and t_o= -0.184. There is little data on the length of the reproductive cycle. Simpfendorfer (1992) stated that the females do not produce a litter each year. The length of the gestation period is also uncertain. Clark and von Schmidt (1965) stated that the gestation period may be slightly over a year, given that many large carcharhinid sharks have biennial reproduction and year-long gestation periods. However, tiger shark investigations off Hawaii conducted by Whitney and Crow (2007) indicated that female tiger sharks there give birth only once every three years with a gestation period of 15 to16 months, beginning in June/July with pups born in September-October. More recent age and growth information on the tiger shark can also be found in Natanson *et al.* (1998) and Wintner and Dudley (2000). The nurseries for the tiger shark appear to be in offshore areas, but they have not been well described. Natanson *et al*. (1998) reported that nursery areas in the western North Atlantic Ocean occur at approximately 35°N and from 33° 45' to 29° 20'N along the east coast of the United States, out to a depth of 100 m. Driggers *et al* (2008), however, concluded from their investigations from 1995 through 2006, that tiger sharks in the western North Atlantic Ocean do not use specific areas as nurseries, although it appears that parturition occurs over a broad range, with areas of high neonate abundance that could be considered important pupping areas within a range extending from 27° to 35°N, larger than previously reported by Natanson *et al*. (1998), with the region from 31° to 33°N probably representing the most important pupping areas. Although neonate tiger sharks are frequently caught in the northern Gulf of Mexico, the locations of pupping or nursery areas in this basin have not been identified (Driggers *et al*., 2008). However, Driggers *et al*. (2008) found areas of highest abundance of tiger shark neonates to be between 83° and 88°W and 93° and 95°W. Hueter and Tyminski (2007) report young-of-the-year collected during surveys in water depths 20 to50 m in July and August along the Louisiana, Mississippi, Alabama, and Florida coasts, and older juveniles occasionally along the central Florida Gulf coast.

Impact of Fisheries: This species is frequently caught in coastal shark fisheries but is usually discarded due to low fin and meat value.

***Essential Fish Habitat for Tiger Shark*:**

- **Neonate/YOY (≤204cm TL):** Off Texas, western Lousiania, and the Florida Panhandle in the Gulf of Mexico. In the Atlantic from the mid-east coast of Florida to Virgina. Please refer to Figure 5.59 for detailed EFH map.

- **Juveniles (205 to 319 cm TL):** In the central Gulf of Mexico and off Texas and Louisiana, and from Mississippi through the Florida Keys. Atlantic east coast from Florida to New England. Please refer to Figure 5.60 for detailed EFH map.

- **Adults (≥320 cm TL):** In the Gulf of Mexico, from Texas to the west coast of Florida, and the Florida Keys. Atlantic east coast from Florida to southern New England. Please refer to Figure 5.61 for detailed EFH map.

5.1.4.7 Sand Tiger Sharks

5.1.4.7.1 Bigeye Sandtiger Shark

Bigeye sand tiger (*Odontaspis noronhai*) This is one of the rarest large sharks. Its large eyes and uniform dark coloration indicate that it is a deep-water species. The few catch records that exist indicate that it frequents the upper layers of the water column at night. The species was originally described based on a specimen from Madeira Beach, Florida. A few specimens were caught at depths of 600 to 1,000 m off Brazil (Compagno, 1984). A 321 cm TL immature female was caught in the Gulf of Mexico, about 70 miles east of Port Isabel, TX in 1984. Another specimen was caught in the tropical Atlantic (5° N; 35°W) at a depth of about 100 m where the water was about 3,600 m deep. These appear to be all the records for the species. Nothing is known of its habits. Possession of this species is prohibited in Atlantic waters of the United States.

***Essential Fish Habitat for Bigeye Sand Tiger Shark*:**

- **Neonate/YOY:** At this time, available information is insufficient for the identification of EFH for this life stage.

- **Juveniles:** At this time, available information is insufficient for the identification of EFH for this life stage.

- **Adults:** At this time, available information is insufficient for the identification of EFH for this life stage.

5.1.4.7.2 Sandtiger Shark

Sand tiger shark (*Carcharias taurus*) The sand tiger is a large, coastal species found in tropical and warm temperate waters throughout the world. It is often found in very shallow water (4 m) (Castro, 1983). It is the most popular large shark in aquaria, because, unlike most sharks, it survives easily in captivity. It has been fished for its flesh and fins in coastal longline fisheries, although possession of this species in Atlantic waters of the United States is now prohibited. In the northwestern Atlantic, mature sand tiger males and juveniles occur between Cape Cod and Cape Hatteras while mature and pregnant females inhabit the more southern waters between Cape Hatteras and Florida (Lucifora *et al.*, 2002)

Reproductive potential: According to Gilmore (1983), males mature at about 191.5 cm TL. According to Branstetter and Musick (1994), males reach maturity at 190 to 195 cm TL or four to five years and females at more than 220 cm TL or six years. The largest immature female seen by J. Castro was 225 cm TL and the smallest gravid female was 229 cm TL, suggesting that maturity is reached at 225 to 229 cm TL. The oldest fish in Branstetter and Musick's (1994) sample of 55 sharks was 10.5 years old, an age that has been exceeded in captivity (Govender *et al.*, 1991). The von Bertalanffy parameters, according to Branstetter and Musick (1994), are for males: L_{max}= 301 cm, K= 0.17, and t_o= -2.25; and for females: L_{max}= 323 cm, K= 0.14, and t_o= -2.56 yrs. Gilmore (1983) gave growth rates of 19 to 24 cm/yr for the first years of life of two juveniles born in captivity. The sand tiger has an extremely limited reproductive potential, producing only two young per litter (Springer, 1948). Reproduction is viviparous (Lucifora *et al.*, 2002). Ecological aspects of reproduction, including the timing and location of reproductive events, gestation, and nursery grounds are unknown through most of the sand tiger shark range, although information on some aspects of the reproductive ecology is available for the Northwest Atlantic Ocean (Lucifora *et al*., 2002). In North America the sand tiger gives birth in March and April to two young that measure about 100 cm TL. Parturition (birth of the young) is believed to occur in winter in the southern portions of its range, and the neonates migrate northward to summer nurseries. The nursery areas are the following Mid-Atlantic Bight estuaries: Chesapeake, Delaware, Sandy Hook, and Narrangansett Bays as well as coastal sounds. Branstetter and Musick (1994) suggested that the reproductive cycle is biennial, but other evidence suggests annual parturition. Additional information on the sand tiger shark may be found in Gelsleichter *et al.* (1999) and Lucifora *et al.* (2002).

Impact of fisheries: The species is extremely vulnerable to overfishing because it congregates in coastal areas in large numbers during the mating season. These aggregations are attractive to fishermen, although the effects of fishing these aggregations probably contribute to local declines in the population abundance. Its limited fecundity (two pups per litter) probably contributes to its vulnerability. In the United States there was a very severe population decline in the early 1990s, with sand tigers nearly disappearing from North Carolina and Florida waters. Musick *et al.*, (1993) documented a decrease in the Chesapeake Bight region of the U.S. Mid-Atlantic coast. In 1997, NMFS prohibited possession of this species in U.S. Atlantic waters.

***Essential Fish Habitat for Sand Tiger Shark*:**

- **Neonate/YOY (≤129cm TL):** Along the Atlantic east coast from northern Florida to Cape Cod. Please refer to Figure 5.62 for detailed EFH map.

- **Juveniles (130 to 229 cm TL):** Mid-east coast of Florida, North Carolina to mid-New Jersey coast. Please refer to Figure 5.63 for detailed EFH map.

- **Adults (≥230 cm TL):** Atlantic east coast along northern Florida, South Carolina, southern North Carolina, and the Outer Banks to New Jersey. Please refer to Figure 5.64 for detailed EFH map.

5.1.4.8 Whale Sharks

Whale shark (*Rhincodon typus*) The whale shark is a sluggish, pelagic filter feeder, often seen swimming on the surface. It is the largest fish in the oceans, reaching lengths of 1,210 cm TL and perhaps longer. It is found throughout all tropical seas, usually far offshore (Castro, 1983).

Predator-prey relationships: There are very few observations of aggregations of whale sharks. Feeding aggregations of whale sharks have been reported in the Atlantic, Indian and Pacific Oceans, typically aggregating in areas of high biological activity (Burks *et al*., 2006). Whale sharks have been observed by Burks *et al*. (2006) in the northern Gulf of Mexico where they appeared to be more abundant in the western region than in the eastern. Over the course of their 1989-1998 study, 119 whale sharks were observed in the northern Gulf, 45 of which were observed in aggregations. Two whale sharks were observed at the head of DeSoto Canyon, an upwelling area south of the Florida panhandle. Hoffmayer *et al*. (2005) also reported a large aggregation of 30 to 100 individuals in the same area. In 2006, Hoffmayer *et al*. (2007) observed an aggregation of 16 whale sharks in the north central Gulf of Mexico, west of the Mississippi River Delta feeding on recently spawned little tunny eggs, by skimming the surface of the water as they swam with their lower jaw positioned slightly under the surface. This represents the first confirmed observation of a feeding aggregation of whale sharks in the Gulf of Mexico. The estimated length of the whale sharks ranged from 6.0 to 12.0 m TL, with most being greater than 8.0 m TL.

Reproductive potential: For many years the whale shark was believed to be oviparous, based on a presumably aborted egg case trawled from the Gulf of Mexico many years ago. Recent discoveries (Joung *et al.,* 1996) proved the whale shark to be viviparous and the most prolific of all sharks. The only gravid female examined carried 300 young in several stages of development. The embryos measured 580 to 640 mm TL, the largest appearing ready for birth.

The length of the reproductive cycle is unknown, but is probably biennial such as the closely related nurse shark (*Ginglymostoma cirratum*) and most other large sharks (Castro, 1996). Based on unpublished information on the growth rate of one surviving embryo from a female reported by Joung *et al*. (1996), the whale shark may be the fastest growing shark. Only a handful of small juveniles have ever been caught, probably because of the extremely fast growth rate or high mortality rate of juveniles. The location of the whale shark nurseries is unknown. Additional life history information can be found in Chang *et al.* (1997), Colman (1997), and Wintner (2000).

Impact of fisheries: There are very few observations of aggregations of whale sharks. The range of the whale shark may be extremely vast, perhaps encompassing entire ocean basins. Thus it may be necessary to consider whale shark fisheries on an ocean-wide perspective. There have been a few small fisheries for whale sharks in India, the Philippines, and Taiwan, but it is of little commercial importance elsewhere. The whale shark used to be fished for its flesh, but presently the fins and oil are also used. Generally, the size of the whale shark safeguards it from most fisheries. Records of the Taiwanese fishery demonstrate that whale sharks, like most elasmobranchs, are susceptible to overfishing. In 1997, NMFS prohibited possession of this species in U.S. Atlantic waters.

***Essential Fish Habitat for Whale Shark*:**

Note: At this time, insufficient data is available to differentiate EFH by size classes, therefore, EFH is the same for all life stages.

- **Neonate/YOY:** Central Gulf of Mexico from Texas to the Florida Panhandle. Please refer to Figure 5.65 for detailed EFH map.

- **Juveniles:** EFH for all life stages have been combined and are considered the same. Please refer to Figure 5.65 for detailed EFH map.

- **Adults:** EFH for all life stages have been combined and are considered the same. Please refer to Figure 5.65 for detailed EFH map.

5.1.5 Small Coastal Sharks

5.1.5.1 Angel Sharks

Atlantic angel shark *(Squatina dumeril)* The angel shark is a flattened shark that resembles a ray. It is a benthic species inhabiting coastal waters of the United States from Massachusetts to the Florida Keys, the Gulf of Mexico, and the Caribbean. It is common from southern New England to the Maryland coast (Castro, 1983).

Reproductive potential: Maturity is probably reached at a length of 90 to 105 cm TL. The pups measure 28 to 30 cm TL at birth. Up to 16 pups in one litter have been observed (Castro, 1983). Very little is known about its biology.

***Essential Fish Habitat for Atlantic Angel Shark*:**

Note: At this time, insufficient data is available to differentiate EFH between the juvenile and adult size classes, therefore, EFH is the same for those life stages.

- **Neonate/YOY (≤31 cm TL):** Insufficient data to determine EFH for this lifestage.
- **Juveniles (32 to 113 cm TL):** Off eastern Louisiana in the Gulf of Mexico. Atlantic east coast from Cape Lookout to the mid-coast of New Jersey. Please refer to Figure 5.66 for detailed EFH map.
- **Adults (≥113 cm TL):** EFH for adult and juvenile life stages have been combined and are considered the same. Please refer to Figure 5.66 for detailed EFH map.

5.1.5.2 Hammerhead Sharks

5.1.5.2.1 Bonnethead Shark

Bonnethead (*Sphyrna tiburo*) The bonnethead is a small hammerhead shark that inhabits shallow coastal waters where it frequents sandy or muddy bottoms. It is confined to the warm waters of the western hemisphere (Castro, 1983). Bonnethead sharks feed mainly on benthic prey such as crustaceans and mollusks. They do not appear to exhibit long distance migratory behavior and thus, little or no mixing of populations (Lombardi-Carlson, 2007).

Reproductive potential: Studies conducted along the Florida Gulf coast found female bonnethead sharks in some locations to have a slower growth rate than males and significant differences in size at maturity (Lombardi-Carlson, 2007). Parsons (1993) reported males maturing at about 70 cm TL, and females at about 85 cm TL. Litters consist of eight to12 pups, with the young measuring 27 to 35 cm TL at birth (Castro, 1983; Parsons, 1993). Parsons (1993) estimated the gestation period of two Florida populations at 4.5 to 5 months, one of the shortest gestation periods known for sharks. The reproductive cycle is annual (Castro, pers. obs.). Hueter (Heuter and Tyminski, 2007) found young-of-the-year and juveniles in the west coast of Florida at temperatures of 16.1° to 31.5°C, salinities of 16.5 to 36.1 ppt, and DO of 2.9 to 9.4 ml/l. Additional life history information can be found in Cortés *et al.* (1996), Cortés and Parsons (1996), Cortés *et al.* (1996), Carlson and Parsons (1997), Lessa and Almeida (1998), Marquez-Farias *et al.* (1998), Carlson *et al.* (1999), and Lombardi-Carlson *et al.* (2003).

Impact of fisheries: The bonnethead is at a lesser risk of overfishing because it is a fast growing species that reproduces annually and, due to its small size, is generally not targeted by commercial fisheries. Although bonnetheads are caught as bycatch in gillnet fisheries operating in shallow waters of the southeastern United States, many of these fisheries have been prohibited by various states, and therefore forced into deeper Federal waters where gillnets are less effective. Bonnethead bycatch in the U.S. Gulf of Mexico shrimp fishery seems to have remained stable over the last twenty years, from 1974 to 1994 (Pellegrin, 1996). This stock was determined to not be overfished with no overfishing occurring in 2008 (May 7, 2008; 73 FR 25665).

***Essential Fish Habitat for Bonnethead Shark*:**

- **Neonate/YOY (≤55 cm TL):** Gulf of Mexico along the coast of Texas, the Florida Panhandle, west coast of Florida, and Florida keys. Atlantic east coast from the mid-coast of Florida to South Carolina. Please refer to Figure 5.67 for detailed EFH map.

- **Juveniles (56 to 81 cm TL):** Gulf of Mexico along the coast of Texas, and Mississippi through the Florida Keys. Atlantic east coast from Florida to southern North Carolina. Please refer to Figure 5.68 for detailed EFH map.

- **Adults (≥82 cm TL):** Gulf of Mexico along the coast of Texas, and Mississippi through the Florida Keys. Atlantic east coast from Florida to Cape Lookout. Please refer to Figure 5.69 for detailed EFH map.

5.1.5.3 Requiem Sharks

5.1.5.3.1 Atlantic Sharpnose Shark

Atlantic sharpnose shark (*Rhizoprionodon terraenovae*) The Atlantic sharpnose shark is a small coastal carcharhinid, inhabiting the waters of the northeast coast of North America. It is a common year-round resident along the coasts of South Carolina, Florida, and in the Gulf of Mexico and an abundant summer migrant off Virginia. Frequently, these sharks are found in schools of uniform size and sex (Castro, 1983). The Atlantic sharpnose shark is the most abundant and exploited small coastal shark in U.S. Atlantic and Gulf of Mexico waters (Cortés, 2002). Atlantic sharpnose sharks are known to occur in a variety of coastal habitats in the Gulf of Mexico, some of which are proposed nursery areas (McCandless *et al*., 2002). In the northeast Gulf of Mexico, juvenile and mature Atlantic sharpnose sharks recruit to coastal waters beginning in April (Carlson and Brusher, 1999). Neonate sharks begin arriving in June (Carlson and Brusher, 1999; Carlson, 2002) and all life stages are present by late June and generally remain in-shore until they emigrate offshore in the fall (Carlson and Brusher, 1999).

Reproductive potential: The male Atlantic sharpnose sharks mature at around 65 to 80 cm TL and grow to 103 cm TL. The females mature at 85 to 90 cm TL and reach a length of 110 cm TL. Litters range from four to seven pups, which measure 29 to 32 cm TL (Castro, 1983). Mating is in late June; the gestation period is about 11 to 12 months (Castro and Wourms, 1993). The von Bertalanffy growth parameter estimates for the species in the Gulf of Mexico are L_4 = 110, K= 0.39, and t_o= -0.86 yr (Carlson and Baremore, 2003). Cortés (1995) calculated the population=s intrinsic rate of increase was, at best, r= .044, or a finite increase of e_r = 1.045, with a mean generation time of 5.8 years. Off South Carolina the young are born in late May and early June in shallow coastal waters (Castro and Wourms, 1993). Hueter and Tyminski (2007) found neonates off the west coast of Florida at Yankeetown and Anclote Key during the months of May to July. These neonates were found in temperatures of 24.0° to 30.7° , salinities of 22.8 to 33.7 ppt, and DO of 5.7 ml/l. Larger juveniles were also found in the area in temperatures of 17.2° to 33.3°C, salinities of 22.8 to 35.5 ppt, and DO of 4.5 to 8.6 ml/l.

Crooked Island Sound and the Apalachicola Bay system (*e.g.*, St. Vincent Island) have also been hypothesized to serve as nursery areas for Atlantic sharpnose sharks in the northeast Gulf of Mexico (Carlson, 2002; Bethea *et al*., 2006). Young of the year (YOY) and juveniles were found in temperatures of 21.8° to 31.7° C, salinities of 29.0 to 37.2, and DO of 2.7 to 6.9

ml/l. Habitat associations for YOY included mud, sand, and seagrass, and for juveniles sand, seagrass, and mud in descending order of predominance (Bethea *et al*., 2006). A recent study indicates that juvenile sharpnose sharks may not exhibit philopatry (tendancy to return to a specific location in order to breed or feed), but likely utilize a series of coastal bays and estuaries throughout the juvenile stage (Carlson *et al*., 2008).

Impact of fisheries: Large numbers of Atlantic sharpnose sharks are taken as bycatch in the U.S. shrimp trawling industry. The Texas Recreational Survey, NMFS Headboat Survey, and the U.S. Marine Recreational Fishing Statistics Survey have estimated a slow increase in the sharpnose fishery. The Atlantic sharpnose is a fast-growing species that reproduces yearly. In spite of being targeted by recreational fisheries and the large bycatch in the shrimp industry, the populations seem to be maintaining themselves. This stock was determined to not be overfished with no overfishing occurring in 2008 (May 7, 2008; 73 FR 25665).

Essential Fish Habitat for Atlantic Sharpnose:

- **Neonate/YOY (≤60 cm TL):** Gulf of Mexico coastal areas from Texas through the Florida Keys. Atlantic east coast from the mid-coast of Florida to Cape Hattaras. Please refer to Figure 5.70 for detailed EFH map.

- **Juveniles (61 to 71 cm TL):** Gulf of Mexico coastal areas from Texas through the Florida Keys. Atlantic east coast from the mid-coast of Florida to Cape Hattaras, and Delaware. Please refer to Figure 5.71 for detailed EFH map.

- **Adults (≥72 cm TL):** Gulf of Mexico coastal areas from Texas through the Florida Keys. Atlantic east coast from the mid-coast of Florida to Maryland. Please refer to Figure 5.72 for detailed EFH map.

5.1.5.3.2 Blacknose Shark

<u>Blacknose shark (*Carcharhinus acronotus*)</u> The blacknose shark is a common coastal species that inhabits the western North Atlantic from North Carolina to southeast Brazil (Bigelow and Schroeder, 1948). It is very abundant in coastal waters from the Carolinas to Florida and parts of the Gulf of Mexico during summer and fall (Castro, 1983). Parsons and Hoffmeyer (2007) state that the blacknose shark is an infrequent visitor to the shallow waters of the north-central Gulf of Mexico as they only captured five blacknose sharks between 1997 and 2000 using gillnet gear between Bay St. Louis, Mississippi to Perdido Bay, Alabama. Branstetter (1981) reported capturing this species on longline gear using longline gear further offshore, indicating that the blacknose shark is a deeper water resident and that the north-central Gulf of Mexico is not an important nursery area for this species. Schwartz (1984) hypothesized that there are two separate populations in the western Atlantic. Tag recapture data for this species show a strong philopatric behavior and an annual homing cycle (Heuter *et al*., 2005; Heuter and Tyminski, 2007).

Blacknose sharks were abundant in coastal waters off South Carolina from May to October with the first occurrence generally corresponding to the water temperature reaching

24°C with mating taking place in the late spring and early summer (Ulrich *et al*., 2007). There was no indication of habitat partitioning between adults and juveniles.

Reproductive potential: Maturity is reached at approximatley 100 cm TL. Litters consist of three to six pups, which measure 50 cm TL at birth (Castro, 1983). In the northern Atlantic Ocean, blacknose sharks reach sexual maturity at 4-5 years of age and give birth to an average 3.53 pups/year with a theoretical longevity of 19 years (Driggers *et al*., 2004a). In the Gulf of Mexico, female blacknose sharks mature at 3 years, have a theoretical longevity of 16 years, and give birth to 3.13 pups/year. Sulikowski *et al*. (2007) determined that reproductive activity peaks in May through July in the northern Gulf of Mexico. Males also have a higher theoretical longevity in the South Atlantic compared to the Gulf of Mexico (Driggers *et al*. 2004b). Furthermore, they also found that blacknose sharks have a clearly defined annual reproductive cycle in the Gulf of Mexico, compared to the South Atlantic where blacknose sharks have a biennial reproductive cycle. The species is common throughout the year off Florida, suggesting that part of the population may be non-migratory and that nursery areas may exist in Florida as well. Additional life history information can be found in Hazin *et al*. (2002).

Neonate (TL = 42-50 cm) and young-of-the-year (TL = 36-62 cm) blacknose sharks are found along GOM beaches in the Tampa Bay and Charlotte Harbor areas throughout June, migrating out of these areas in October (Hueter and Tyminski, 2007). Hueter and Tyminski (2007) found 13 neonates in the Ten Thousand Islands and off Sarasota in June and July at temperatures 29° to 30.1°C, salinities of 32.2 to 37.0 ppt, and DO of 6.5 ml/l. He also found young-of-the-year and juveniles at temperatures of 17.3° to 34°C, salinities of 25.0 to 37.0 ppt, and DO of 4.8 to 8.5 ml/l. Driggers (unpubl. data) extensively sampled coastal waters off South Carolina with handline gear over a 3-year period and did not observe any neonate blacknose sharks. However, 15 young-of-the-year blacknose sharks were collected in nearshore waters, suggesting the possibility that blacknose sharks make limited use of South Carolina's nearshore waters as a nursery (Ulrich *et al*., 2007).

Hueter and Tyminski (2007) found older juveniles of this species present along Gulf of Mexico beaches off Tampa Bay and Charlotte Harbor beginning in early March and remaining throughout the summery months. Juvenile blacknose sharks are rarely seen after October in the inshore gulf waters but are present in the Florida Keys in the winter months.

Impact of fisheries: Blacknose sharks are caught predominantly (36-70 percent) in the shrimp trawl fishery as bycatch. Landings also occur in commercial fisheries targeting sharks using longline and gillnet gear. Total annual removals of blacknose sharks averaged 82,500/year between 1993 and 2005. There are also significant landings of blacknose sharks in recreational fisheries. The 2007 stock assessment found estimates of biomass are below 1.0 and fishing mortality is greater than 1.0 indicating an overfished condition with overfishing continuing to occur. This stock was determined to be overfished with overfishing occurring in 2008 (May 7, 2008; 73 FR 25665).

Essential Fish Habitat for Blacknose Shark:

- **Neonate/YOY (≤55 cm TL):** In the Gulf of Mexico coastal areas along the Florida Panhandle and the northern and mid-west coast of Florida. Atlantic east coast along Georgia and South Carolina. Please refer to Figure 5.73 for detailed EFH map.

- **Juveniles (56 to 90 cm TL):** Off Texas and western Louisania, and Mississippi through the Florida Keys. Atlantic east coast from the mid-coast of Florida to Cape Hattaras. Please refer to Figure 5.74 for detailed EFH map.

- **Adults (≥91 cm TL):** Coastal Gulf of Mexico from the mid-coast of Texas through the Florida Keys. Atlantic east coast from the mid-coast of Florida to Cape Hattaras. Please refer to Figure 5.75 for detailed EFH map.

5.1.5.3.3 Caribbean Sharpnose Shark

Caribbean sharpnose shark (*Rhizoprionodon porosus*) The Atlantic sharpnose and the Caribbean sharpnose sharks are cognate species, or a species with a common origin, separable only by having different numbers of precaudal vertebrae (Springer, 1964). However, they have non-overlapping ranges, as the Caribbean sharpnose shark inhabits the Atlantic from 24°N to 35°S, while the Atlantic sharpnose is found at latitudes higher than 24°N. Their biology is very similar. The Caribbean sharpnose shark is a prohibited species; therefore, it can not be retained in commercial or recreational fisheries.

Essential Fish Habitat for Caribbean Sharpnose:

- **Neonate:** At this time, available information is insufficient for the identification of EFH for this life stage.

- **Juveniles:** At this time, available information is insufficient for the identification of EFH for this life stage.

- **Adults:** At this time, available information is insufficient for the identification of EFH for this life stage.

5.1.5.3.4 Finetooth Shark

Finetooth shark (*Carcharhinus isodon*) This is a common inshore species of the west Atlantic. It ranges from North Carolina to Brazil. It is abundant along the southeastern United States and the Gulf of Mexico (Castro, 1983). Sharks captured in the northeastern Gulf of Mexico ranged in size from 48 to 150 cm total length were generally found in water temperatures averaging 27.3°C and depths of 4.2 m (Carlson, 2002). Important nursery habitat is located in South Carolina (Ulrich and Riley, 2002; Abel *et al.*, 2007), Louisiana (Neer *et al.*, 2002), and off the coast of Texas (Jones and Grace, 2002). Adult, juvenile, and neonate specimens were collected in Winyah Bay and North Inlet, South Carolina at sites where salinity was at least 23.5 practical salinity units (psu) (Abel *et al.*, 2007). Ulrich *et al*. (2007) collected 965 finetooth sharks in waters adjacent to South Carolina ranging in size from 38.3 to 137 cm FL. They found that finetooth sharks generally arrive when water temperatures reach 22°C (mid-May) and remain until water temperatures drop to 20°C (October). In the Gulf of Mexico, 71 adult, neonate, and juvenile finetooth sharks were collected in Terrebonne and Timbalier Bays off the coast of Louisiana between 1999 and 2003 and were collected most frequently in the mid to late summer (Neer *et al*., 2007). Hendon and Hoffmeyer (2007) found that young of the year finetooth sharks seek different types of habitat than their older conspecifics in the eastern portion of the Mississippi sound region.

Reproductive potential: Males mature at about 130 cm total length and females mature at about 135 cm TL. The young measure 48 to 58 cm TL at birth. Litters range from two to six embryos, with an average of four. The gestation period lasts about a year, and the reproductive cycle is biennial. Some of the nurseries are in shallow coastal waters of South Carolina (Castro, 1993a; Abel *et al.*, 2007) and the Gulf of Mexico. Neer *et al*. (2007) collected pregnant female finetooth sharks in September in the vicinity of Terrebonne and Timbalier Bays off the coast of Louisiana, in temperatures ranging from 27.2° to 29.5°C, salinities between 27.1 and 29.8 ppt, and at depths between 2.1 and 8.2 m. Additional life history information can be found in Carlson *et al.* (2003), Hoffmayer and Parsons (2003), and Bethea *et al*. (2004).

Ulrich *et al*. (2007) collected neonate finetooth sharks with umbilical scars from late May until mid-June exclusively in estuarine waters in salinities ranging from 18 to 37 ppt. The abundance of neonate finetooth sharks in South Carolina's estuarine waters indicated that this area is a primary nursery area for this species (Ulrich *et al.*, 2007). Hueter and Tyminski (2007) collected a 63 cm (TL) young-of-the-year specimen in the vicinity of Yankeetown, Florida, suggesting that pupping takes place in that area. The average depth of this nursery area is 1.8-2.4 m with temperatures ranging between 17° to 32.4°C and salinities ranging from 15.8 to 34.9 parts per thousand. Neer *et al*. (2007) collected one neonate finetooth shark in May, which suggests that the vicinity of Terrebonne and Timbalier Bay's off coastal Louisiana are pupping grounds in early spring as well. Gurshin (2007) sampled 13 neonate finetooth sharks in estuarine waters in the vicinity of the lower Duplin River and Doboy Sound in the vicinity of the Sapelo Island National Estuarine Research Reserve off the coast of Georgia the summer (June-August) of 1997. Bottom water temperatures ranged from 25° to 30°C and salinities were between 24 to 26 ppt. Peak abundance occurred at the end of June and first half of July. Hendon and Hoffmeyer (2007) found that young-of-the-year finetooth sharks were abundant in the eastern portion of the Mississippi Sound, specifically off western Horn, Sound, and Round Islands.

Juvenile finetooth sharks were observed by Ulrich *et al*. (2007) in May through August off South Carolina in salinities ranging from 25 to 37 ppt. Additionally, shallow coastal waters less than five meters deep with muddy bottoms, and on the seaward side of coastal islands from Apalachee Bay to St. Andrews Bay, Florida, especially around the mouth of the Apalachicola River. Bethea *et al.* (2004) collected 109 juvenile finetooth sharks in the vicinity of Apalachicola Bay for a study to compare the foraging ecology of four shark species. The study showed that juvenile finetooth sharks occurred in coastal waters out to the 25 m isobath from Mobile Bay, Alabama to Atchafalaya Bay, Louisiana from 88° W to 91.4°W, and from near Sabine Pass, Texas at 94.2°W to Laguna Madre, Texas at 26°N; also, coastal waters out to the 25 m isobath from South Carolina north to Cape Hatteras, North arolina at 35.5°N. Older juveniles (N = 70; TL = 22-127 cm) were observed by Hueter and Tyminski (2007) along the beaches of the lower Texas coast during spring and fall migrations. Neer *et al*. (2007) collected a total of 33 males and 38 females ranging in size from 49.2 to 117.9 cm (FL) in the vicinity of Terrebonne and Timbalier Bays off the coast of Louisina. These specimens were collected in areas with water temperatures ranging from 27.2° to 29.5°C, in salinities between 27.1 and 29.8 ppt, and at depths between 2.1 and 8.2 m. Parsons and Hoffmeyer (2007) sampled 440 young-of-the-year and juvenile finetooth sharks between Bay St. Louis, Mississippi and Perdido Bay, Alabama in depths ranging from 3.1 to 8.2 m depth, at temperatures between 27.1° and 30.6°C, in salinities ranging from 18 to 20 ppt. Hendon and Hoffmeyer (2007) caught juvenile finetooth sharks with varying levels of catch per unit effort in the Mississippi Sound north of Cat, Ship, Horn, and Petit Bois Islands off the coast of Louisiana. Five juvenile finetooth sharks were collected by Gurshin (2007) in the vicinity of the lower Duplin River and Doboy Sound in the vicinity of the Sapelo Island National Estuarine Research Reserve off the coast of Georgia the summer (June-August) of 1997. Bottom water temperatures ranged from 25° to 30°C and salinities were 24 to 26 ppt. Peak abundance occurred at the end of June and first half of July.

Off the coast of South Carolina the ratio of adult males to females was not significantly different than expected (1:1). In estuarine waters, however, the ratio of adult males to females was 1.25:1. Adults off South Carolina were caught in salinities ranging from 30 to 37 ppt (Ulrich *et al*., 2007). Winyah Bay and North Inlet, estuaries in northeast South Carolina, were identified as pupping habitat for adult finetooth sharks. Additionally, shallow coastal waters less than five meters deep with muddy bottoms, and on the seaward side of coastal islands from Apalachee Bay to St. Andrews Bay, Florida, especially around the mouth of the Apalachicola River, including areas identical to those for juveniles: coastal waters out to the 25 m isobath from Mobile Bay, Alabama to Atchafalaya Bay, Louisiana from 88° to 91.4°W, and from near Sabine Pass, Texas at 94.2°W to Laguna Madre, Texas at 26°N. Hendon and Hoffmeyer (2007) caught adult finetooth sharks with varying levels of catch per unit effort in the Mississippi Sound north of Cat, Ship, Horn, and Petit Bois Islands between the islands and the coast of Louisiana.

Impact of fisheries: Finetooth sharks comprise only a small fraction of the small coastal shark landings and are managed as a single stock throughout their range. They are caught commercially using gillnets, longlines, and handlines (in descending order). Recreational catch has been approximately half of the commercial catch since the 1990s. Generally, finetooth sharks are not caught as frequently in shrimp trawls because their distribution is closer to shore. The 2002 stock assessment indicated that overfishing of finetooth sharks was occurring. The 2007 stock assessment produced estimates of biomass that were above 1.0 and estimates of fishing mortality that were below 1.0, suggesting that the species is no longer experiencing overfishing and is not overfished. However, the assessment suggested a cautious management strategy due to the lack of data which influenced the number of models that could be employed (SEDAR 13, 2007).

***Essential Fish Habitat for Finetooth Shark*:**

Note: At this time, insufficient data is available to differentiate EFH between the juvenile and adult size classes, therefore, EFH is the same for those life stages.

- **Neonate/YOY (≤85 cm total length):** Along the Gulf of Mexico coast of Texas, eastern Louisiana, Mississippi, Alabama, and the Florida Panhandle. Atlantic east coast along Georgia and South Carolina. Please refer to Figure 5.76 for detailed EFH map.

- **Juvenile (66 to 125 cm total length):** Gulf of Mexico coast along southern Texas, eastern Louisiana through the Florida Panhandle, and Key West, Florida. Atlantic east coast from the mid-coast of Florida to Cape Hattaras. Please refer to Figure 5.77 for detailed EFH map.

- **Adult (≥126 cm total length):** EFH for juvenile and adult life stages have been combined and are considered the same. Please refer to Figure 5.77 for detailed EFH map.

5.1.5.3.5 Smalltail Shark

Smalltail shark *(Carcharhinus porosus)* This is a small, tropical, and subtropical shark that inhabits shallow coastal waters and estuaries in the western Atlantic, from the Gulf of Mexico south to Brazil, and in the eastern Pacific from the Gulf of California to Peru (Castro, 1983). A few specimens have been caught in the Gulf of Mexico off Louisiana and Texas.

Reproductive potential: There is almost no published data on its reproductive processes. Females observed in Trinidad were in different stages of gestation, suggesting a wide breeding season. Embryos up to 35 cm TL were observed. The reproductive cycle appears to be annual. Lessa *et al*. (1999b) conducted life history research off the coast of Brazil where smalltail sharks comprise a more significant portion of commercially caught elasmobranchs. Males and females reach sexual maturity at 71 and 70 cm, respectively. The largest smalltail shark ever collected off the coast of Brazil was 134 cm.

Impact of fisheries: The smalltail shark is a prohibited species and can not be retained in commercial or recreational fisheries. However, based on research conducted off the coast of Brazil, Lessa *et al* (1999b) conclude that fisheries for smalltail sharks mainly affect juveniles, which could result in growth-overfishing because of their slow growth, small litters, and long gestation period.

Essential Fish Habitat for Smalltail Shark

Note: At this time, insufficient data is available to differentiate EFH by size classes, therefore, EFH is the same for all life stages.

- **Neonate/YOY:** Along the southern Texas coast and off the mid-coast of Louisiana in the Gulf of Mexico. Please refer to Figure 5.78 for detailed EFH map.

- **Juveniles:** EFH for all life stages have been combined and are considered the same. Please refer to Figure 5.78 for detailed EFH map.

- **Adults:** EFH for all life stages have been combined and are considered the same. Please refer to Figure 5.78 for detailed EFH map.

5.1.6 Pelagic Sharks

5.1.6.2 Cow sharks

5.1.6.2.1 Bigeye Sixgill Shark

Bigeye sixgill shark (*Hexanchus nakamurai*) This is a poorly known deep-water shark that was not described until 1969 (Springer and Waller, 1969). Bigeye sixgill sharks may move to the surface at night in the tropics (Compagno 1984; Compagno *et al*., 1989) and have been found as deep as 600 m (Bunkley-Williams and Williams, 2004). In North America most catches have come from the Bahamas and the Gulf of Mexico. This shark has a wide but patchy distribution. It has been sporadically caught in the western central Atlantic in the Bahamas (Compagno, 1984; Springer and Waller, 1969), Dominican Republic (Bunkley-Williams and Williams, 2004), Costa Rica (Compagno, 1984), Cuba (Claro, 1994), Mexico (Bonfil, 1977), Nicaragua (Compagno, 1984), Trinidad and Tobago (Ramjohn, 1999), Venezuela (Cervigón *et al*., 1993); it also occurs in parts of the eastern Atlantic, Indian Ocean, and Western Pacific (Compagno and Niem, 1998). Museum records for this fish represent new locality records for Florida, the Florida Keys, the Gulf of Mexico, Puerto Rico (Dennis, 2003), and Tortola. New deep-water records were also found for Barbados, Puerto Rico, the southern Caribbean Sea, and St. Thomas in museum specimens.

Essential Fish Habitat for Bigeye Sixgill Shark

Note: At this time, insufficient data is available to differentiate EFH by size classes, therefore, EFH is the same for all life stages.

- **Neonate/YOY:** In the western Gulf of Mexico off of Texas, and in the vicinity of Puerto Rico and U.S. Virgin Islands. Please refer to Figure 5.79 for detailed EFH map.

- **Juveniles:** EFH for all life stages have been combined and are considered the same. Please refer to Figure 5.79 for detailed EFH map.

- **Adults:** EFH for all life stages have been combined and are considered the same. Please refer to Figure 5.79 for detailed EFH map.

5.1.6.2.2 Sevengill Shark

Sevengill shark (*Heptranchias perlo*) This is a deep-water species of the continental slopes, where it appears to be most common at depths of 27 to 1,000 m (Bester, 2008c). *Heptranchias perlo* was first described by Bonnaterre in 1788, and is commonly known as the sharpnose sevengill shark; it may be confused with the broadnose sevengill shark (*Notorynchus cepedianus*). It has a world-wide distribution in deep tropical and warm temperate waters with the exception of the northeast Pacific Ocean (Bester, 2008c). In the western Atlantic Ocean, this shark is distributed from North Carolina and northern Gulf of Mexico to Cuba and from Venezuela south to Argentina, and in the eastern Atlantic from Morocco to Namibia, including the Mediterranean Sea. The sharpnose sevengill shark is also found in the Indian Ocean in waters off southwestern India, Aldabra Island, southern Mozambique, and South Africa. Distribution in the Pacific Ocean occurs from Japan to China, Indonesia, Australia, and New Zealand as well as off the coast of northern Chile (Bester, 2008c).

Sharpnose sevengill sharks feed primarily on benthic organisms, mainly teleosts and cephalopods, batoids, and benthic invertebrates. *Heptranchias perlo* has displayed a generalist feeding strategy with enhanced feeding and activity during night time (Frentzel-Beyme and Koster, 2002).

Reproductive potential: Sevengill sharks are the smallest of the hexanchoid sharks (Bester, 2008c). Sevengill sharks grow to a maximum length of 137 cm TL for males and 140 cm TL for females. However, this species is more commonly observed at lengths of 60 to120 cm. Males reach maturity at 75 to 85 cm TL, and females reach maturity at slightly larger sizes of 90 to 100 cm TL (Bester, 2008c). The sevengill shark is an ovoviviparous species. Litters consist of nine to 20 pups, which measure about 25 cm TL at birth (Castro, 1983). According to Tanaka and Mizue (1977), off Kyushu, Japan the species reproduces year round. Biologists have observed formation of mucus on the tips of the claspers on mature and subadult males. It is believed this indicates the onset of maturity and perhaps sexual activity (Frentzel-Beyme and Koster, 2002; Bester, 2008c). The lengths of the reproductive and gestation cycles as well as the location of nurseries are unknown.

Impact of fisheries: The sharpnose sevengill shark is sometimes caught in large numbers as bycatch in fisheries using bottom trawls or longlines (Compagno, 1984). In North America it is occasionally seen in small numbers as bycatch of tilefish longlines (Castro, unpubl. data). The species is currently assessed as "Near Threatened" by the World Conservation Union (IUCN).

Essential Fish Habitat for Sevengill Shark

Note: At this time, insufficient data is available to differentiate EFH by size classes, therefore, EFH is the same for all life stages.

- **Neonate/YOY:** In the Gulf of Mexico off Texas, eastern Louisiana, and Key West, FL. Please refer to Figure 5.80 for Detailed EFH map.
- **Juveniles:** EFH for all life stages have been combined and are considered the same. Please refer to Figure 5.80 for detailed EFH map.
- **Adults:** EFH for all life stages have been combined and are considered the same. Please refer to Figure 5.80 for detailed EFH map.

5.1.6.2.3 Sixgill Shark

Sixgill shark (*Hexanchus griseus*) The sixgill shark is one of the largest and most primitive sharks known. The shark is primarily a deepwater species living in deep, cool waters, close to the bottom (100 to1,000 m), possibly rising to surface at night to feed (Serena, 2005). These sharks have been found to dive as deep as 1,500 m (Carey and Clark, 1995). Juveniles stray into very shallow, cool waters.

The sixgill shark is one of the wider ranging sharks, residing in temperate and tropical seas around the world (Castro, 1983). In the western Atlantic Ocean, this range includes from North Carolina to Florida and from the northern Gulf of Mexico to northern Argentina including Nicaragua, Costa Rica, and Cuba. This species is also found in deep waters (600 to 900 m) around Bermuda (Carey and Clark, 1995). In the eastern Atlantic, this shark is found from Iceland and Norway south to Namibia, including the Mediterranean Sea (Serena, 2005). Its range in the Indian Ocean includes waters off Madagascar and Mozambique. It also resides in the Pacific Ocean with distribution in the western Pacific from eastern Japan to Australia and New Zealand as well as Hawaii. In the eastern Pacific, the sixgill shark has been documented in waters from the Aleutian Islands, Alaska south to Baja California, Mexico and Chile (Hart, 1973; Castro, 1983; Serena, 2005; Bester, 2008a).

The sixgill shark feeds nocturnally on a wide variety of prey items. It consumes large bony and cartilaginous fishes such as dolphinfish, billfish, flounder, cod, hagfish, lampreys, chimaeras, and rays. Spiny dogfish (*Squalus acanthias*), longnose dogfish (*Squalus blainvillei*), shortnose dogfish (*Squalus megalops*), and prickly sharks (*Echinorhinus cookei*) are also consumed by the sixgill shark (Ebert, 1986). Other prey includes small fishes, snails, crabs, shrimp, and squid. It also scavenges on the carrion of seals, sea lions, and whales as well as on bait from longlines set for other targeted fisheries.

Reproductive potential: Very few mature sixgill sharks have been examined by biologists; thus the reproductive processes are poorly known (McFarlane *et al*., 2002). Ebert (1986) reported a 421 cm TL female to be gravid with term embryos. Springer and Waller (1969), based on the examination of a few large specimens, estimated that females reached maturity at 450 cm TL. The maximum reported size for this species is a 480 cm TL (Bester, 2008a) male individual. The maximum published weight is 590 kg. Longevity for this species is thought to be 80 years (Bester, 2008a). Females tend to be slightly larger than males, averaging around 4.3 m in length while males tend to stay near 3.4 m (Bauml, 2004). Males reach maturity at lengths of 300 cm and 200 kg while females mature at 400 cm in length and 400 kg in weight (Ebert, 1992). Although age determination is difficult (McFarlane *et al*., 2002), it is suggested that the corresponding age when males reach maturity is 11 to14 years and 18 to35 years for females.

The pups measure 60 to 70 cm TL at birth (Castro, 1983). They are ovoviviparous and have reported litter sizes ranging from 22 to 108 (Compagno, 1984; Ebert, 1992). Juveniles are often caught in coastal waters, suggesting that the nurseries are in waters much shallower than those inhabited by the adults (Compagno, 1984). Nothing else is known about its nurseries.

Impact of fisheries: Although juveniles are common in deep continental shelf waters and often enter coastal waters, the adults are seldom taken (Springer and Waller, 1969; Ebert, 1986). Apparently, adults are in waters deeper than those regularly fished, or perhaps these very large animals break the gear and escape. Thus, the very deep habitat of the adults or perhaps their large size seems to convey some measure of protection from most fisheries. According to Harvey-Clark (1995), in 1991 the sixgill shark became the target of a directed, subsidized, longline fishery off British Columbia, Canada. At about the same time, the species also became of interest as an ecotourism resource, with several companies taking diving tourists out to watch sixgill sharks in their environment. The fishery was unregulated and lasted until 1993, when the commercial harvest of sixgill sharks was discontinued due to conservation and management concerns. According to Harvey-Clark (1995), diver observations of sharks decreased in 1993, and it was unclear at the time whether the fishery or the ecotourism could be sustained. It is difficult to evaluate the vulnerability of the sixgill shark because of the lack of fisheries or landings data. The only fishing operations on record collapsed in a few years, suggesting that the species may be very vulnerable to overfishing. The sixgill shark is considered "Near Threatened" by the World Conservation Union (IUCN).

Essential Fish Habitat for Sixgill Shark

Note: At this time, insufficient data is available to differentiate EFH by size classes, therefore, EFH is the same for all life stages.

- **Neonate/YOY:** Along eastern Louisiana, and in the eastern Gulf of Mexico off the mid-west Flordia coast and Key West, FL. In the Atlantic off the northern Florida coast and Cape Hatteras. Please refer to Figure 5.81 for detailed EFH map.

- **Juveniles:** EFH for all life stages have been combined and are considered the same. Please refer to Figure 5.81 for detailed EFH map.

- **Adults:** EFH for all life stages have been combined and are considered the same. Please refer to Figure 5.81 for detailed EFH map.

5.1.6.3 Mackerel Sharks

5.1.6.3.1 Longfin Mako Shark

Longfin mako shark (*Isurus paucus*) This is a deep dwelling lamnid shark found in warm waters. The species was not described until 1966 and it is very poorly known.

Reproductive potential: There is very little data on the reproductive processes of the longfin mako. Litters consist of two to eight pups, which may reach 120 cm TL at birth (Castro, unpubl. data).

Impact of fisheries: The longfin mako is a seasonal bycatch of the pelagic tuna and swordfish fisheries. Possession of this species in Atlantic waters of the United States is now prohibited.

***Essential Fish Habitat for Longfin Mako Shark*:**

Note: At this time, insufficient data is available to differentiate EFH by size classes, therefore, EFH is the same for all life stages.

- **Neonate/YOY (≤149 cm TL):** Central Gulf of Mexico through the Florida Keys. In the Atlantic from southern Florida through South Carolina, off North Carloina, and Cape Hatteras to Cape Cod. Please refer to Figure 5.82for detailed EFH map.

- **Juveniles (150 to 244 cm TL):** EFH for all life stages have been combined and are considered the same. Please refer to Figure 5.82for detailed EFH map.

- **Adults (≥245 cm TL):** EFH for all life stages have been combined and are considered the same. Please refer to Figure 5.82 for detailed EFH map.

5.1.6.3.2 Porbeagle Shark

Porbeagle (*Lamna nasus*) The porbeagle shark is a lamnid shark common in deep, cold temperate waters of the North Atlantic, South Atlantic and South Pacific Oceans. Francis *et al*. (2007) provided evidence based on differing ages at sexual maturity and longevity that New Zealand and North Atlantic porbeagle sharks may be genetically isolated. It is valued for its flesh. The porbeagle shark is primarily an opportunistic piscivore with a diet characterized by a wide range of species (Joyce *et al*., 2002). In the northwest Atlantic, teleosts and cephalopods constituted 91 percent and 12 percent of porbeagle shark stomach contents, respectively.

Reproductive potential: Very little is known about its reproductive processes. Aasen (1963) estimated that maturity was reached at 150 to 200 cm TL for males and 200 to 250 cm TL for females. Castro estimated that porbeagle sharks reach 20 years of age and possibly 30. Shann (1911) reported an embryo 61 cm TL, and estimated that porbeagle sharks were probably born at about 76 cm TL. Bigelow and Schroeder (1948) recorded a free swimming specimen at 76 cm TL. Gauld (1989) gave 3.7 as the mean number of embryos in a sample of 12 females. The frequency of reproduction is not known. According to Aasen (1963), porbeagle sharks likely reproduce annually, but there is no evidence to support this claim. Nurseries are probably located in continental shelf waters. More recent life history information can be found in Francis and Stevens (2000), Jensen *et al*. (2002), Joyce *et al.* (2002), Natanson *et al.* (2002), Campana and Joyce (2004), and Francis and Duffy (2005).

Impact of fisheries: Porbeagle sharks are presently targeted in northern Europe and along the northeast coast of North America. Whether the porbeagle sharks in the North Atlantic constitute one or more separate stocks is not known. A small porbeagle shark fishery resumed in the early 1990s in the northeastern United States, after being practically non-existent for decades. Intensive fisheries have depleted the stocks of porbeagle sharks in a few years wherever they have existed, demonstrating that the species cannot withstand heavy fishing pressure. Cassoff *et al*. (2007) observed in the northwest Atlantic increased growth rate and decreased age at maturity following exploitation, which supports the hypothesis of a compensatory density-dependent growth response to population declines. This species was determined to be overfished with no overfishing occurring in 2007 (November 7, 2007, 71 FR 65086).

***Essential Fish Habitat for Porbeagle Shark*:**

- **Neonate/YOY (≤116 cm TL):** Northern North Carolina to Delaware, southern New England and the Gulf of Maine. Please refer to Figure 5.83 for detailed EFH map.

- **Juveniles (117 to 217 cm TL):** In the central Gulf of Mexico and in the Atlantic off northern North Carolina, Delaware, and New Jersey. Southern New England through the Gulf of Maine. Please refer to Figure 5.84 for detailed EFH map.

- **Adults (≥218 cm TL):** In the central Gulf of Mexico and in the Atlantic off New Jersey. Southern New England and the Gulf of Maine. Please refer to Figure 5.85 for detailed EFH map.

5.1.6.3.3 Shortfin Mako Shark

Shortfin mako shark (*Isurus oxyrinchus*) The shortfin mako is an oceanic species found in warm and warm-temperate waters throughout all oceans. It feeds on fast-moving fishes such as swordfish, tuna, and other sharks (Castro, 1983) as well as clupeids, needlefishes, crustaceans and cephalopods (Maia *et al*. 2007a). It is considered one of the great game fishes of the world, and its flesh is considered among the best to eat.

Reproductive potential: Considerable variation exists in the descriptions of reproductive life history for shortfin mako sharks. Cailliet and Mollet (1997) estimated that a female mako shark matures at four to six years, has a two-year reproductive cycle, and a gestation period of approximately 12 months. According to Pratt and Casey (1983), females mature at about 7 years of age; however, Bishop *et al*. (2006) estimated median age at maturity in New Zealand waters to be 19 to 21 years for females and 7 to 9 years for males. In Maia *et al*. (2007b), length at maturity for males is estimated at 180 cm fork length and female maturation is estimated to occur between 210-290 cm FL. Cailliet *et al*. (1983) estimated the von Bertalanffy parameters (*n*= 44) for the shortfin as: L_4 = 3210 mm, K= .072, and t_o= -3.75. The litters range from 12 to 20 pups based on examination of a handful of pregnant females (Castro, unpubl. data). Based on cohort analysis of fish in the eastern North Atlantic, average growth was determined as 61.1 cm/year for the first year and 40.6 cm/year for the second year (Maia *et al.* 2007b). There was a marked seasonality in growth, with average monthly rates of 5.0 cm/month in summer and 2.1 cm/month in winter. Lack of sex differences in cohort analysis for the first years of life is in accordance with previous studies reporting that male and female mako sharks grow at the same rate until they reach about 200 cm FL (Casey and Kohler, 1992; Campana *et al*., 2005). Bishop *et al*. (2006) described rapid initial growth rates to approx. 39 cm fork length in the first year. Thereafter, males and females grow at similar, but slower rates until about age 7 years, after which the relative growth of males declines. Life span estimates vary and have been published as 11.5 years (Pratt and Casey, 1983), 25 years for females (Cailiet and Mollet, 1997), 29 and 28 years for males and females, respectively (Bishop *et al.* 2006). Additional life history information can be found in Stillwell and Kohler (1982), Pratt and Casey (1983), Heist *et al*. (1996), Mollet *et al*. (2000), Campana *et al*. (2002), Estrada *et al*. (2003), Francis and Duffy (2005), Loefer *et al*. (2005), and MacNeil *et al*. (2005).

Very weak evidence of population structure throughout the Atlantic and Pacific Oceans was found in microsatellite analysis by Schrey and Hiest (2003). This same study indicated that integrating the results from microsatellite- and mitochondrial-based studies may provide evidence for gender-biased dispersal for the shortfin mako. The significant genetic structure detected in mtDNA data indicate that female shortfin makos may exhibit philopatry for parturition sites, and thus reproductive stocks of makos may exist in the presence of considerable male-mediated gene flow. Pregnant shortfin makos have only been captured between 20° and 30° N or S (Gilmore, 1993); however, there is no information about the area where mating occurs. A discussion of various considerations from research on shortfin mako reproductive behavior and location can be found in Maia *et al*. (2007b).

Impact of fisheries: The shortfin mako is a common bycatch in tuna and swordfish fisheries. Because of their high market value, shortfin mako are usually the only sharks retained in some pelagic fleets with high shark bycatch rates. Off the northeast coast of North America, most of the catch consists of immature fish (Casey and Kohler, 1992). The index of abundance for shortfin makos in the commercial longline fishery off the Atlantic coast of the United States shows a steady decline (Cramer, 1996). The few indices available (ICES, 1995; Cramer, 1996; Holts *et al.*, 1996) indicate substantial population decreases. The median size of shortfin mako sharks in the commercial catch off the eastern coast of Canada has declined since 1998, suggesting the loss of larger sharks (Campana *et al*., 2005). Because the species is commonly caught in widespread swordfish and tuna operations, it is reasonable to assume that similar decreases are occurring in areas for which there are limited data.

***Essential Fish Habitat for Shortfin Mako*:**

Note: At this time, insufficient data is available to differentiate EFH by size classes, therefore, EFH is the same for all life stages.

- **Neonate/YOY (≤163 cm TL):** In the central Gulf of Mexico through the Florida Keys and in the Atlantic from southeast Florida to southern New England. Please refer to Figure 5.86 for detailed EFH map.

- **Juveniles (164 to 244 cm TL):** EFH for all life stages have been combined and are considered the same. Please refer to Figure 5.86 for detailed EFH map.

- **Adults (≥245 cm TL):** EFH for all life stages have been combined and are considered the same. Please refer to Figure 5.86 for detailed EFH map.

5.1.6.4 Requiem Sharks

5.1.6.4.1 Blue Shark

Blue shark (*Prionace glauca*) One of the most common and widest-ranging of sharks, the blue shark is cosmopolitan in tropical, subtropical and temperate waters. It is a pelagic species that inhabits clear, deep, blue waters, usually in temperatures of 10° to 20°C, at depths greater than 180 m (Castro, 1983). Its migratory patterns are complex and encompass great distances. Queiroz *et al*. (2005) reported that 28 of 34 blue sharks tagged in the northeast Atlantic travelled less than 1,000 km while the remaining fish travelled longer distances to north-west Africa, central Atlantic and the Bay of Biscay. One shark made a trans-Atlantic migration of 3,187 km from the tagging site. North-south movements seemed to be related to seasonal sea-surface temperature variation in the north-east Atlantic and seasonal segregation of different life stages also occurred. Males and females are known to segregate in many areas (Strasburg, 1958; Gubanov and Grigoryev, 1975). Strasburg (1958) showed that blue sharks are most abundant in the Pacific between latitudes of 40°N and 50°N.

Reproductive potential: Pratt (1979) used different criteria for determining maturity of males and gave a range of 153 to 183 cm FL for male maturity, but when he used the standard criterion of clasper calcification, he observed that the males reached maturity at 183 cm FL (218 cm TL). Bigelow and Schroeder (1948) suggested that females mature at 213 to 243 cm TL. Strasburg (1958) stated that the smallest gravid female seen by him measured 214 cm TL. Nakano (1994) used data from 105,600 blue sharks and stated that females matured at 140 to160 cm (166 and 191 cm TL, using the regression of Pratt), and males at 130 to 160 cm PCL, based on clasper development. Lessa *et al.* (2004) estimated size at maturity to be 225 cm TL for males and 228 cm TL for females. Francis and Duffy (2005) estimated reported size at maturity at about 190 to 195 cm FL for males and 170 to 190 cm FL for females in New Zealand waters. Skomal and Natanson (2003) found that full maturity is attained by 5 years of age in both sexes. Nakano (1994) gave the age at maturity as four or five years for males and five or six years for females, based on growth equations. According to Cailliet *et al*. (1983), blue sharks become reproductively mature at six or seven years of age.

According to Skomal and Natanson (2003), both sexes grew similarly to age seven, when growth rates decreased in males and remained constant in females. Skomal and Natanson (2003) also provide growth parameters that show the species grows faster and has a shorter life span than previously reported for the North Atlantic Ocean.

This is probably the most prolific of the larger sharks; litters of 28 to 54 pups have been reported often (Bigelow and Schroeder, 1948; Pratt, 1979), but up to 135 pups in a litter have also been reported (Gubanov and Grigoryev, 1975). Nakano (1994) observed 669 pregnant females in the North Pacific and stated that the number of embryos ranged from one to 62, with an average of 25.6 embryos. Strasburg (1958) gave the birth size as 34 to 48 cm TL. Suda (1953) examined 115 gravid females from the Pacific Ocean and concluded that gestation lasts nine months and that birth occurs between December and April. Pratt (1979) examined 19 gravid females from the Atlantic and used data from 23 other Atlantic specimens to arrive at a gestation period of 12 months. Nakano (1994) stated that gestation lasts about a year, based on length frequency histograms, but did not state how many gravid animals had been observed nor showed any data. The length of the reproductive cycle is believed to be annual.

The nursery areas appear to be in open oceanic waters in the higher latitudes of the range. Strasburg (1958) attributed the higher CPUE in the 30°N to 40°N zone of the Pacific Ocean in summer to the presence of newborn blue sharks, and commented on the absence of small blue sharks in the warmer parts of the range. Nakano (1994) also stated that parturition occurred in early summer between latitudes of 30°N to 40°N of the Pacific Ocean. Additional life history and ecological information can be found in Kenney *et al*. (1985), Estrada *et al*. (2003), Skomal and Natanson (2003), and Simpfendorfer *et al*. (2002).

Impact of fisheries: Although finning is prohibited in U.S. Atlantic waters, blue sharks have historically been finned and discarded because of the low value of their flesh. Numerically, the blue shark is the top nontarget species captured by the U.S. Atlantic pelagic longline fleet (Beerkircher *et al*., 2002). The blue shark is one of the most abundant large vertebrates in the world, yet it may be vulnerable to overfishing because it is caught in tremendous numbers as bycatch in numerous longline fisheries. Catch rate information from the North Atlantic suggests that this species may be declining (Campana *et al*., 2006). Diaz and Serafy (2005) found that blue shark tolerance to the stresses associated with longline capture decreases with animal size at levels that vary with set duration.

***Essential Fish Habitat for Blue Shark*:**

- **Neonate/YOY (≤90 cm TL):** Northern North Carolina and Delware, New Jersey through Cape Cod, and the Gulf of Maine. Please refer to Figure 5.87 for detailed EFH map.

- **Juveniles (91 to 220 cm TL):** Off the mid-east coast of Florida and South Carolina. Cape Hattaras to the Gulf of Maine. Please refer to Figure 5.88 for detailed EFH map.

- **Adults (≥221 cm TL):** In the Atlantic off Florida and Georgia. South Carolina to the Gulf of Maine, also off Puerto Rico and U.S. Virgin Islands. Please refer to Figure 5.89 for detailed EFH map.

5.1.6.4.2 Oceanic Whitetip Shark

Oceanic whitetip shark (*Carcharhinus longimanus*) The oceanic whitetip is one of the most common large sharks in warm oceanic waters (Castro, 1983). It is circumtropical and nearly ubiquitous in water deeper than 180 m and warmer than 21°C.

Reproductive potential: Both males and females appear to mature at about 190 cm TL (Bass *et al.*, 1973). The young are born at about 65 to 75 cm TL (Castro, 1983). The number of pups per litter ranges from two to ten, with a mean of six (Backus *et al.,* 1956; Guitart Manday, 1975). The length of the gestation period has not been reported, but it is probably ten to 12 months, as for most large carcharhinids. The reproductive cycle is believed to be biennial (Backus *et al.*, 1956). Although the location of nurseries has not been reported, preliminary work by Castro indicates that very young oceanic whitetip sharks are found well offshore along the southeastern United States in early summer, suggesting offshore nurseries over the continental shelves. Additional life history information can be found in Lessa *et al.* (1999a), Lessa *et al.* (1999c), and Whitney *et al.* (2004).

Impact of fisheries: Large numbers of oceanic whitetip sharks are caught as bycatch each year in pelagic tuna and swordfish fisheries. Strasburg (1958) reported that the oceanic whitetip shark constituted 28 percent of the total shark catch in exploratory tuna longline fishing south of 10° N in the central Pacific Ocean. According to Berkeley and Campos (1988), oceanic whitetip sharks constituted 2.1 percent of the shark bycatch in the swordfish fishery along the east coast of Florida in 1981 to1983. Guitart Manday (1975) demonstrated a marked decline in the oceanic whitetip shark landings in Cuba from 1971 to1973. The oceanic whitetip shark is probably vulnerable to overfishing because of its limited reproductive potential, and because it is caught in large numbers in various pelagic fisheries and in directed fisheries. There are no data on populations or stocks of the species in any ocean.

***Essential Fish Habitat for Oceanic Whitetip Shark*:**

Note: At this time, insufficient data is available to differentiate EFH by size classes, therefore, EFH is the same for all life stages.

- **Neonate/YOY (≤90 cm TL):** Throughout the central Gulf of Mexico and Florida Keys, and in the Atlantic from southern Florida to southern New England, Carribean, and outside of the U.S. EEZ. Please refer to Figure 5.90 for detailed EFH map.

- **Juveniles (91 to 189 cm TL):** EFH for all life stages have been combined and are considered the same. Please refer to Figure 5.90 for detailed EFH map.

- **Adults (≥190 cm TL):** EFH for all life stages have been combined and are considered the same. Please refer to Figure 5.90 for detailed EFH map.

5.1.6.5 Thresher Sharks

5.1.6.5.1 Bigeye Thresher Shark

Bigeye thresher shark (*Alopias superciliosus*) The bigeye thresher shark is cosmopolitan in warm and warm-temperate waters. It exhibits distinct twilight or dawn and dusk, vertical migrations, staying at 200 to 500 m depth during the day and at 10 to 130 m at night (Nakano *et al*., 2003; Weng and Block, 2004). Bigeye thresher sharks have also been captured on longlines set near the surface at night at depths from 0 to 65 m (Fitch and Craig, 1964; Stillwell and Casey, 1976; Thorpe, 1997; Buencuerpo *et al*., 1998). A pattern of slow ascents and relatively rapid descents during the night has been observed. Since bigeye thresher sharks have large eyes extending upwards onto the dorsal surface of the cranium, it may be more efficient for them to hunt prey, which are highlighted against the sea surface from below (Nakano *et al.*, 2003). Endothermy has been described for this species, which can provide a physiological advantage over ectothermic prey species and buffers the eyes and brain from the large temperature changes associated with diel vertical migration (Weng and Block, 2004). The longest straight-line movement of a conventionally tagged bigeye thresher shark to date is 2,767 km from waters off New York to the eastern Gulf of Mexico (Kohler and Turner, 2001). It feeds on squids of all sizes, including Humboldt squid and small fishes including Sciaenids (drums), Merlucciids (hakes), and Myctophids (lanternfishes) (Castro, 1983; Polo-Silva *et al*., 2007). This is one of the larger sharks, reaching up to 460 cm TL (Nakamura, 1935).

Reproductive potential: Males mature at about 270 cm TL and females at about 340 cm TL (Moreno and Moron, 1992). In Indonesian waters, litters consisted of two embryos, one in each uterus (White 2007). The length of the reproductive cycle and the location of nursery areas are unknown. Additional life history information can be found in Chen *et al*. (1997), Liu *et al*. (1998), and Weng and Block (2004).

Impact of fisheries: The bigeye thresher shark is often caught as bycatch in swordfish fisheries. They will often dislodge several baits before impaling or hooking itself. The flesh and fins of the bigeye thresher shark are of poor quality, thus it is usually discarded dead in swordfish and tuna fisheries. Possession of this species in Atlantic waters of the United States is now prohibited.

***Essential Fish Habitat for Bigeye Thresher Shark*:**

Note: At this time, insufficient data is available to differentiate EFH by size classes, therefore, EFH is the same for all life stages.

- **Neonate/YOY (≤127 cm TL):** Central Gulf of Mexico and off Key West, Florida. Atlantic east coast from southern to the mid-Florida coast, and EFH patches off of Georgia to southern New England. Please refer to Figure 5.91 for detailed EFH map.

- **Juveniles (128 to 354 cm TL):** EFH for all life stages have been combined and are considered the same. Please refer to Figure 5.91 for detailed EFH map.

- **Adults (≥355 cm TL):** EFH for all life stages have been combined and are considered the same. Please refer to Figure 5.91 for detailed EFH map.

5.1.6.5.2 Thresher Shark

Thresher shark (*Alopias vulpinus*) The common thresher shark is cosmopolitan in warm and temperate waters. It is found in both coastal and oceanic waters, but according to Strasburg (1958) it is more abundant near land. The thresher shark is capable of regional endothermy thus providing a physiological advantage over ectothermic prey species (Bernal and Sepulveda, 2005). It feeds on invertebrates such as squid and pelagic crabs as well as small fishes such as anchovy, sardines, hakes, and small mackerels (Preti *et al*., 2004).

Reproductive potential: According to Strasburg (1958), females in the Pacific mature at about 315 cm TL. According to Cailliet and Bedford (1983), males mature at about 333 cm TL. Cailliet and Bedford (1983) stated that the age at maturity ranges from three to seven years. Litters consist of four to six pups, which measure 137 to 155 cm TL at birth (Castro, 1983; Mancini and Amorim, 2006). According to Bedford (1985), gestation lasts nine months and female threshers give birth annually every spring (March to June). Age and growth information can be found in Gervelis (2005).

Impact of fisheries: Thresher sharks are caught in many fisheries. Total catches of thresher sharks in the Atlantic peaked at about 5,300 fish in 1984 and 1999 (Cortés, 2002). A maximum of about 1,200 and 1,300 fish were estimated to have been landed by the commercial fishery in 1995 and 1997, respectively, whereas recreational landings peaked at about 5,250 fish in 1984. The maximum estimate of dead discards from the pelagic longline fishery was about 700 fish in 1989 (Cortés, 2002). Thresher shark (*Alopias spp*.) catch rates from the Pelagic Logbook series show a generally decreasing trend from 1987 to 1999, after an initial steep increase from 1986 to 1987 (Cortés, 2002). Off the U.S. Atlantic coast, the CPUE has shown a considerable decline (Cramer, 1996).

***Essential Fish Habitat for Thresher Shark*:**

Note: At this time, insufficient data is available to differentiate EFH by size classes, therefore, EFH is the same for all life stages.

- **Neonate/YOY (≤191 cm TL):** In the central Gulf of Mexico and Florida Keys. Atlantic off the mid-east coast of Florida, Georgia, South Carolina, North Carolina through Cape Cod, and the Gulf of Maine. Please refer to Figure 5.92 for detailed EFH map.

- **Juveniles (192 to 376 cm TL):** EFH for all life stages have been combined and are considered the same. Please refer to Figure 5.92 for detailed EFH map.

- **Adults (≥377 cm TL):** EFH for all life stages have been combined and are considered the same. Please refer to Figure 5.92 for detailed EFH map.

Table 5.0.1 Size ranges for different life stages of sharks.

Large Coastal Sharks	Young-of-the-year (1) TL (cm) ≤	Literature (2) young-of-the-year size range TL (cm)	Literature embryo size range or max embryo size in term females TL (cm)	Juveniles TL (cm)	Literature (4) M 1st maturity ≥ or range (50% mat) TL (cm)	Literature F 1st maturity ≥ or range (50% mat) TL (cm)	Adults F 50% mat or max range at 1st mat TL (cm) ≥
Cetorhinidae							
Cetorhinus maximus	240		150-200 Sund 43 cited in Francis & Duffy 02	242-979		810-980 Compagno 84	980
Sphyrnidae							
Sphyrna mokarran	89	89 Hueter & Tyminski 02	67.5 Clarke & von Schmidt 65	90-299		210-300 Steven & Lyle 89	300
S. lewini	60	40-60 Piercy et al 06	30-40 Piercy et al 06	61-179	(180) Piercy et al 06	(180) Piercy et al 06	180
S. zygaena	72		60* NMFS upubl.	67-219	220 Castro 83	220 Castro 83	220
Lamnidae							
Carcharodon carcharias	207	130-207 Wintner & Cliff 99	151 Uchida et al 96	208-499		450-500 Francis 96	500
Ginglymostomatidae							
Ginglymostoma cirratum**	52	28-52 Pratt & Carrier 02	28-30.5 Castro 00	53-230	214-214.6 Castro 00	222-231 Castro 00	231
Carcharhinidae							
Carcharhinus altimus	84		70 Fourmanoir 61	85-225		205-282 Compagno 84, Crow et al 96	282
C. limbatus	75	55-75 Carlson et al. 05	58-62.5*** Castro 93b & 96	76-136	(124) Carlson et al. 05	(137) Carlson et al. 05	137
C. leucas	95	70-95 Neer et al. 05	60-70 Neer et al. 05	96-219	(200) Neer et al. 05	(220) Neer et al. 05	220

C. perezi	90	72-90 Garla et al 06		91-199		200 Compagno 84	200
C. obscurus	121	70-121 Simpfendorfer 00, Ulrich et al 07		122-299		257-300 Castro 99	300
C. galapagensis - NO DATA (all Atlantic data off Bermuda)	97		81 Wetherbee et al 96	97-214		215-245 Wetherbee et al 96	245
Negaprion brevirostris	86	55-86 Freitas et al 06, Hueter & Tyminski 02	62 Clarke & von Schmidt 65	87-239		240 Compagno 84	240
C. brachyurus - NO DATA	N/A		N/A	N/A	N/A	N/A	N/A
C. signatus	72	(50-60) Hazin et al 00, Carlson unpubl.		61-199	185-190 Hazin et al 00	200-205 Hazin et al 00	205
C. plumbeus	78	44-78 Merson 98	64 Castro 93b	79-190	(181) Merson 98	(191) Merson 98	191
C. falciformis	92	65-92 Bonfil et al 93	77 Bonfil et al 93	93-244	216 Bonfil et al 93	232-245 Bonfil et al 93	245
C. brevipinna	70	55-70 Carlson & Baremore 05	55 Carlson & Baremore 05	71-179	(170) Carlson & Baremore 05	(180) Carlson & Baremore 05	180
Galeocerdo cuvier	204	78-204 Natanson et al 99, Kneebone 05	82 NMFS upubl.	205-319	310 Branstetter et al 87	315-320 Branstetter et al 87	320
Odontaspididae Odontaspis noronhai - NO DATA	N/A		N/A	N/A	N/A	N/A	N/A
Carcharias taurus	129	95-129 Gilmore et al 83, Goldman et al 06	106 Gilmore et al 83	130-229	190-195 Gilmore et al 83	220-230 Gilmore et al 83	230
Rhincodontidae Rhincodon typus	N/A			N/A			N/A

LITTLE DATA, ONE MAP							
Small Coastal Sharks							
Squatinidae Squatina dumeril							
Sphyrnidae Sphyrna tiburo	55	30-55 Lombardi-Carlson et al. 03	24.9 Lombardi-Carlson et al. 03	56-81	(72.1) Lombardi-Carlson et al. 03	(82.2) Lombardi-Carlson et al. 03	82
Carcharhinidae Rhizoprionodon terraenovae	60	33-60 Carlson & Baremore 03, Loeffer & Sedberry 03	32.3 Carlson & Baremore 03, Loeffer & Sedberry 03	61-71	(74.1) Carlson & Baremore 03, Loeffer & Sedberry 03	(72.3) Carlson & Baremore 03, Loeffer & Sedberry 03	72
Carcharhinus acronotus	55	45-55 Carlson et al 99	45 Carlson et al 99	56-	88.1 cm FL Driggers et al 04	90.9 cm FL Driggers et al 04	
R. porosus - NO DATA							N/A
C. isodon	85	65-85 Carlson et al 03, Drymon et al in press	53 Castro (1993)	86-125	(120) Carlson et al 03, Drymon et al in press	(126) Carlson et al 03, Drymon et al in press	126
C. porosus LITTLE DATA, ONE MAP	N/A			N/A			N/A
Pelagic Sharks **Hexanchidae** Hexanchus vitulus LITTLE DATA, ONE MAP	N/A			N/A		140-175 Springer & Waller 69	175
Heptranchias perlo LITTLE DATA, ONE MAP	N/A			N/A		89-93 Compagno 84	N/A

Hexanchus griseus LITTLE DATA, ONE MAP	N/A			N/A		421-450 Springer & Waller 69, Ebert 86	N/A
Lamnidae Isurus paucus	163		135.5 NMFS upubl	164-244		245 Guitart-Manday 66	245
Lamna nasus	116	61-116 Jensen et al 02, Natanson et al 02	72 Jensen et al 02	117-217		(218) Jensen et al 02	218
I. oxyrinchus	140	71-140 Natanson et al 06	77 Duffy & Francis 01	141-297	(201) Natanson et al 06	(298) Natanson et al 06	298
Carcharhinidae Prionace glauca	90	35-90 Stevens 75, Silva 96, Skomal & Natanson 03	54.4 Pratt 1979	91-220	(218) Pratt 79	221 Pratt 79	221
C. longimanus	90	60-90 Leesa et al 99	75 Seki et al 98	91-179		180-190 Leesa et al 99	190
Alopiidae Alopias superciliosus	127		105.5 Gilmore 83	128-354		341-355 Stillwell and Casey 76, Moreno & Moron 92	355
A. vulpinus	191		159 Moreno et al 89	192-376	308 Gervelis 05 , NMFS unpubl.	377 Gervelis 05 , NMFS unpubl.	377

Table 5.0.2 References used to determine size ranges for sharks in Table 5.1.

*confirmed report of the smallest free swimming individual

**nurse sharks below 37 cm TL in the 1999 FMP database were actually embryos and not free swimming sharks

***Castro has seen one litter with sizes beyond the above range (70.4-74.2 cmTL). This litter was not included because it was unusually large for this species.

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Table 5.0.3 Essential fish habitat maps by species.

TUNAS Figure 5.1 to 5.2 Atlantic albacore tuna (*Thunnus alalunga*) Figure 5.3 to 5.4 Atlantic bigeye tuna (*Thunnus obesus*) Figure 5.5 to 5.7 Atlantic bluefin tuna (*Thunnus thynnus*) Figure 5.8 to 5.10 Atlantic skipjack tuna (*Katsuwonus pelamis*) Figure 5.11 to 5.13 Atlantic yellowfin tuna (*Thunnus albacares*) **SWORDFISH** Figure 5.14 to 5.16 Swordfish (*Xiphias gladius*) **BILLFISH** Figure 5.17 to 5.19 blue marlin (*Makaira nigricans*) Figure 5.20 to 5.21 white marlin (*Tetrapturus albidus*) Figure 5.22 to 5.24 sailfish (*Istiophorus platypterus*) Figure 5.25 to 5.26 spearfish (*Tetrapturus pfluegeri*) **LARGE COASTAL SHARKS** **Basking sharks - Cetorhnidae** Figure 5.27 basking shark (*Cetorhinus maximus*) **Hammerhead sharks - Sphyrnidae** Figure 5.28 great hammerhead shark (*Sphyrna mokarran*) Figure 5.29 to 5.31 scalloped hammerhead shark (*S. lewini*) Figure 5.32 to 5.33 smooth hammerhead shark (*S. zygaena*) **Mackerel sharks - Lamnidae** Figure 5.34 white shark (*Carcharodon carcharias*) **Nurse sharks - Ginglymostomatidae** Figure 5.35 to 5.36 nurse shark (*Ginglymostoma cirratum*) **Requiem sharks - Carcharhinidae** Figure 5.37 bignose shark (*Carcharhinus altimus*) Figure 5.38 to 5.40 blacktip shark (*C. limbatus*) Figure 5.41 to 5.43 bull shark (*C. leucas*) Figure 5.44 Caribbean reef shark (*C. perezi*) Figure 5.45 to 5.46 dusky shark (*C. obscurus*) Figure 5.47 to 5.49 lemon shark (*Negaprion brevirostris*) Figure 5.50 night shark (*C. signatus*) Figure 5.51 to 5.54 sandbar shark (*C. plumbeus*) Figure 5.55 silky shark (*C. falciformis*) Figure 5.56 to 5.58 spinner shark (*C. brevipinna*) Figure 5.59 to 5.61 tiger shark (*Galeocerdo cuvier*)	**Sand tiger sharks - Odontaspididae** Figure 5.62 to 5.64 sand tiger shark (*Carcharias taurus*) **Whale sharks - Rhincodontidae** Figure 5.65 whale shark (*Rhincodon typus*) **SMALL COASTAL SHARKS** **Angel sharks - Squatinidae** Figure 5.66 Atlantic angel shark (*Squatina dumeril*) **Hammerhead sharks - Sphyrnidae** Figure 5.67 to 5.69 bonnethead shark (*Sphyrna tiburo*) **Requiem sharks - Carcharhinidae** Figure 5.70 to 5.72 Atlantic sharpnose shark (*R.. terraenovae*) Figure 5.73 to 5.75 blacknose shark (*C. acronotus*) Figure 5.76 to 5.77 finetooth shark (*C. isodon*) Figure 5.78 smalltail shark (*C. porosus*) **PELAGIC SHARKS** **Cow sharks - Hexanchidae** Figure 5.79 bigeye sixgill shark (*Hexanchus nakamurai*) Figure 5.80 sevengill shark (*Heptranchias perlo*) Figure 5.81 sixgill shark (*Hexanchus griseus*) **Mackerel sharks - Lamnidae** Figure 5.82 longfin mako shark (*Isurus paucus*) Figure 5.83 to 5.85 porbeagle shark (*Lamna nasus*) Figure 5.86 shortfin mako shark (*Isurus oxyrinchus*) **Requiem sharks - Carcharhinidae** Figure 5.87 to 5.89 blue shark (*Prionace glauca*) Figure 5.90 oceanic whitetip shark (*C. longimanus*) **Thresher sharks - Alopiidae** Figure 5.91 bigeye thresher shark (*Alopias superciliosus*) Figure 5.92 thresher shark (*A. vulpinus*)

Table 5.0.4 List of abbreviations and acronyms for EFH data sources used in the maps.

Belcher	Belcher and Shierling 2002
Carlson	Carlson 2002
COASTSPAN	Cooperative Atlantic States Shark Pupping and Nursery Area Program
CSTP	Cooperative Shark Tagging Program
CTS	Cooperative Tagging System
Govoni	Govoni *et al*., 2003
Gurshin	Gurshin 2002
Jensen	Jensen *et al*., 2002
Jones/Grace	Jones and Grace 2002
Michel/ST	Michel and Steiner 2002
Mote	Mote Marine Laboratory
Neer	Neer *et al*., 2002
Parsons	Parsons 2002
POP	Pelagic Observer Program
SEAMAP	Southeast Area Monitoring and Assessment Program
SELL	Southeast Longline Survey
SOP	Shark Observer Program
Ulrich	Ulrich and Riley 2002

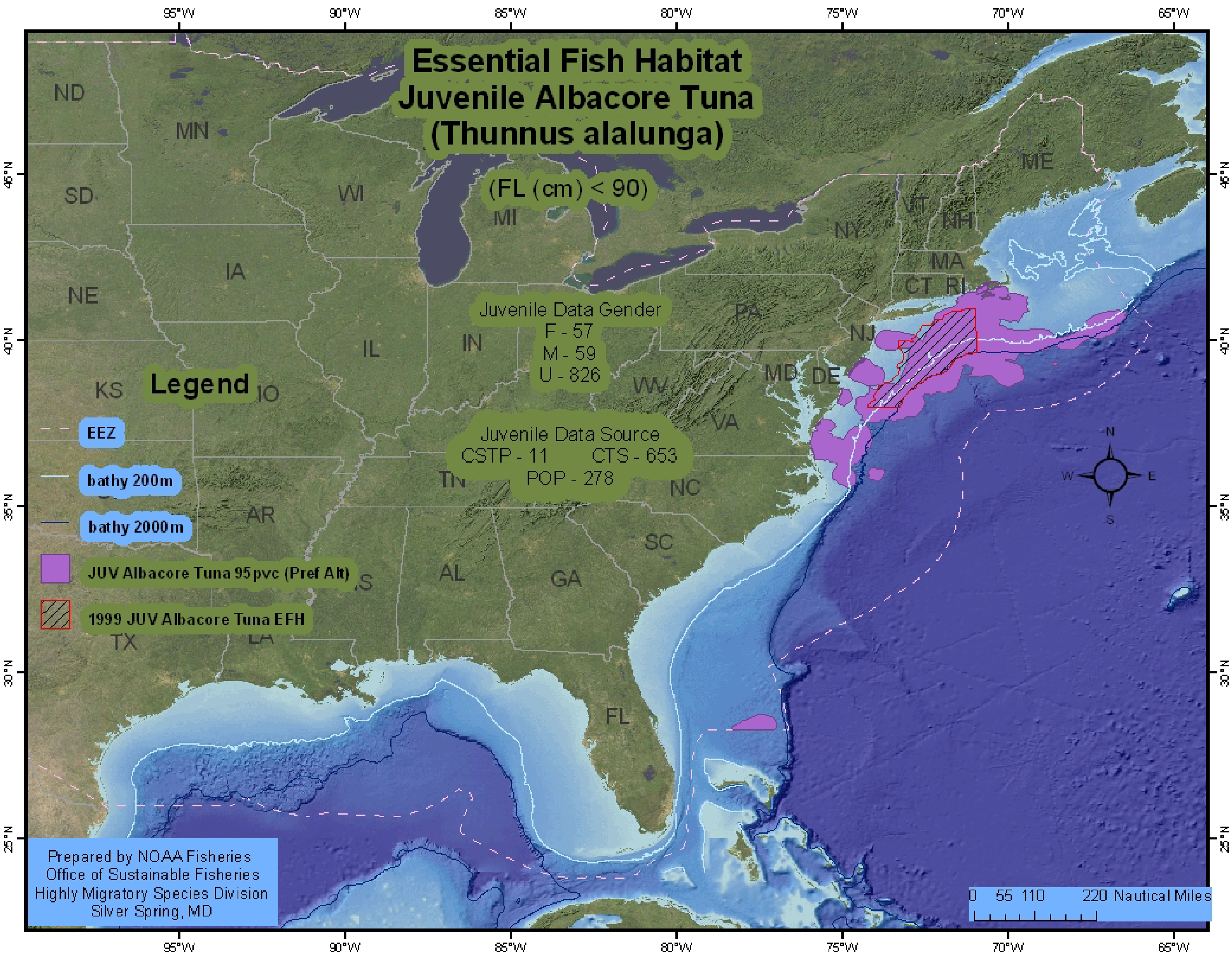

Figure 5.1 **Atlantic Albacore Tuna Juvenile.**

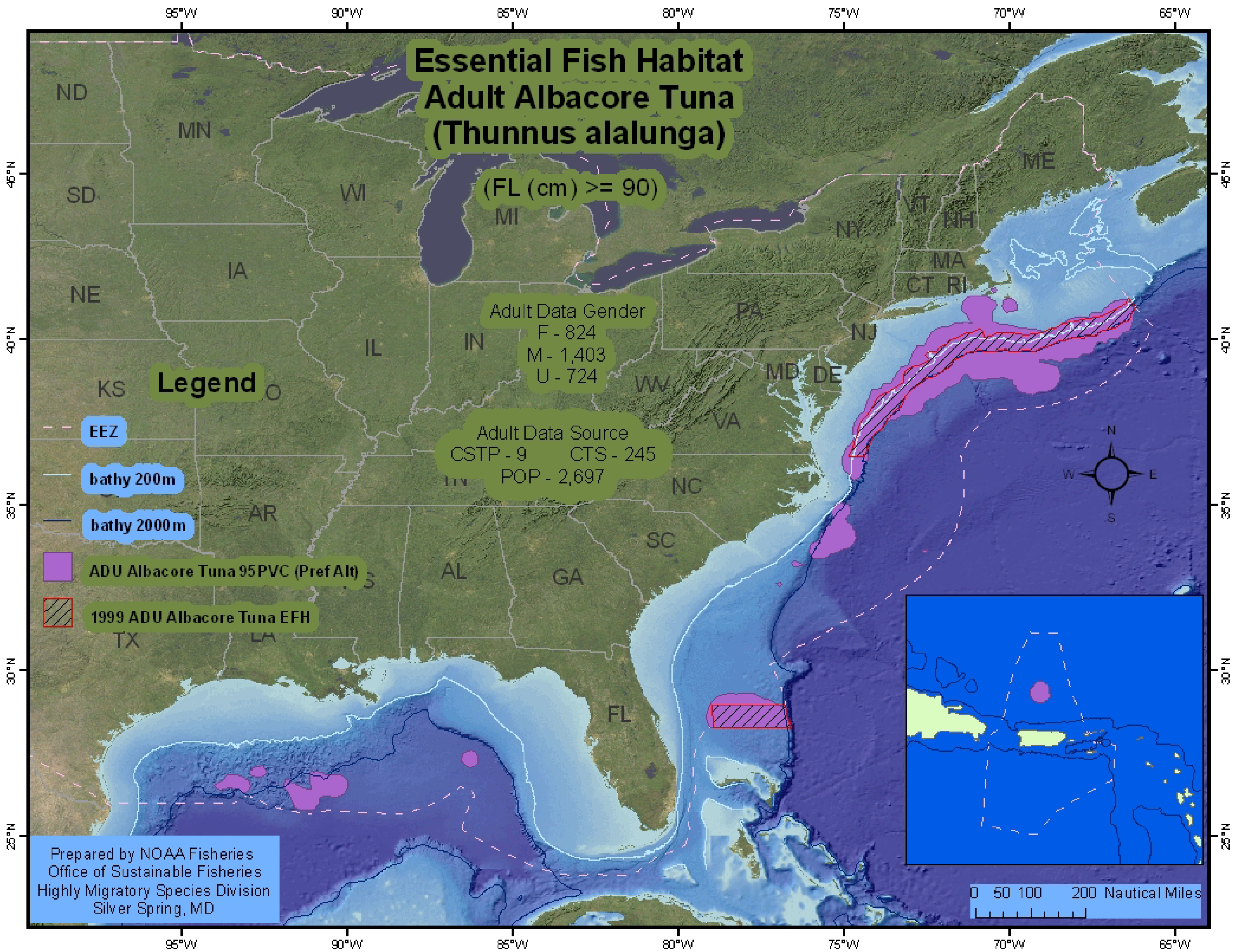

Figure 5.2 Atlantic Albacore Tuna Adult.

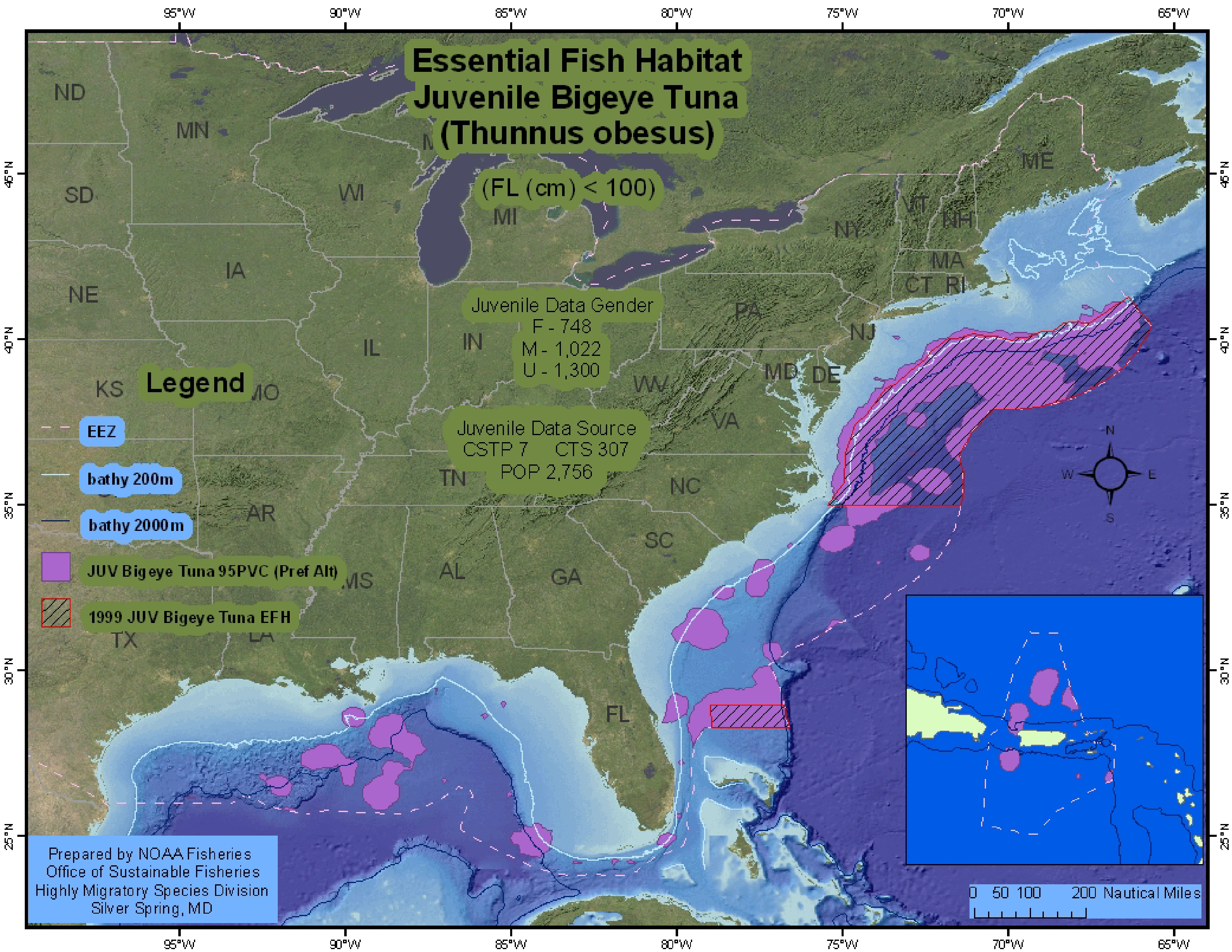

Figure 5.3 Atlantic Bigeye Tuna: Juvenile.

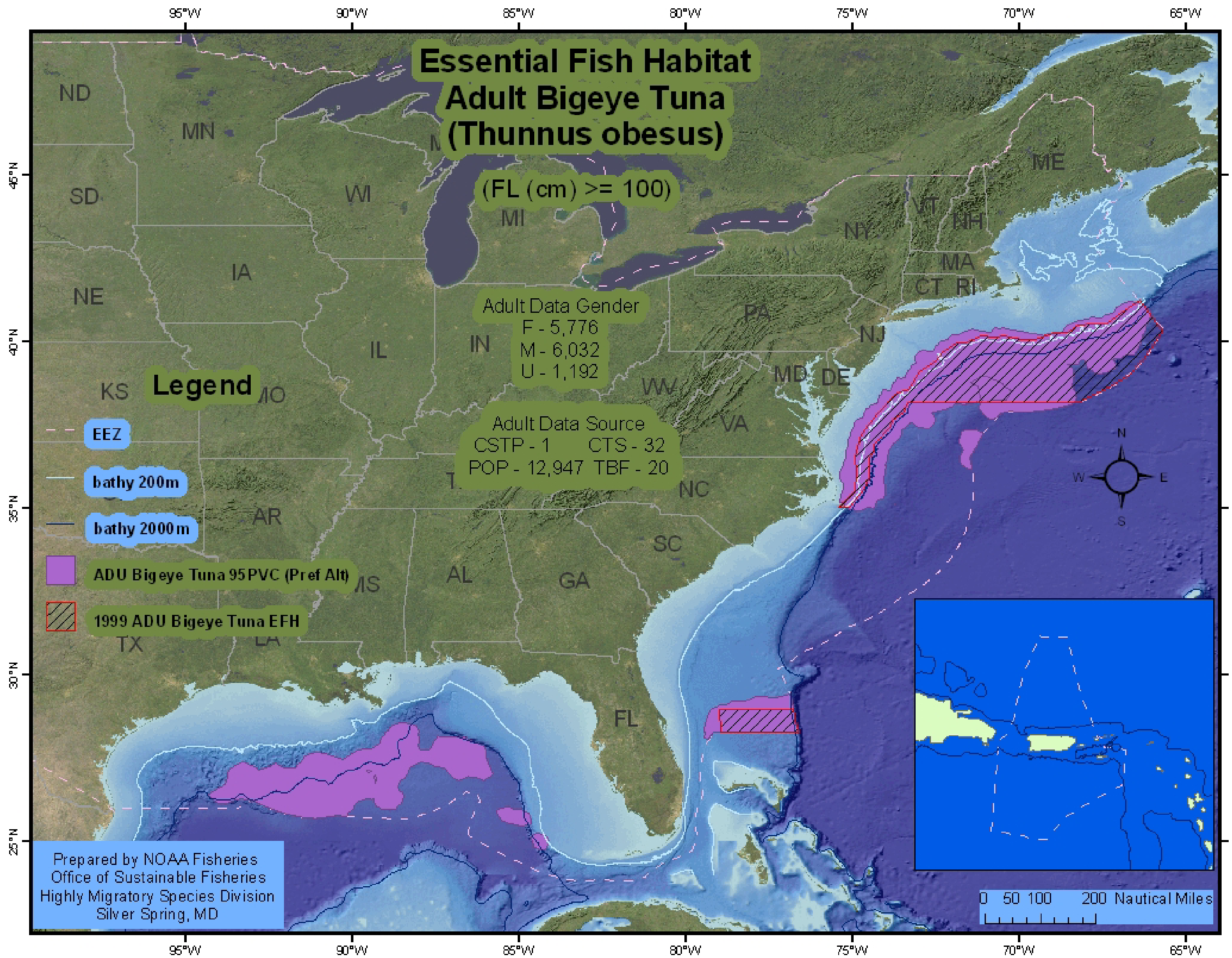

Figure 5.4 Atlantic Bigeye Tuna: Adult.

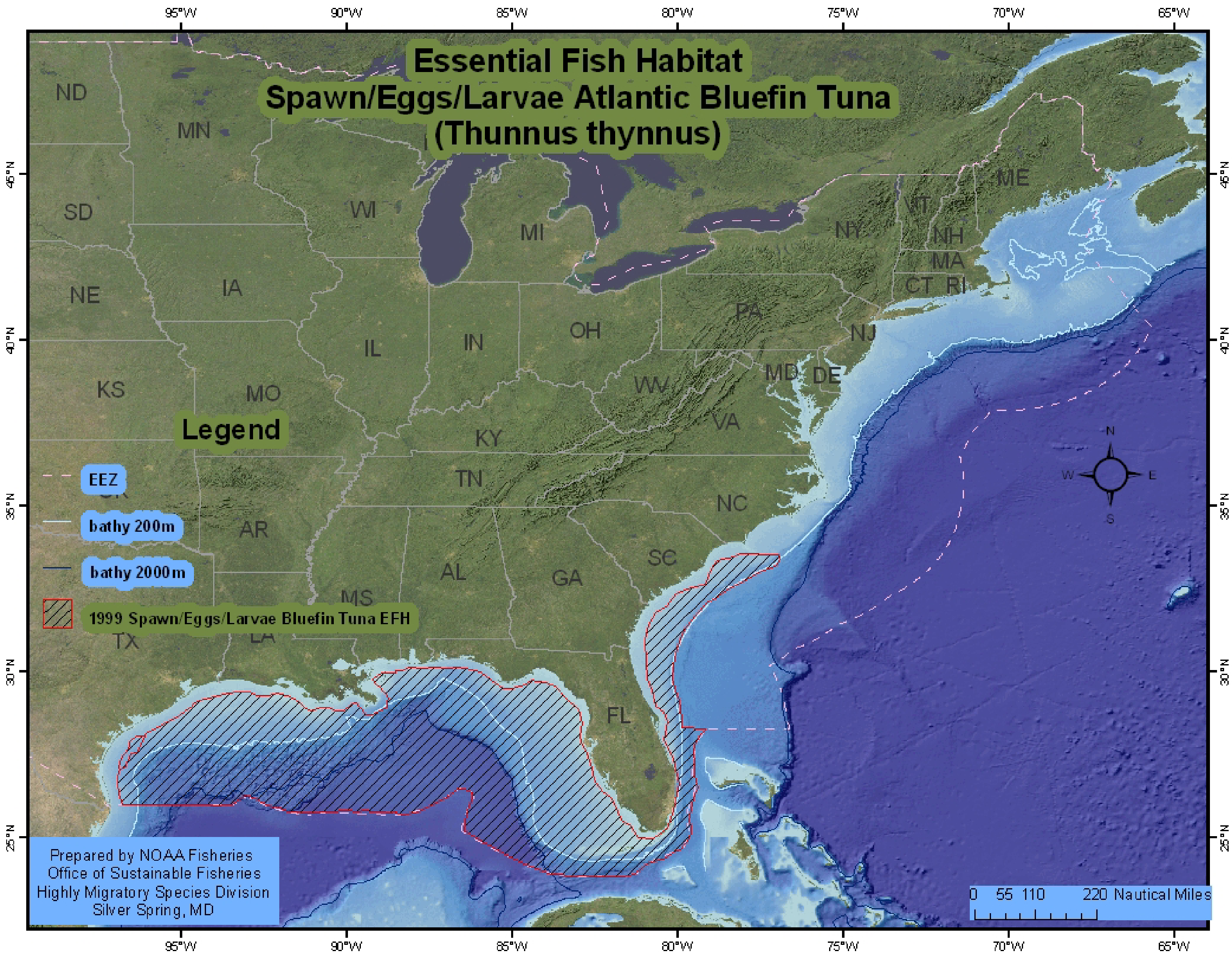

Figure 5.5 Atlantic Bluefin Tuna: Spawning, Eggs, and Larvae. No changes are being proposed to the 1999 boundary. The 1999 boundary will remain in effect.

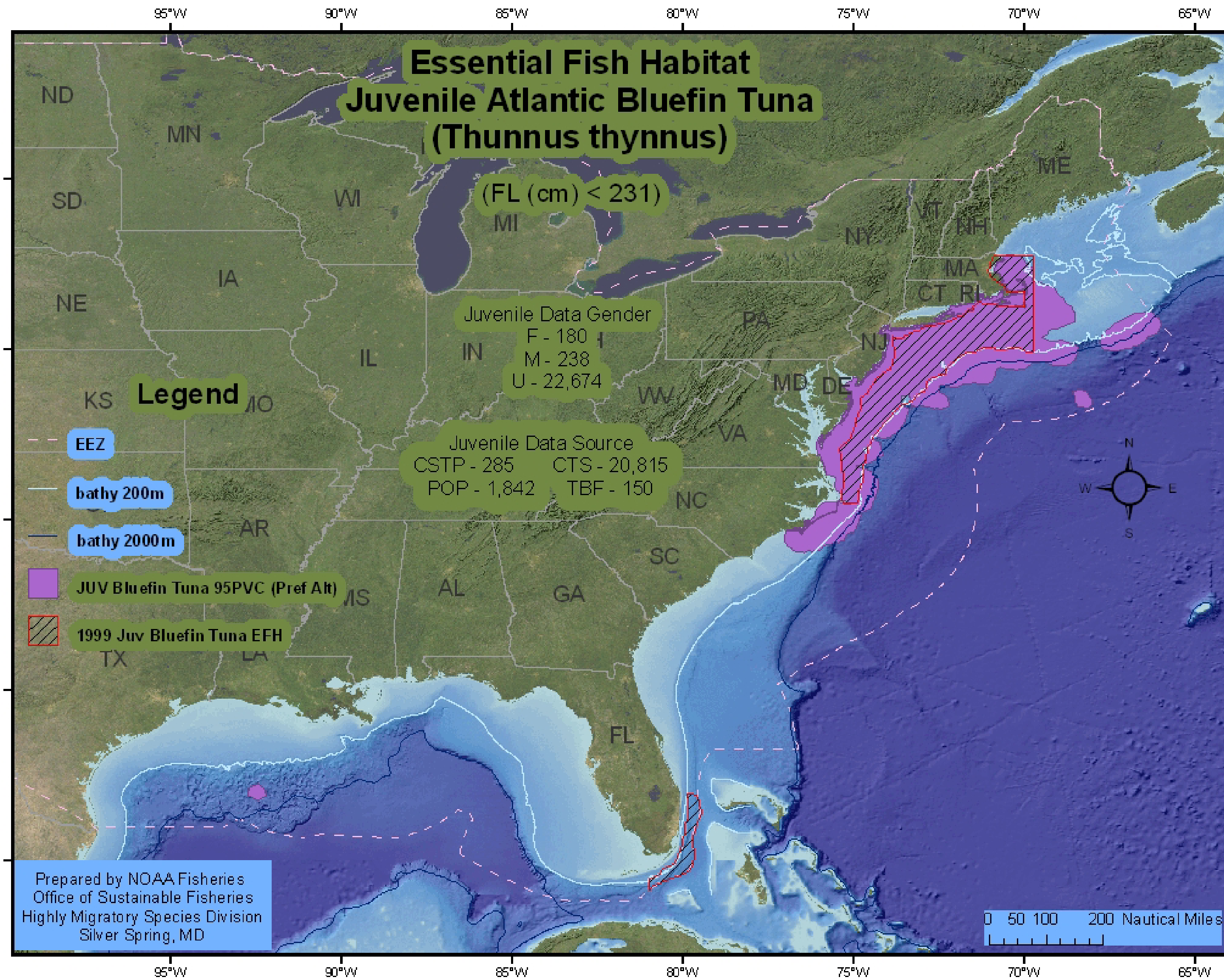

Figure 5.6 **Atlantic Bluefin Tuna: Juvenile.**

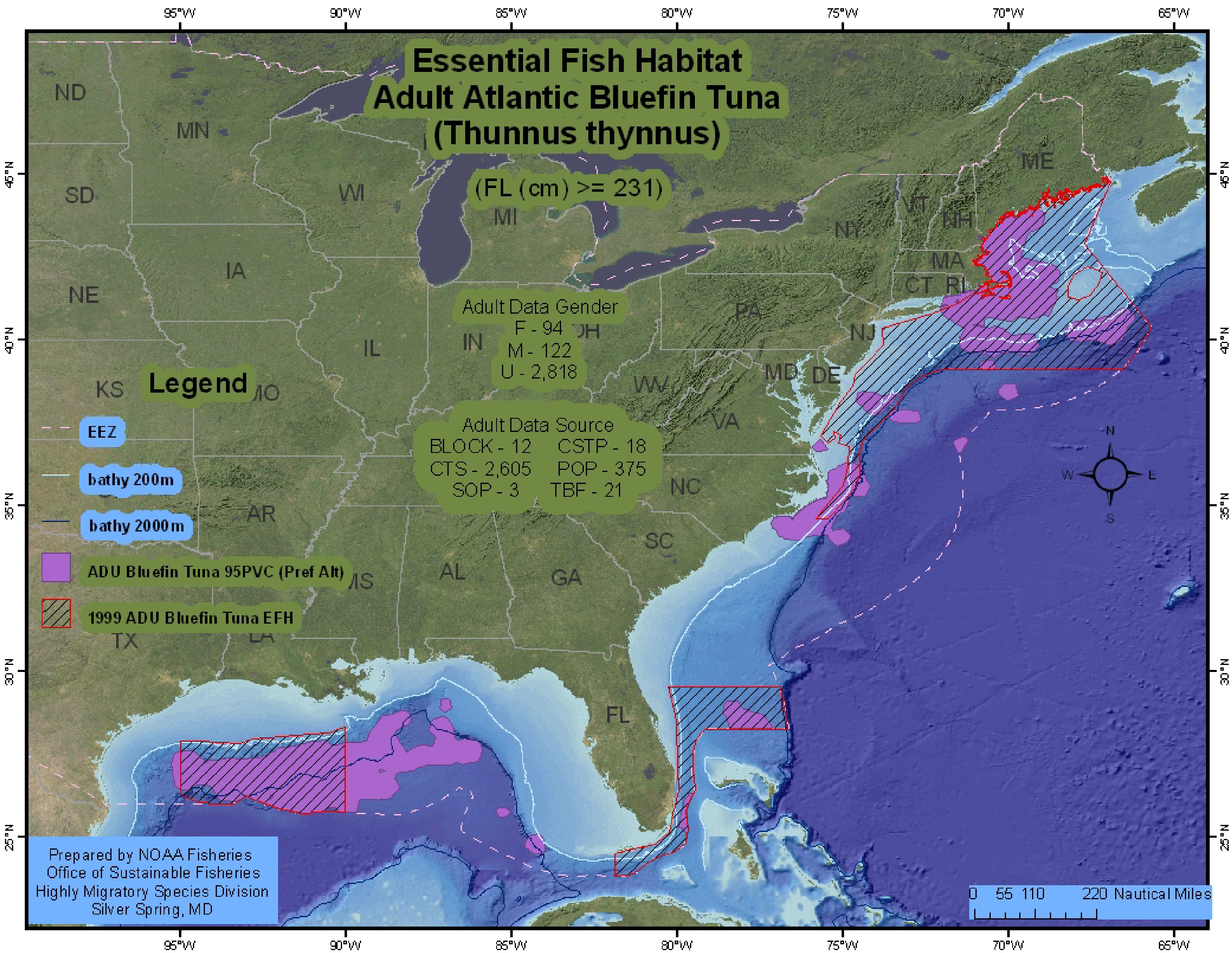

Figure 5.7 **Atlantic Bluefin Tuna: Adult.**

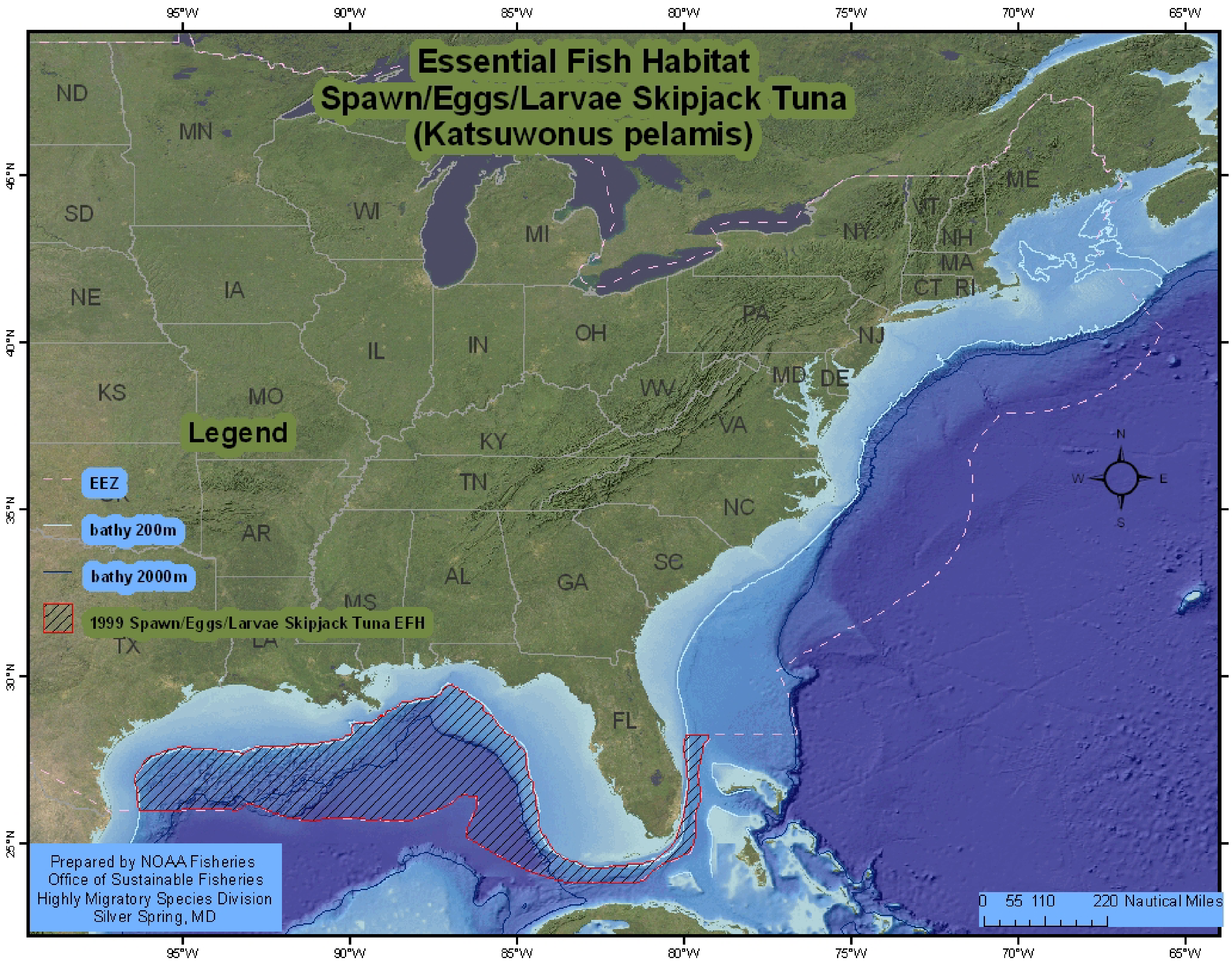

Figure 5.8 Atlantic Skipjack Tuna: Spawning, Eggs, and Larvae. No changes are being proposed to the 1999 boundary. The 1999 boundary will remain in effect.

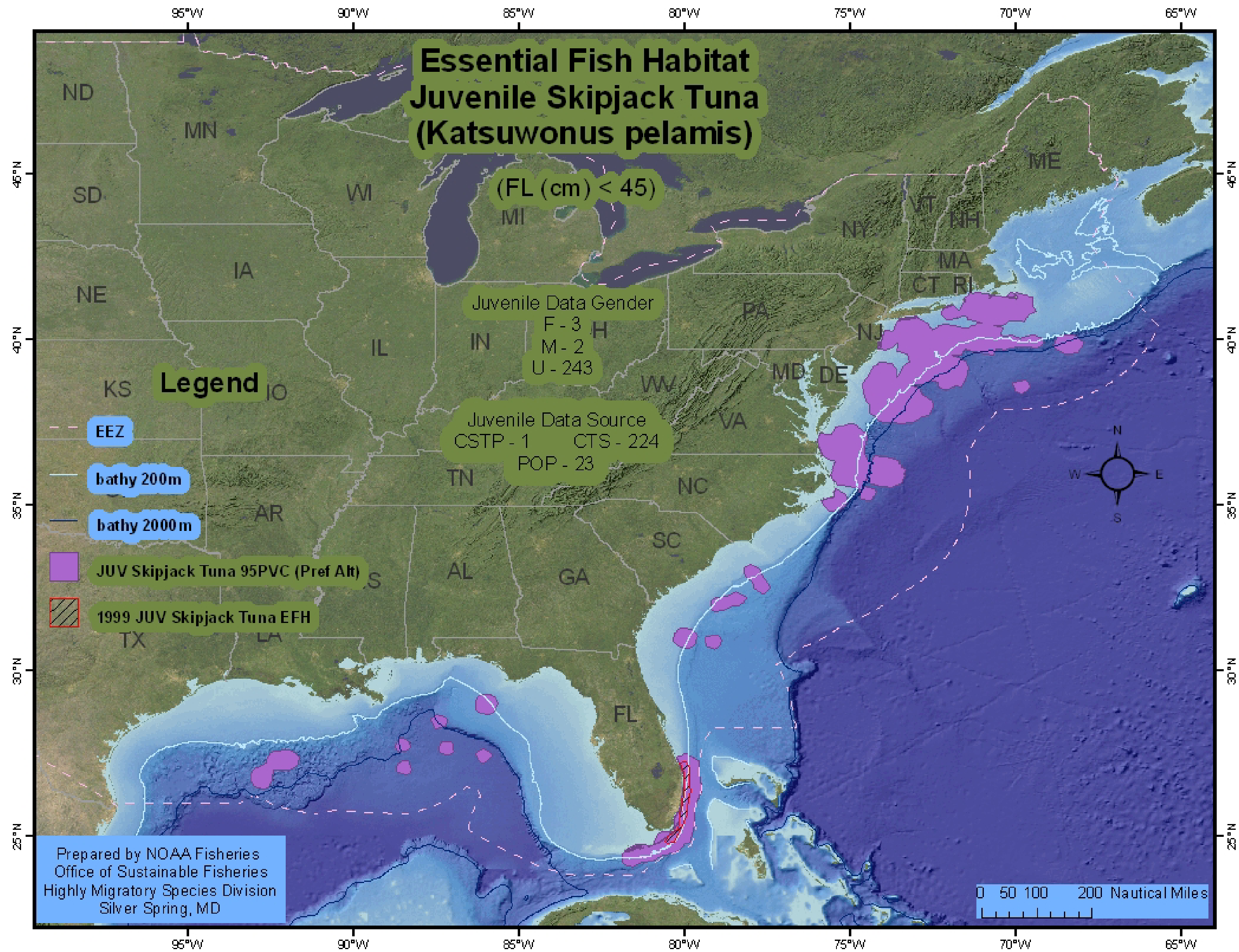

Figure 5.9 **Atlantic Skipjack Tuna: Juvenile.**

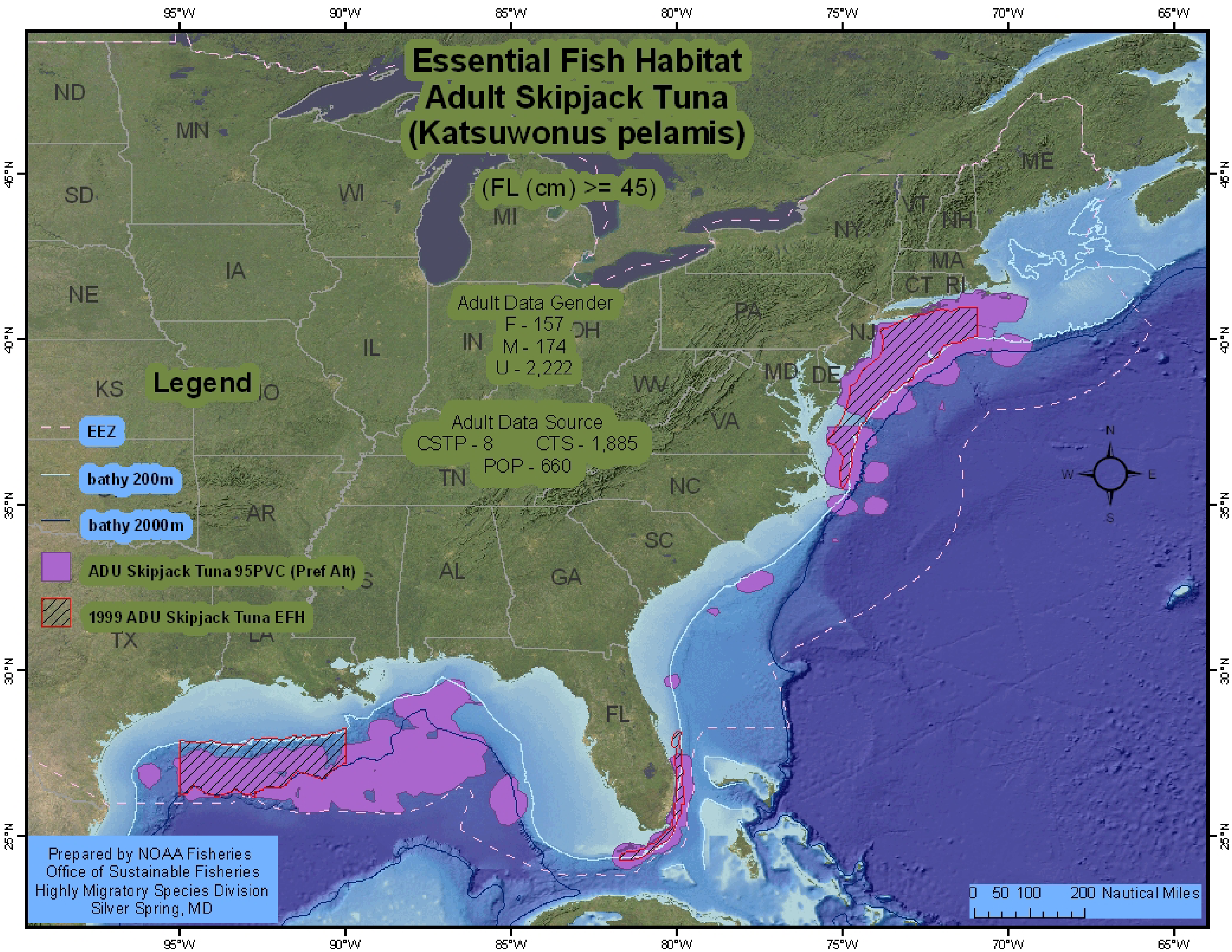

Figure 5.10 **Atlantic Skipjack Tuna: Adult.**

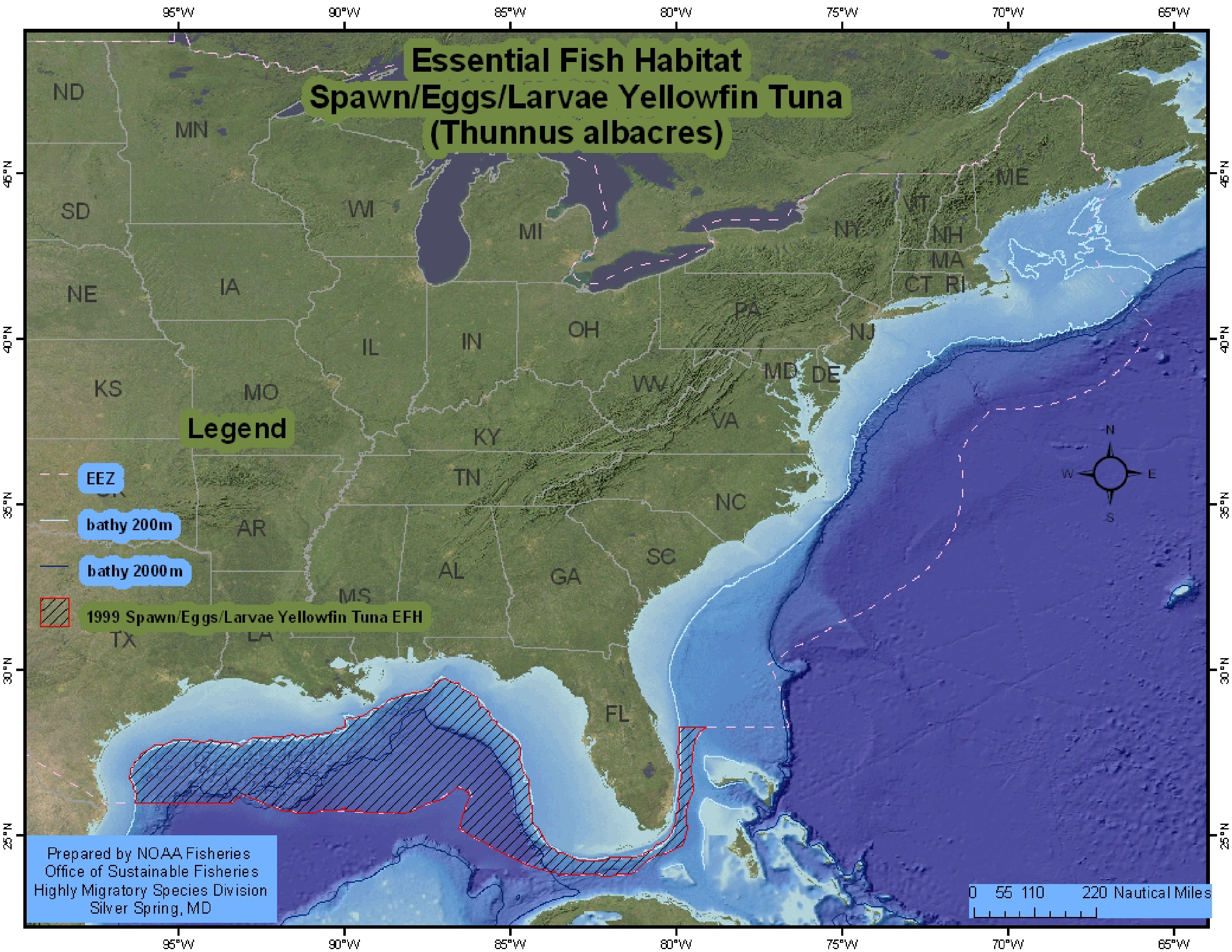

Figure 5.11 **Atlantic Yellowfin Tuna: Spawning, Eggs, and Larvae. No changes are being proposed to the 1999 boundary. The 1999 boundary will remain in effect.**

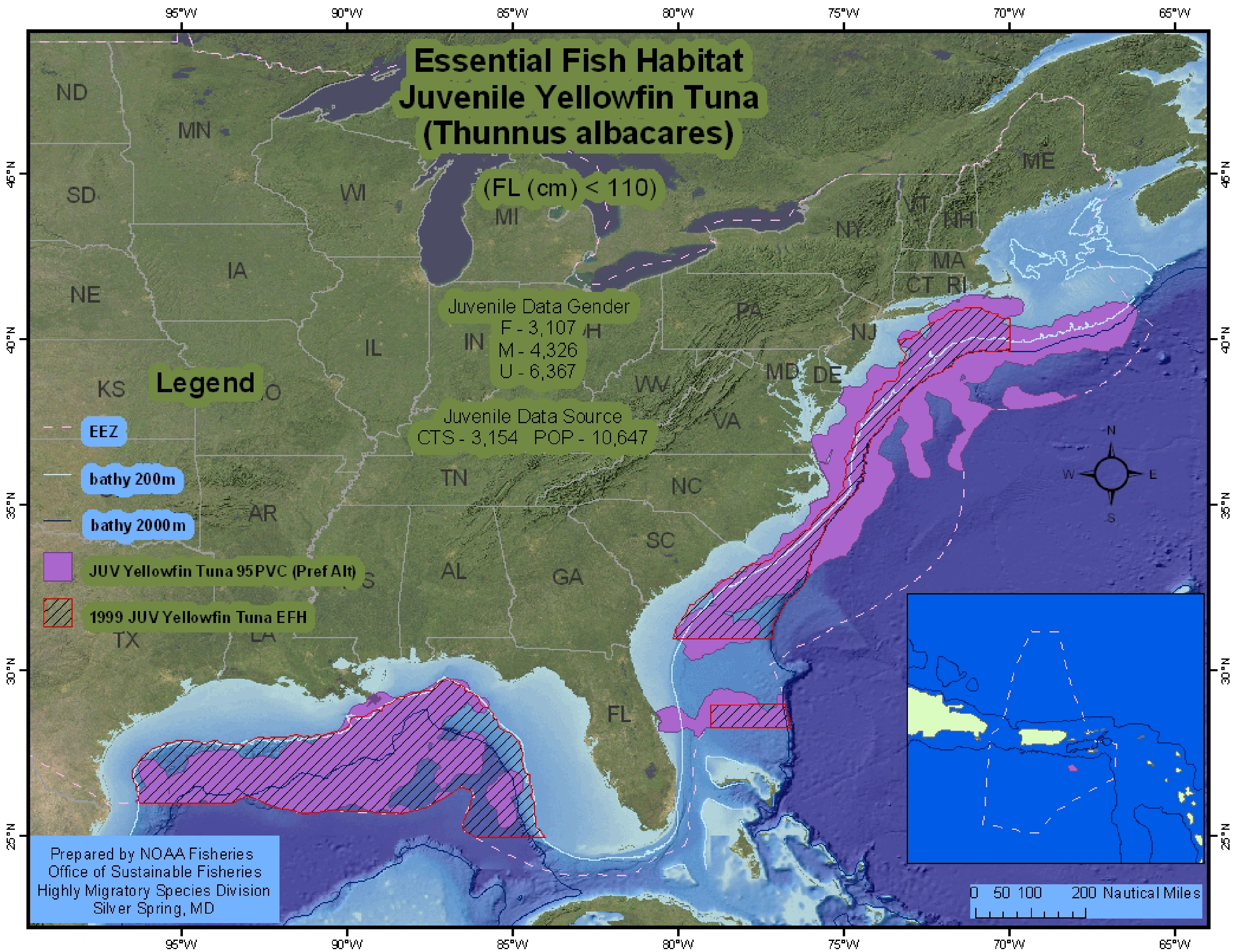

Figure 5.12 **Atlantic Yellowfin Tuna: Juvenile.**

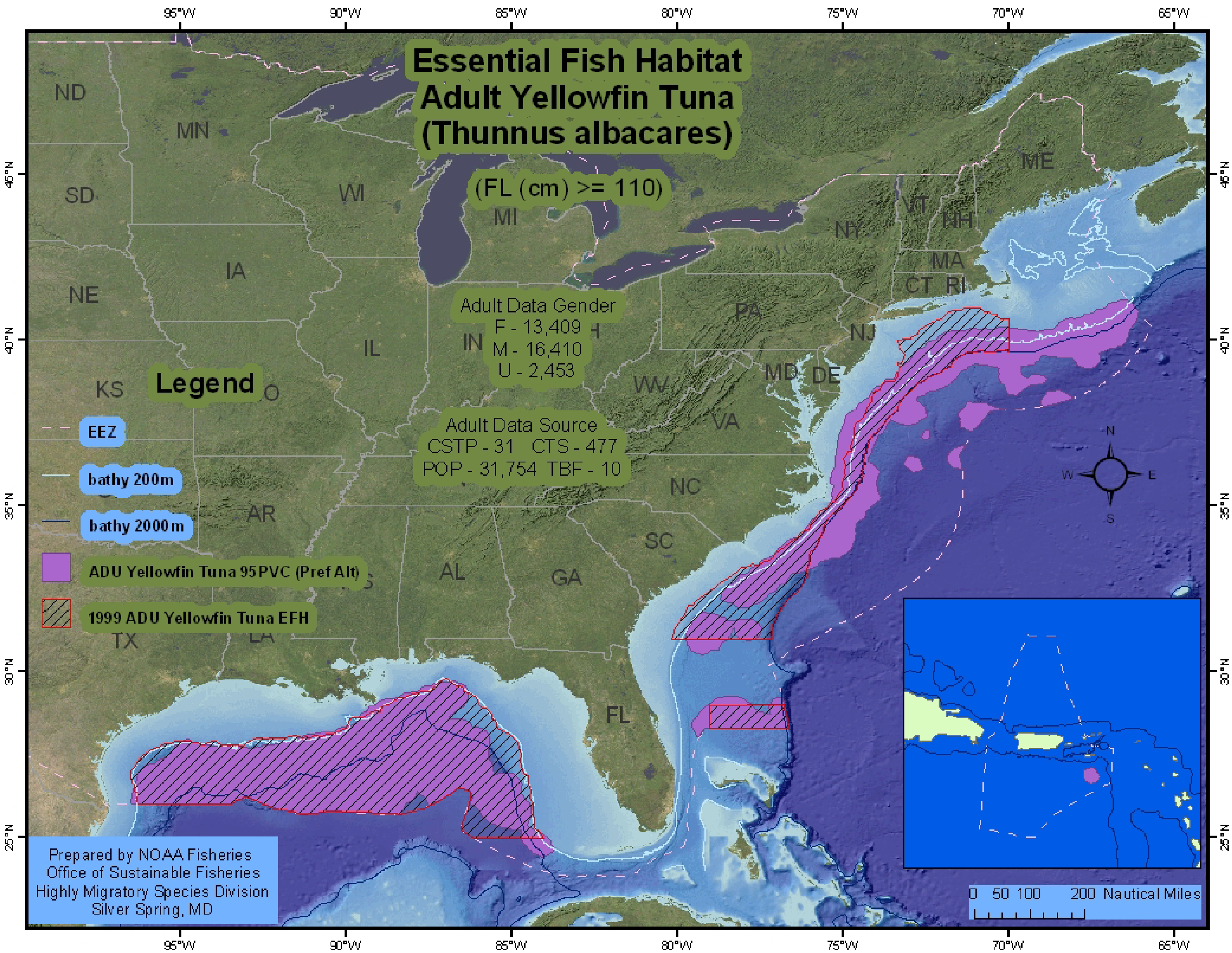

Figure 5.13 Atlantic Yellowfin Tuna: Adult.

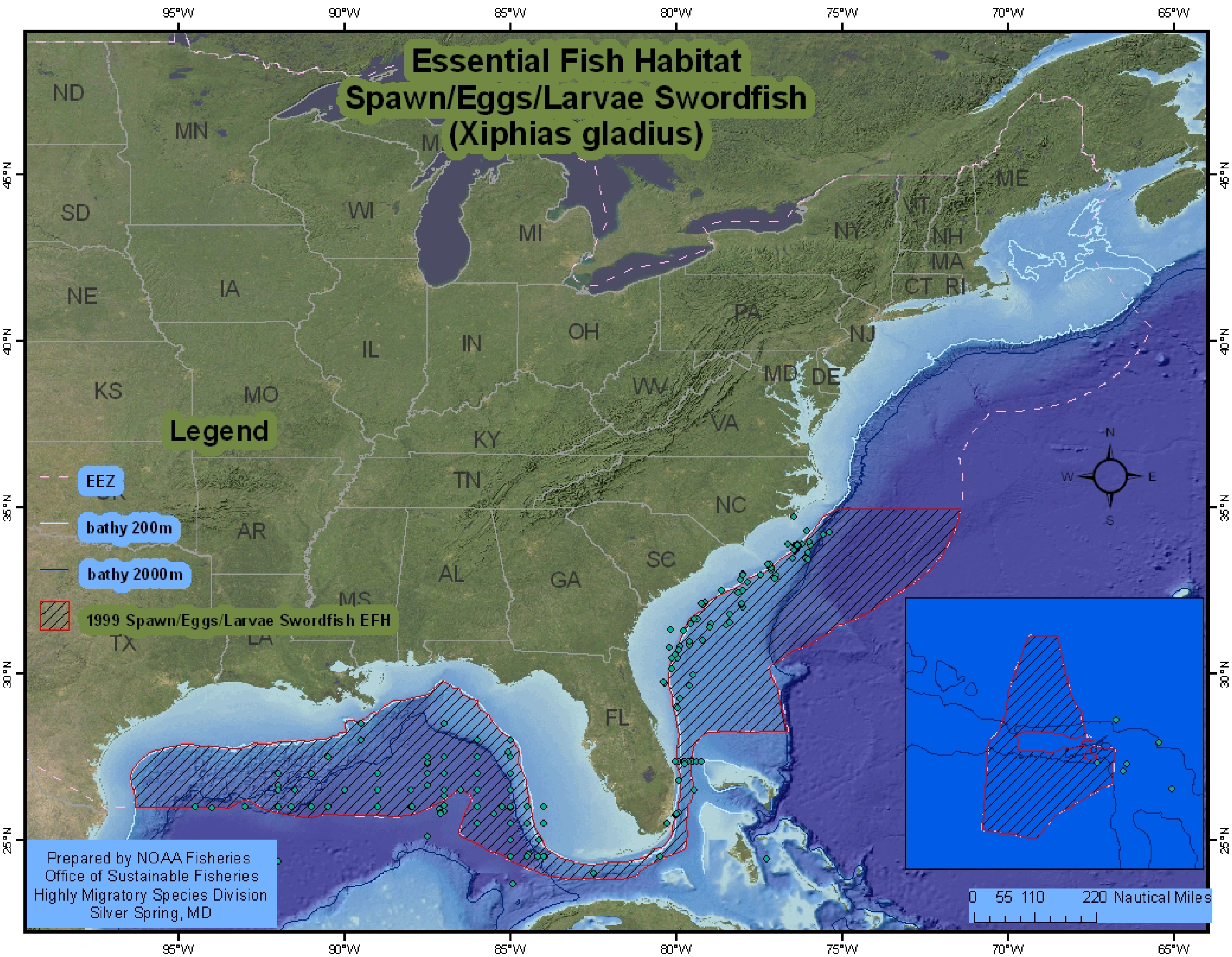

Figure 5.14 Atlantic Swordfish: Spawning, Eggs, and Larvae. No changes are being proposed to the 1999 boundary. The 1999 boundary will remain in effect.

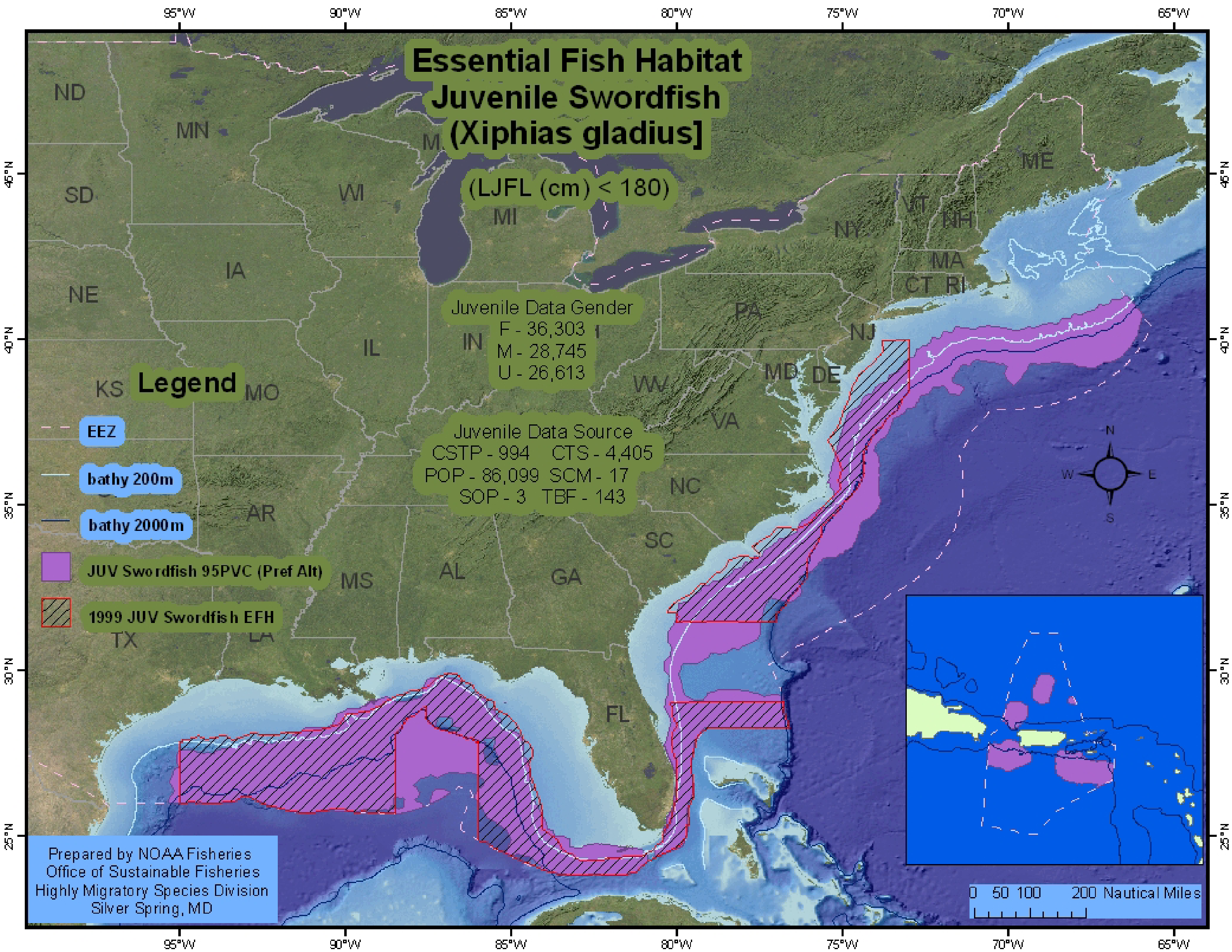

Figure 5.15 **Atlantic Swordfish: Juvenile.**

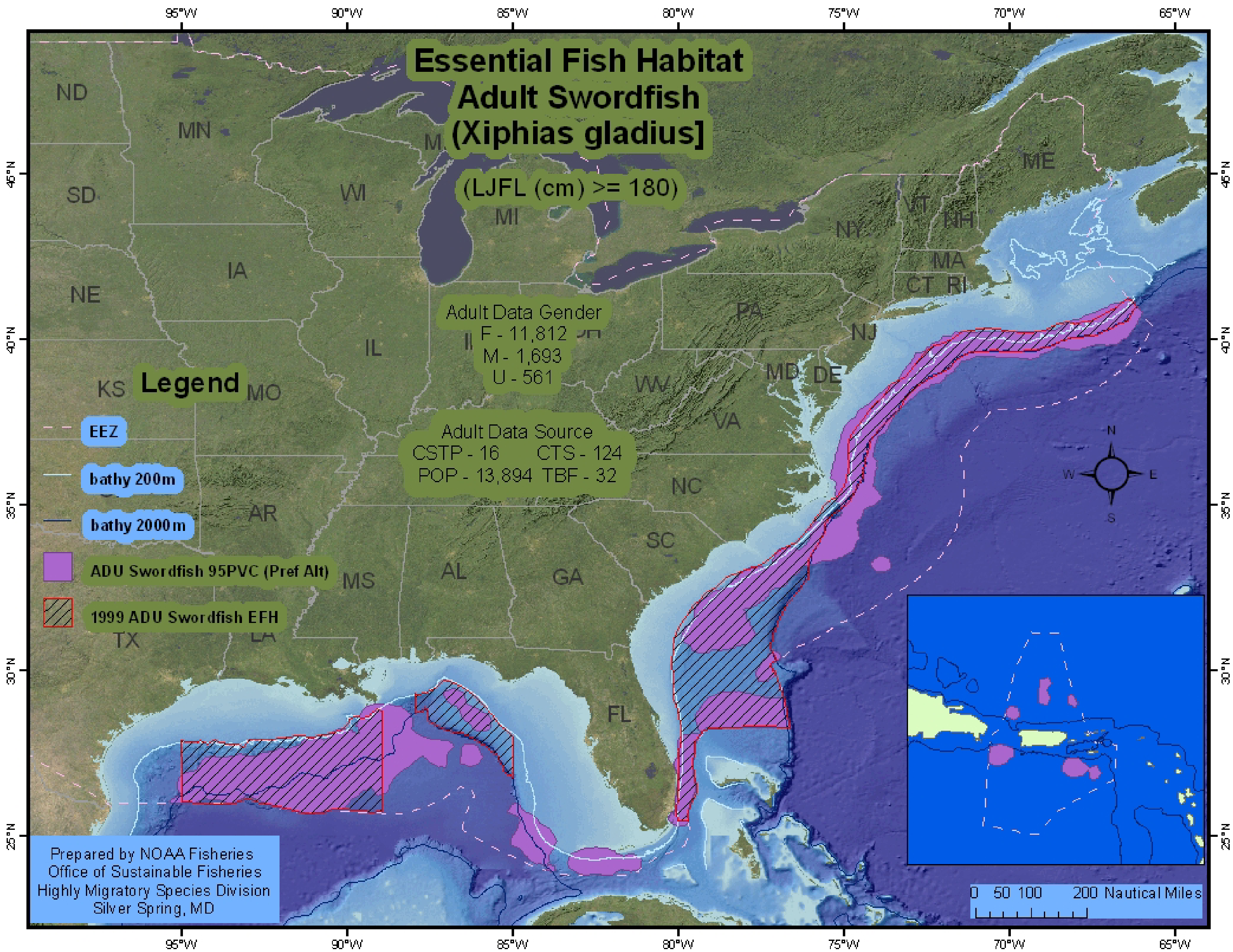

Figure 5.16 **Atlantic Swordfish: Adult.**

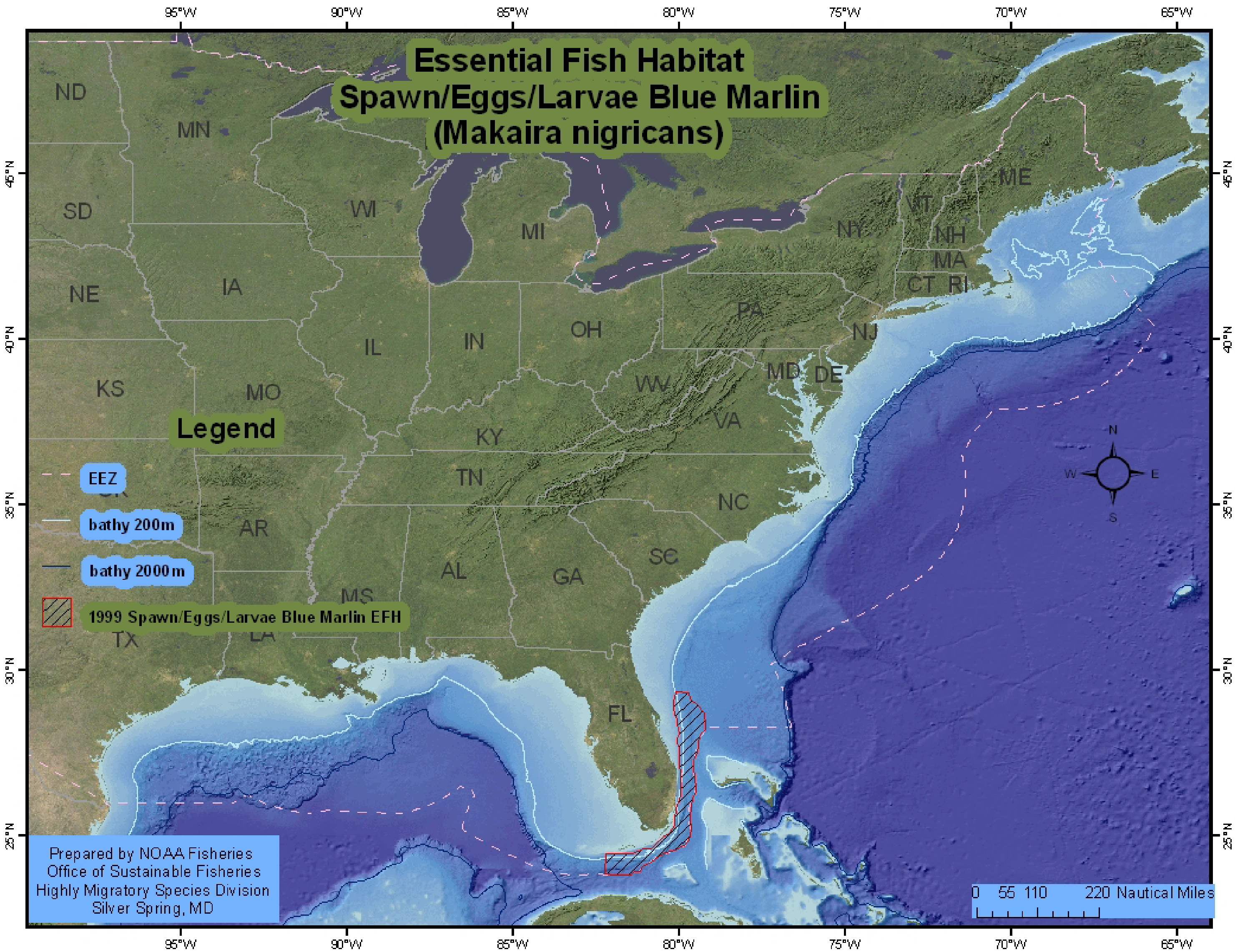

Figure 5.17 Blue Marlin: Spawning, Eggs, and Larvae. No changes are being proposed to the 1999 boundary. The 1999 boundary will remain in effect.

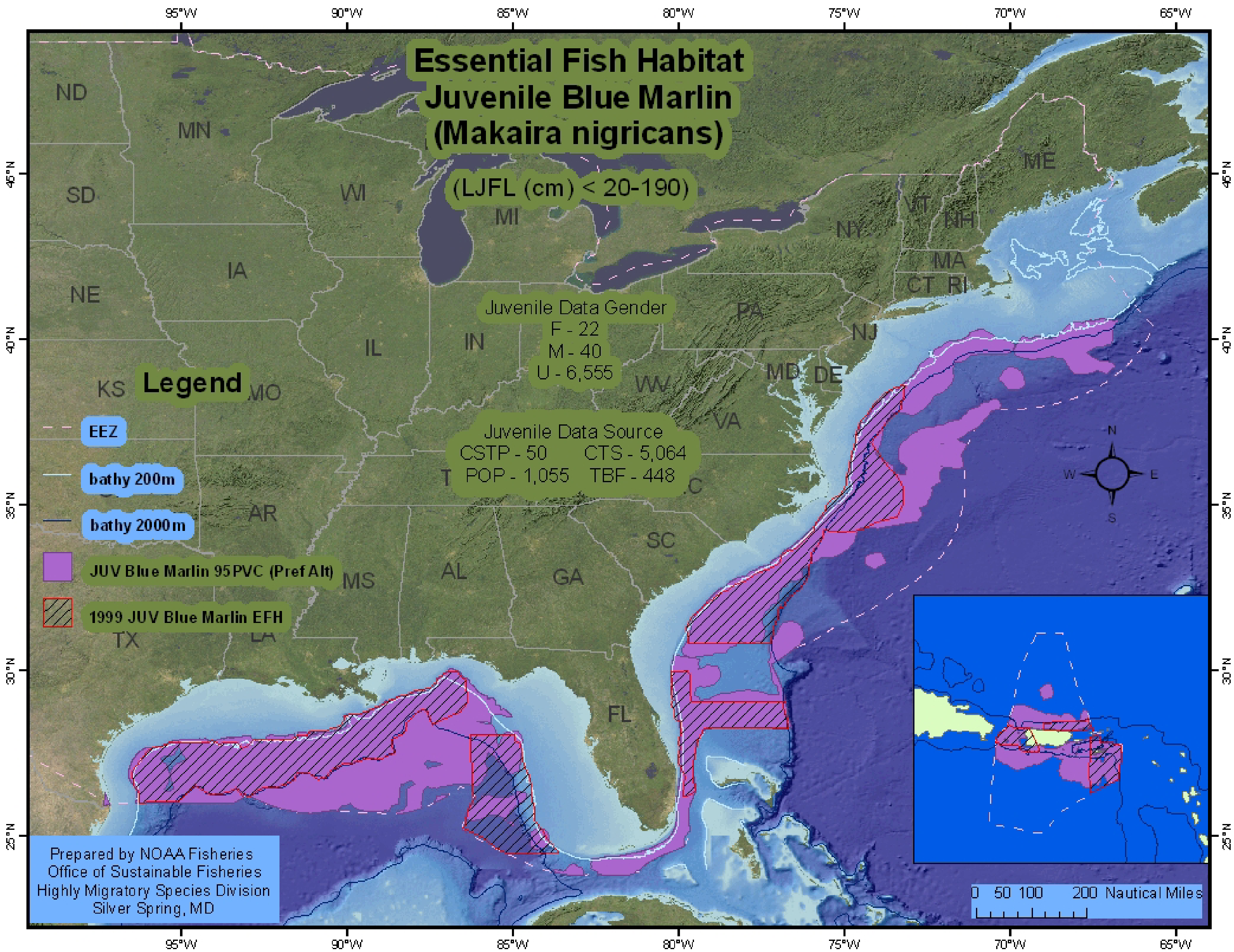

Figure 5.18 **Blue Marlin: Juvenile.**

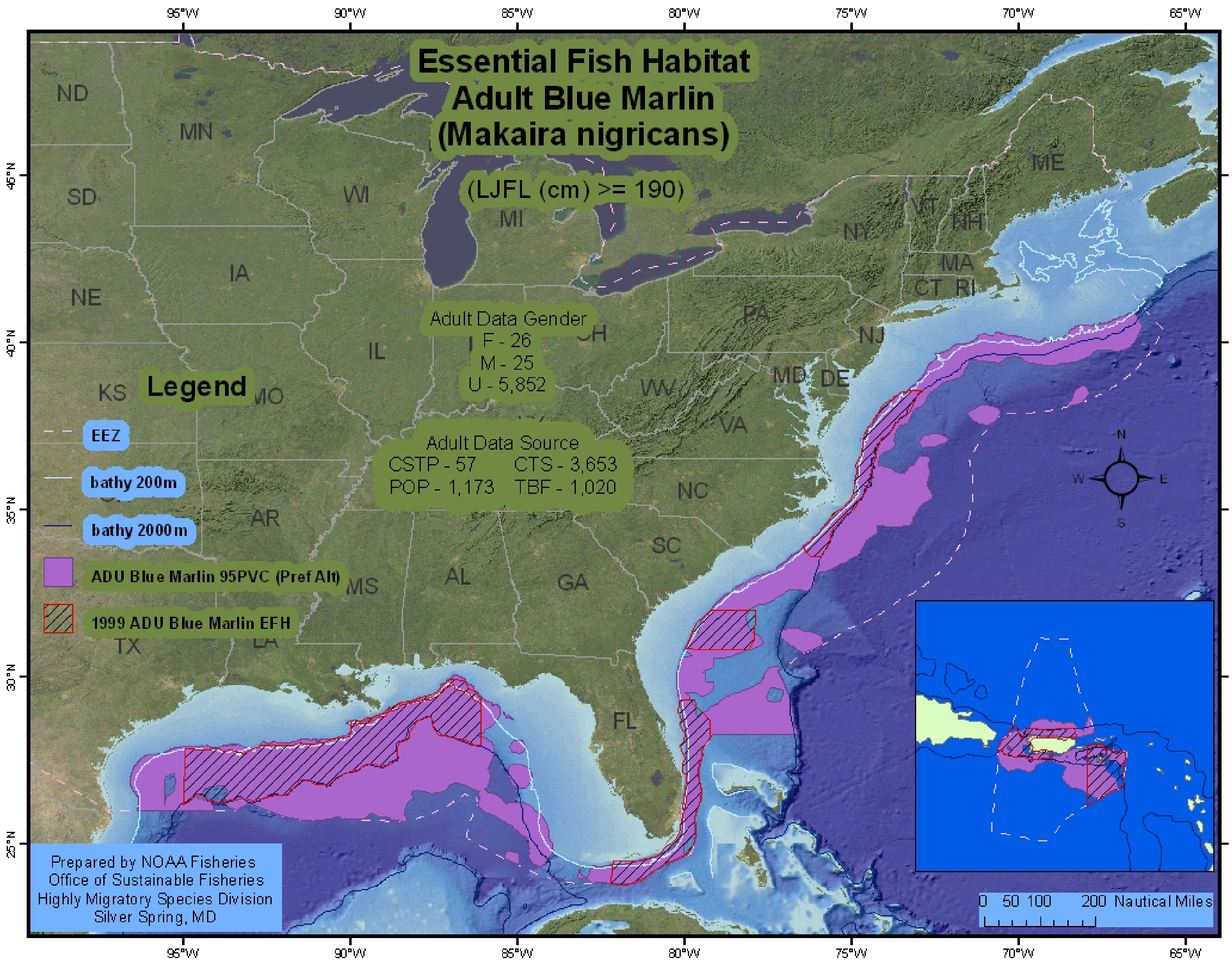

Figure 5.19 Blue Marlin: Adult.

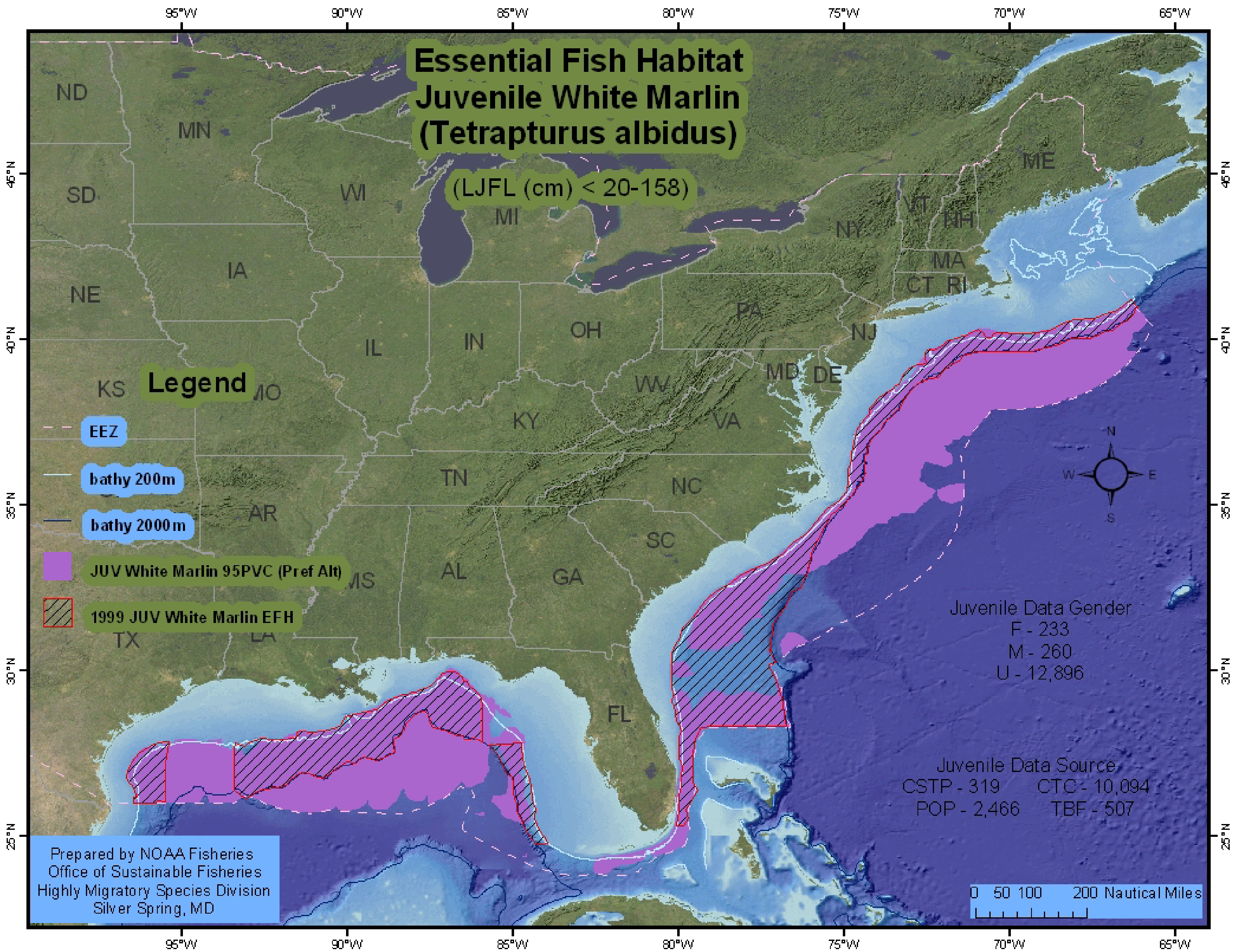

Figure 5.20 **White Marlin: Juvenile.**

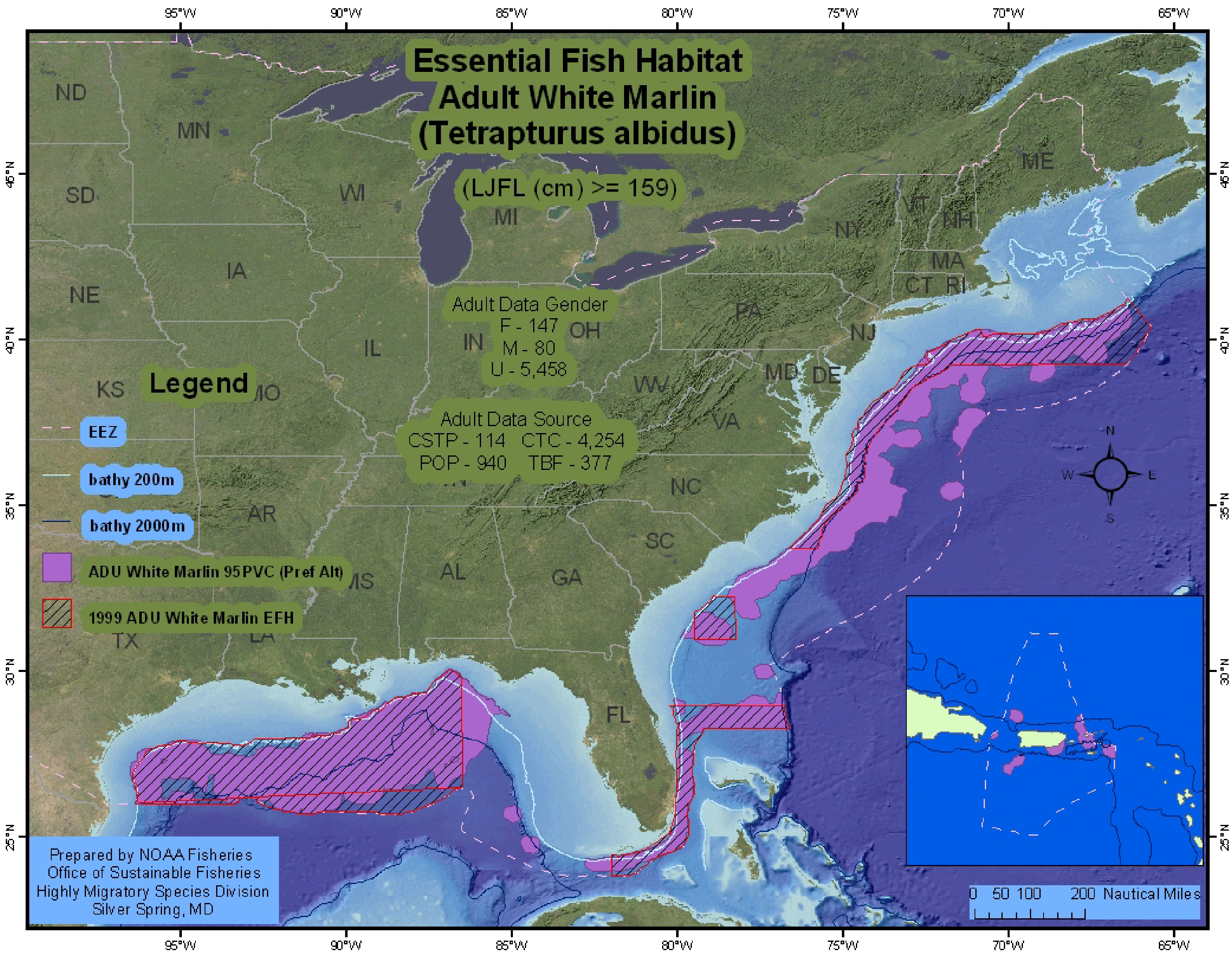

Figure 5.21 **White Marlin: Adult.**

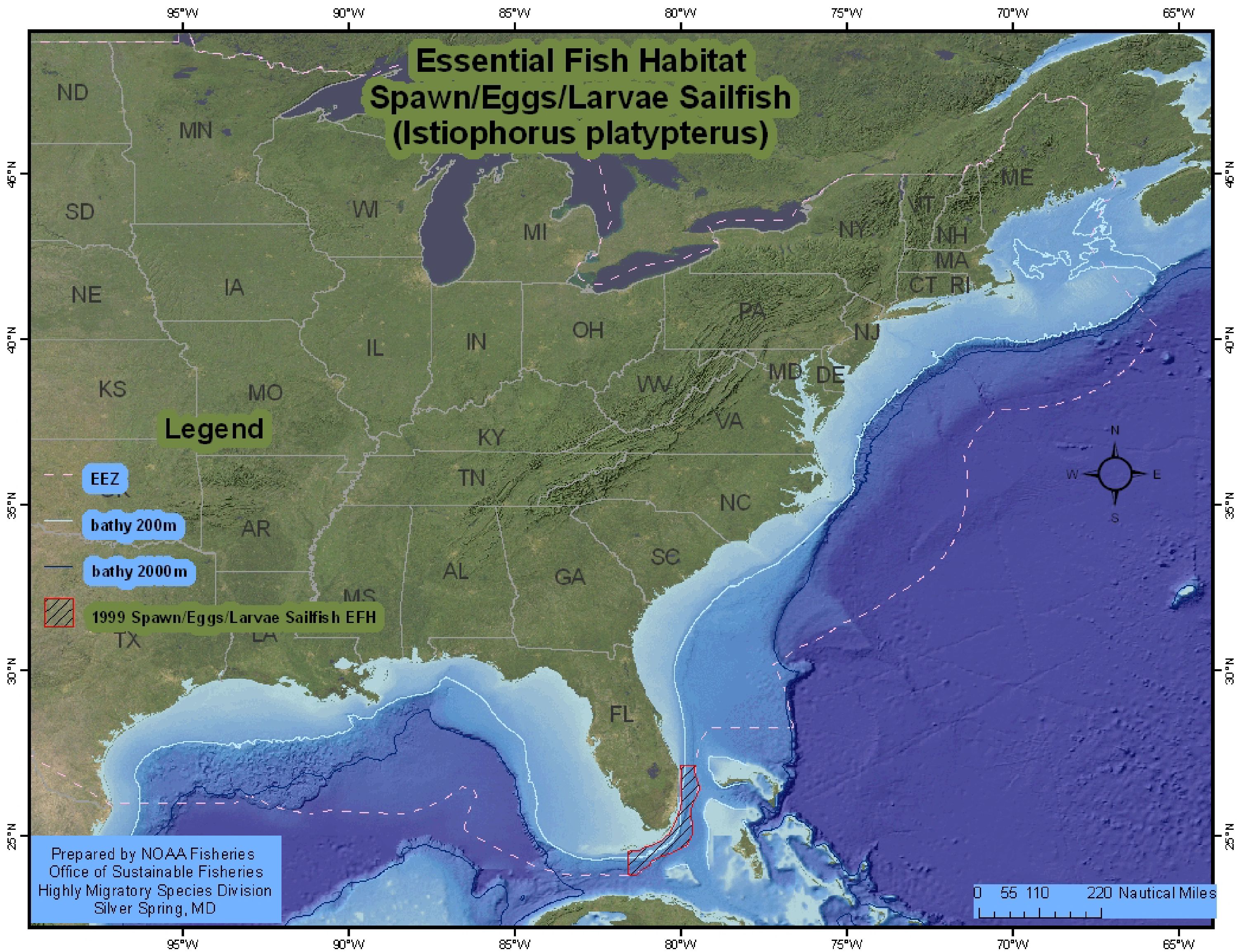

Figure 5.22 Sailfish: Spawning, Eggs, and Larvae. No changes are being proposed to the 1999 boundary. The 1999 boundary will remain in effect.

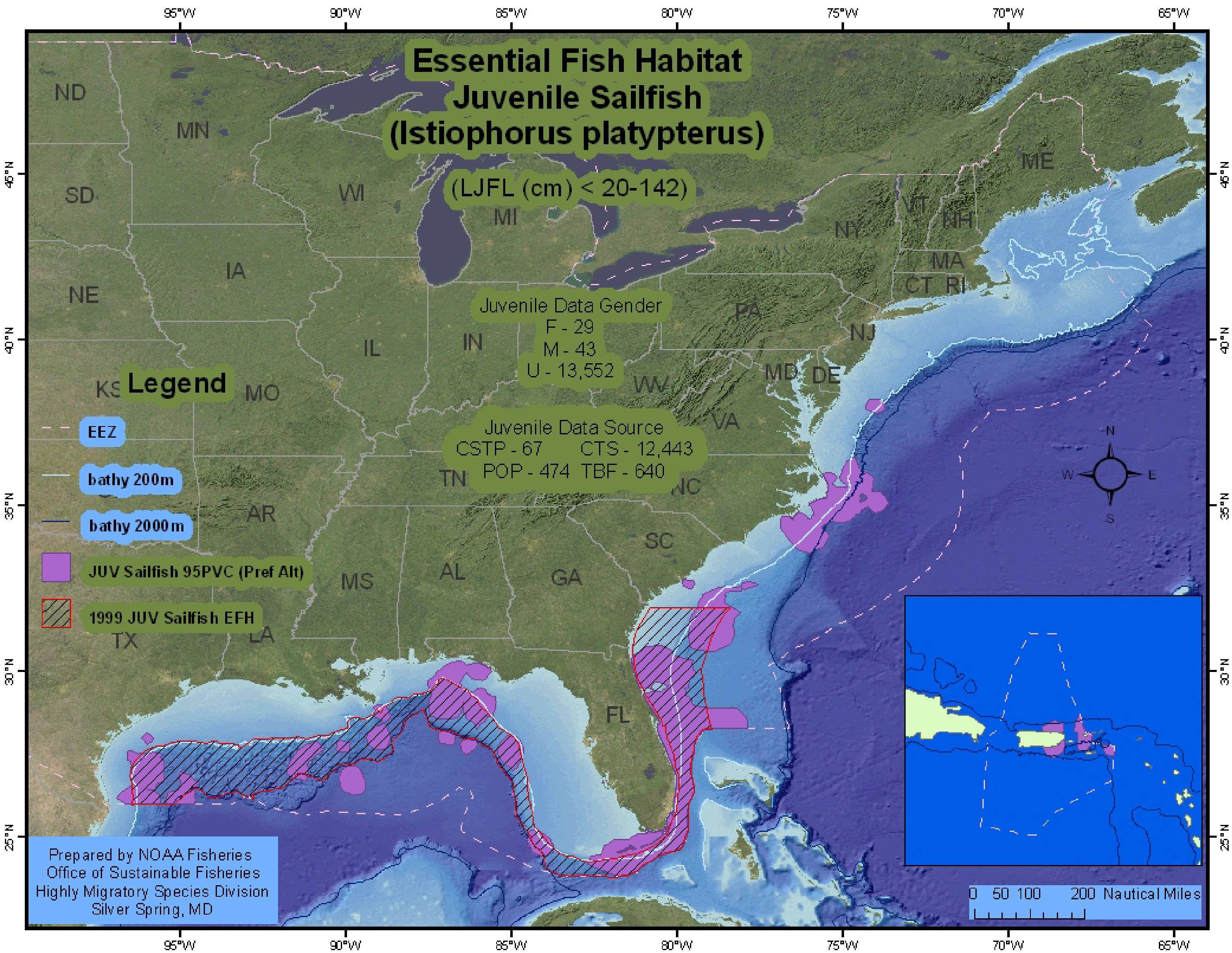

Figure 5.23 **Sailfish: Juvenile.**

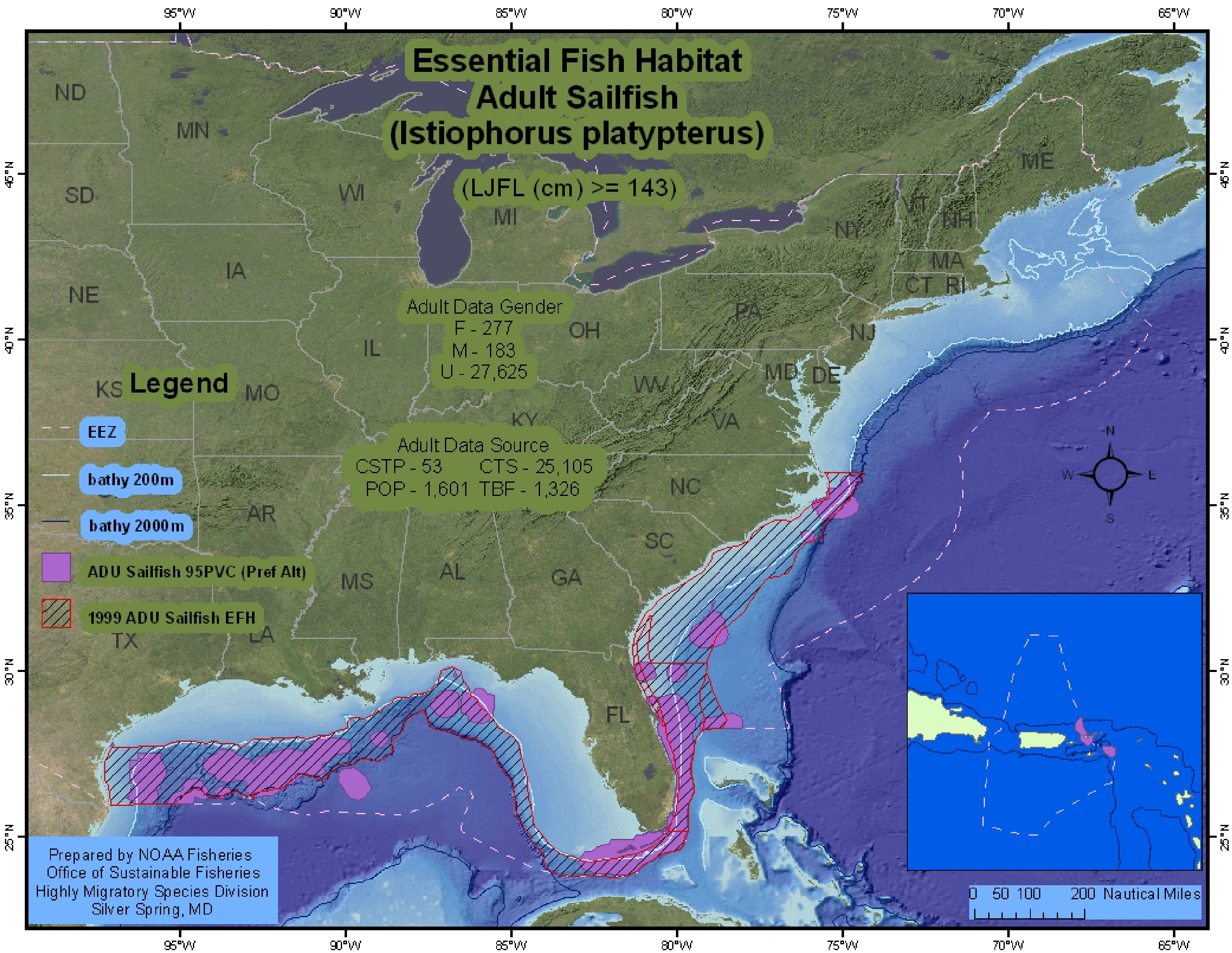

Figure 5.24 Sailfish: Adult.

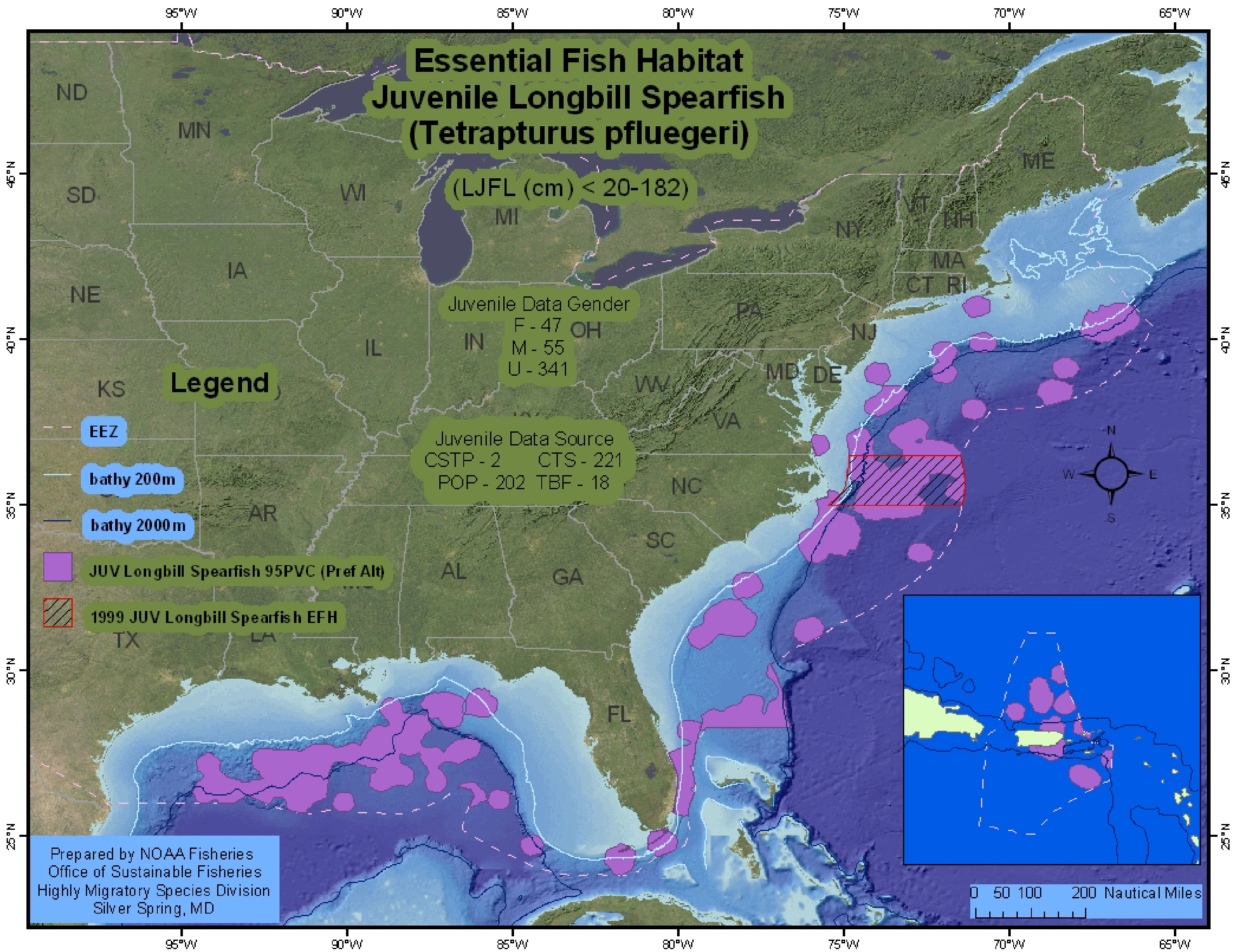

Figure 5.25 Longbill Spearfish: Juvenile.

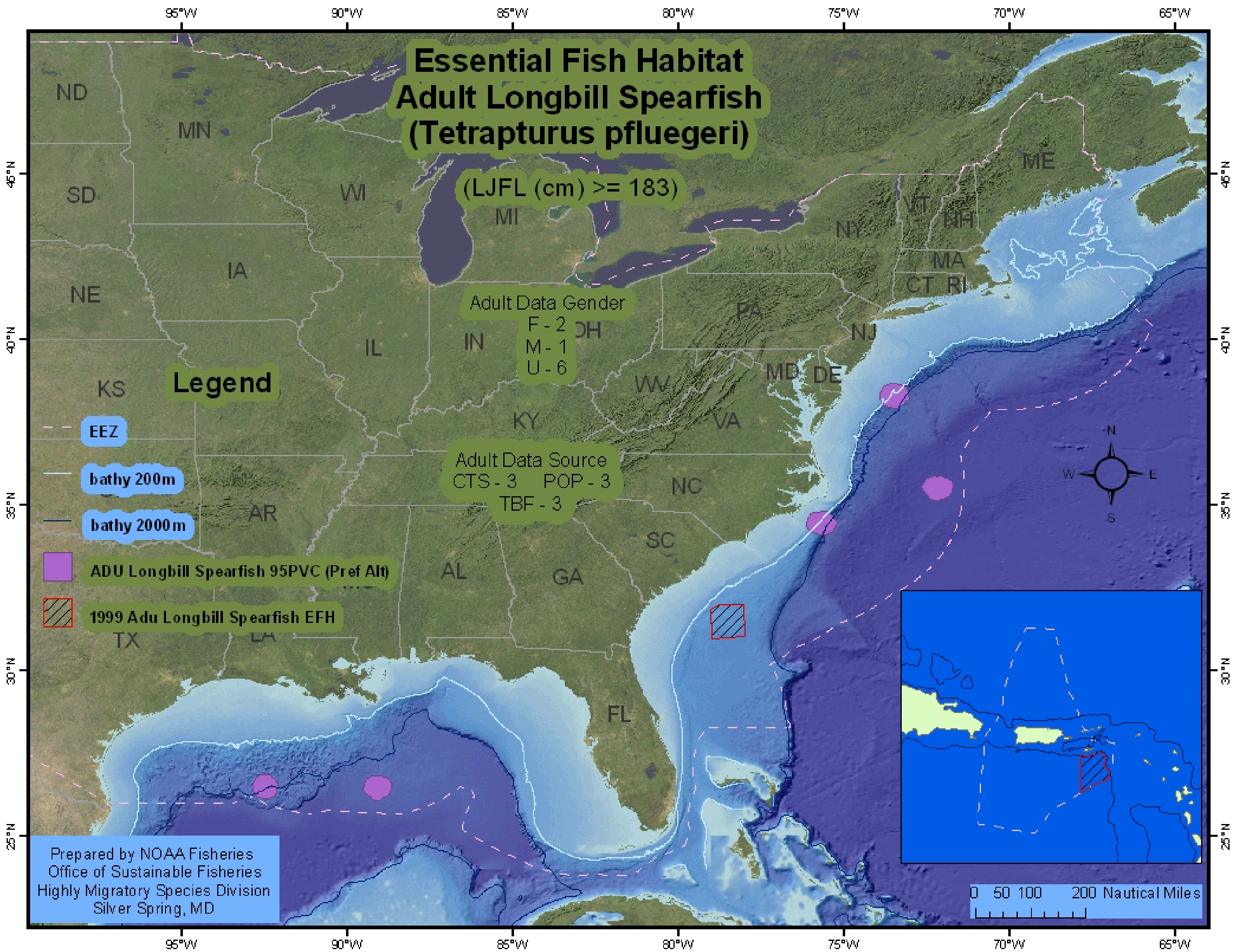

Figure 5.26 Longbill Spearfish: Adult.

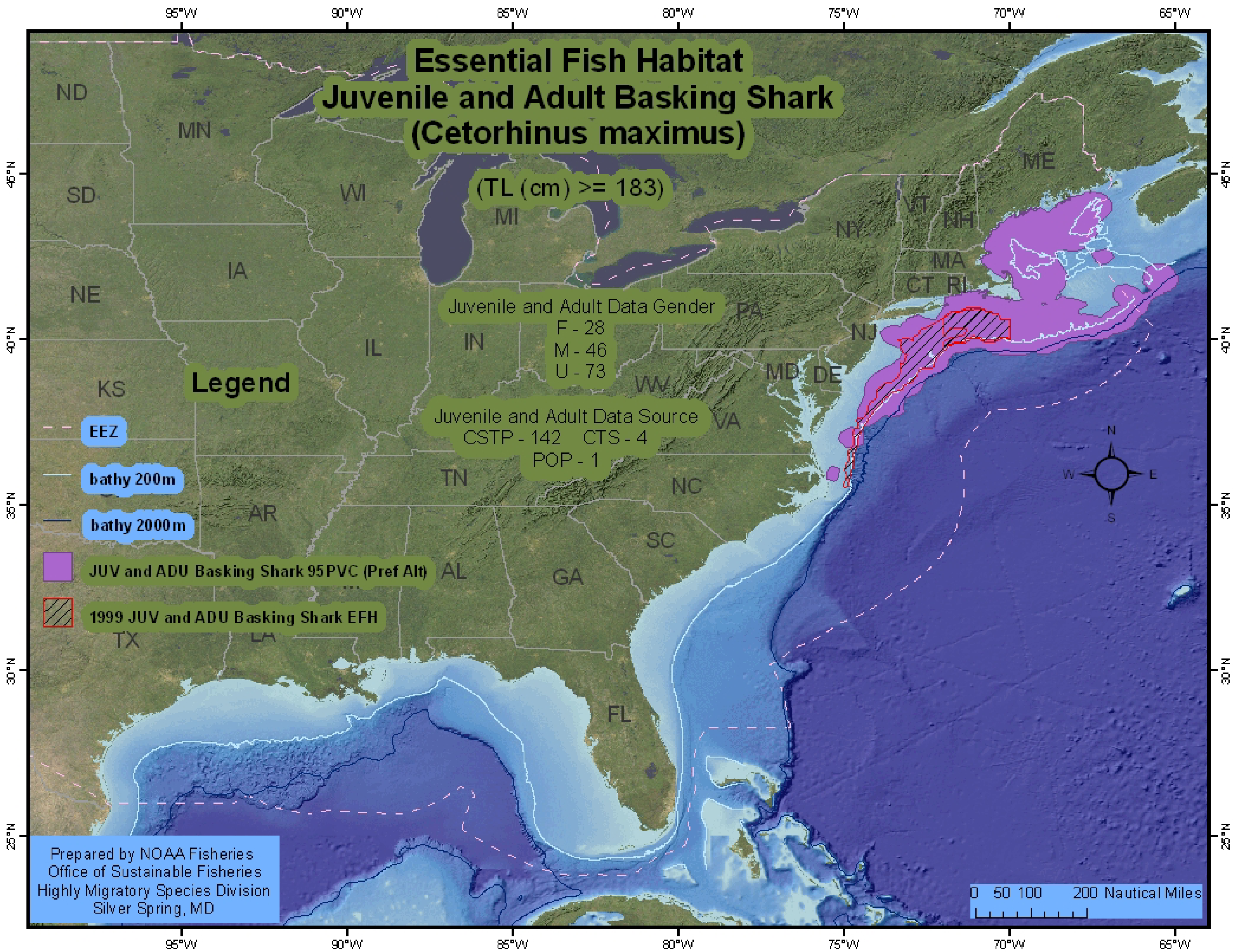

Figure 5.27 **Basking Shark: Juvenile and Adult Combined.**

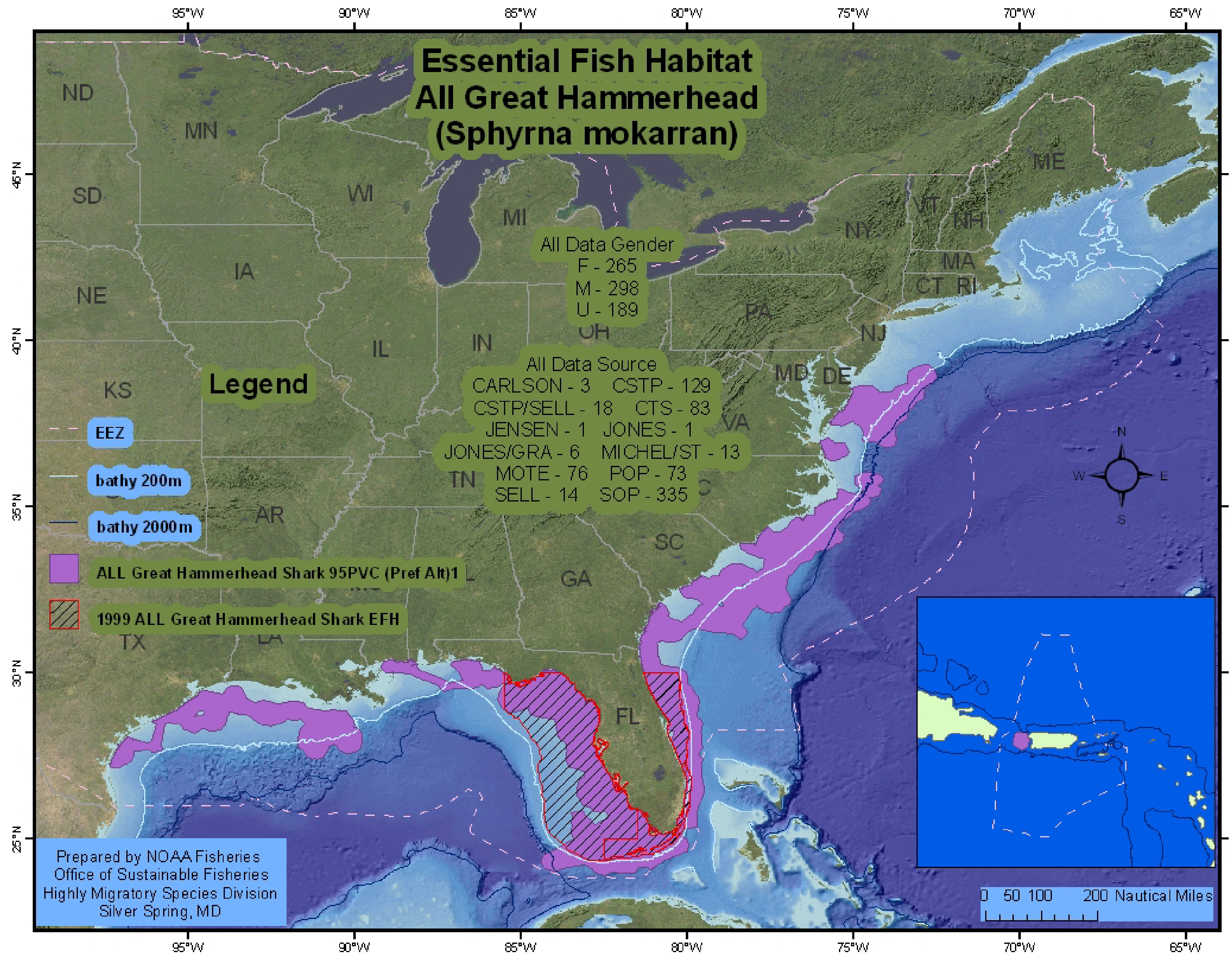

Figure 5.28 Great Hammerhead: All Life Stages Combined.

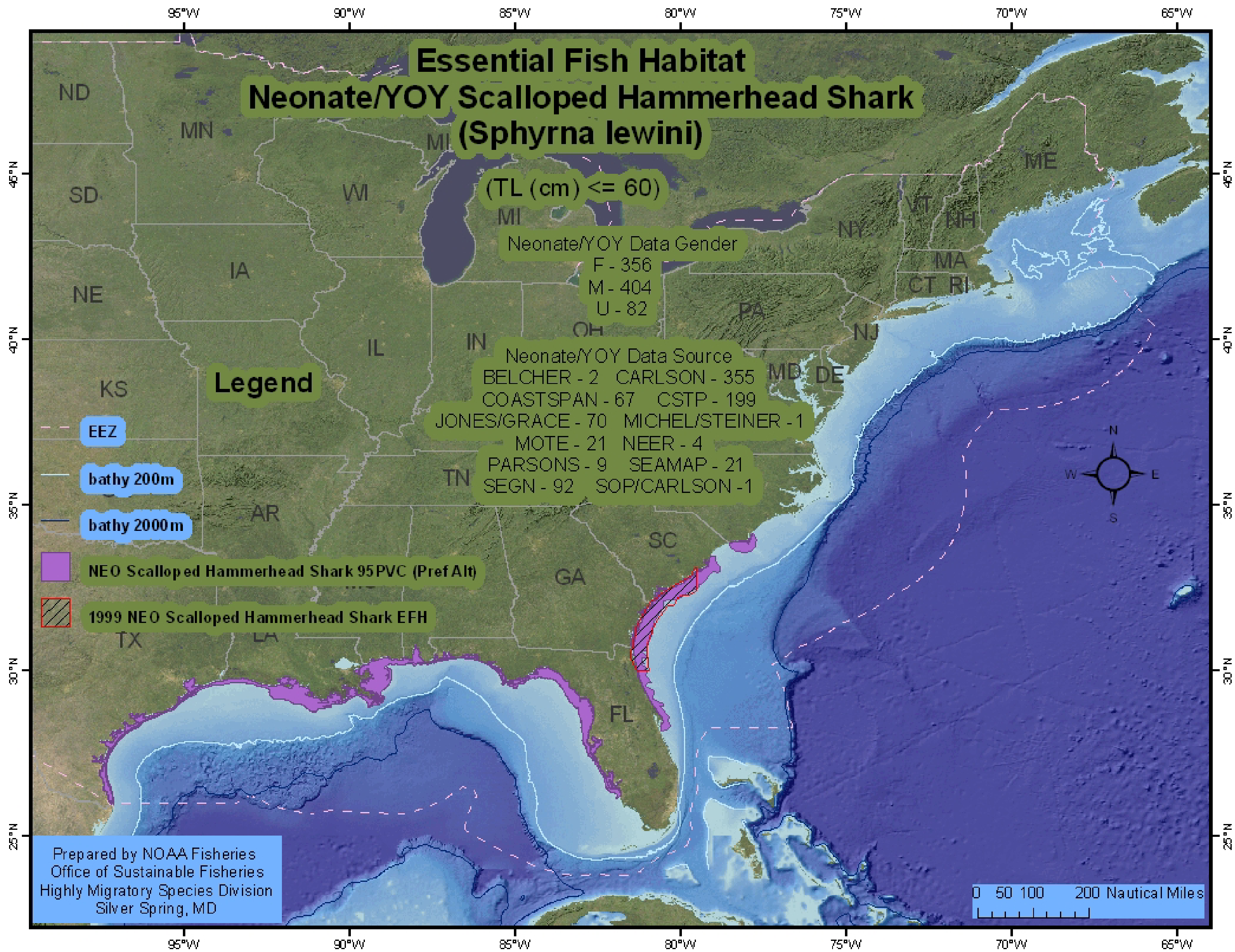

Figure 5.29 **Scalloped Hammerhead: Neonate.**

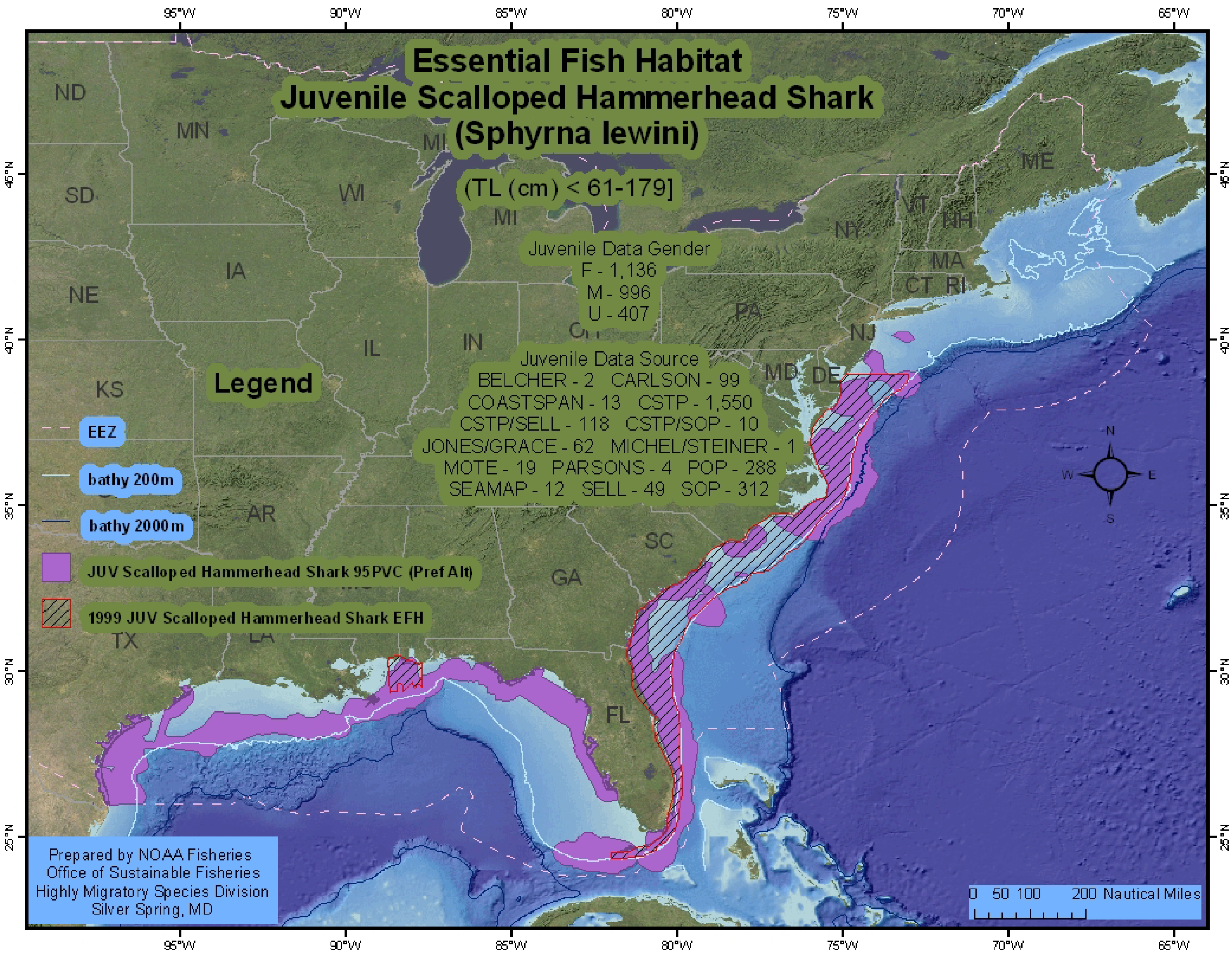

Figure 5.30 **Scalloped Hammerhead: Juvenile.**

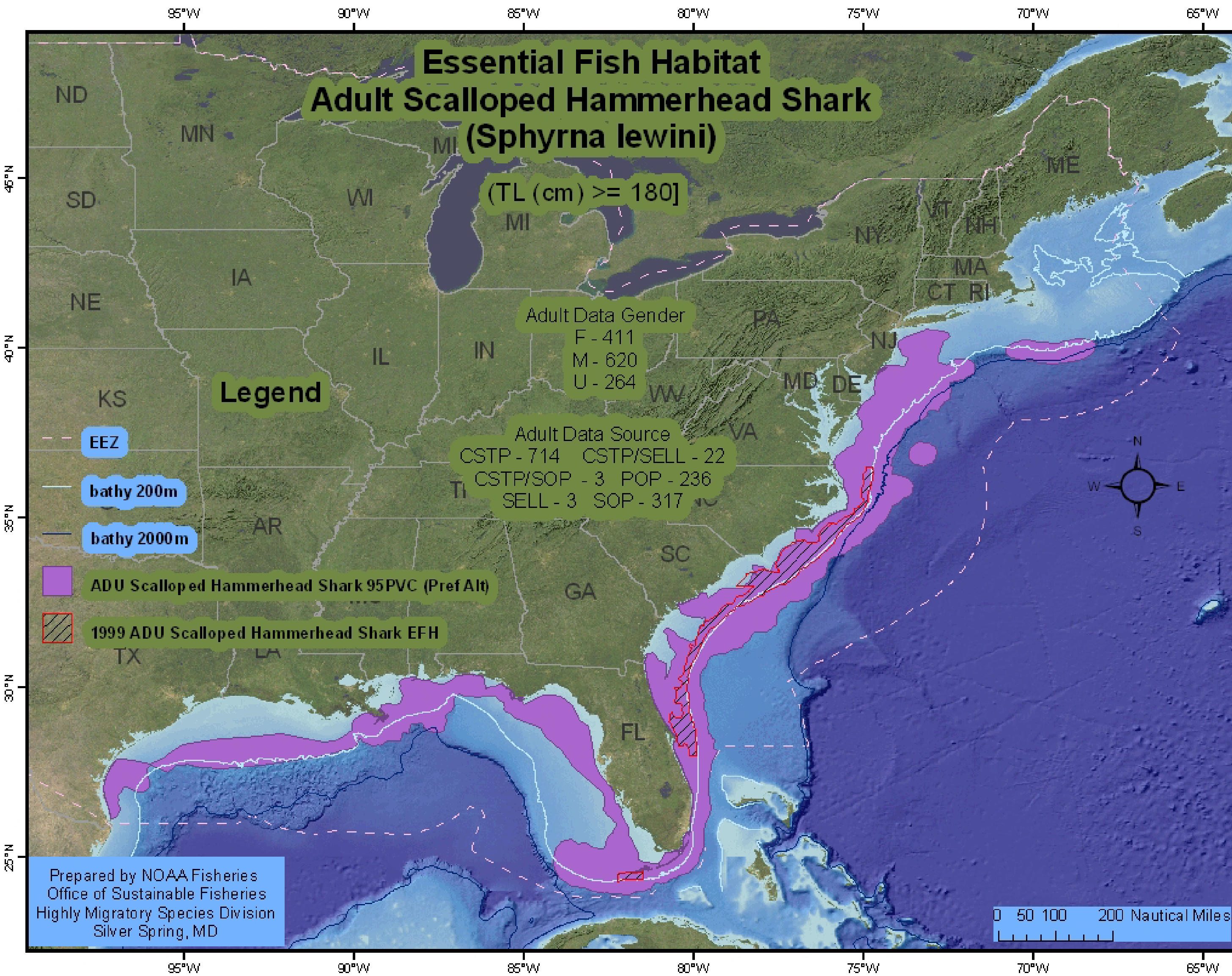

Figure 5.31 **Scalloped Hammerhead Adult.**

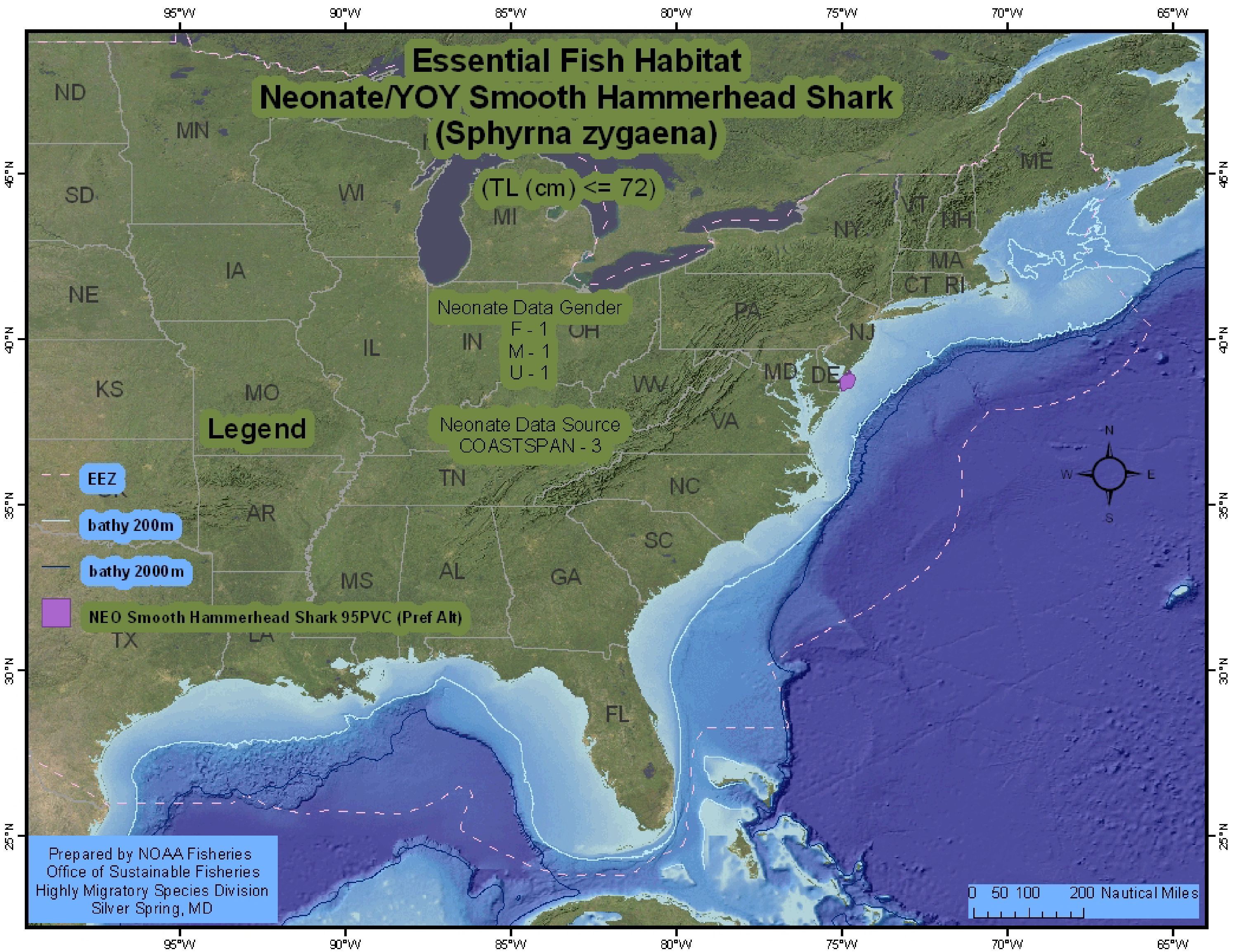

Figure 5.32 **Smooth Hammerhead: Neonate.**

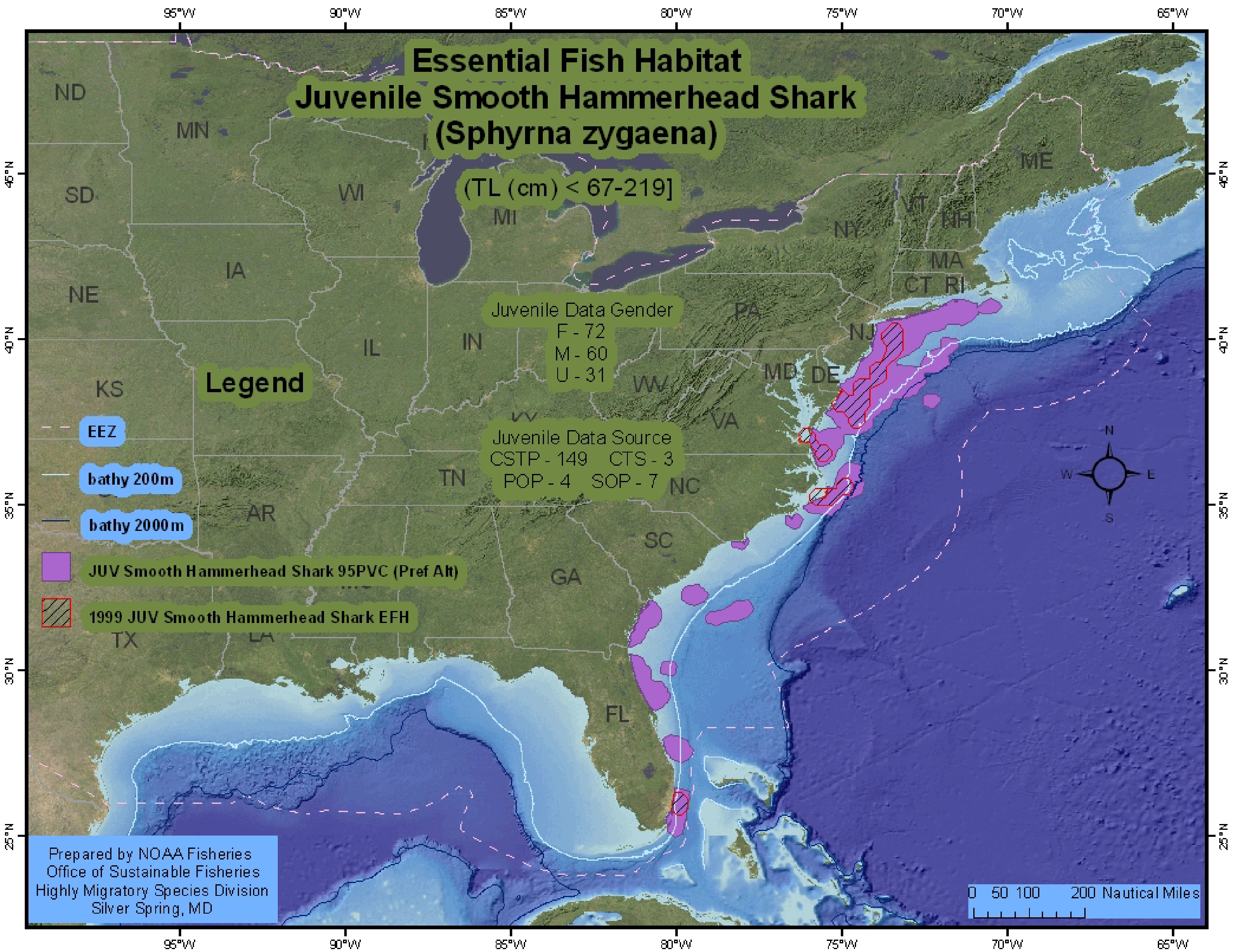

Figure 5.33 Smooth Hammerhead: Juvenile.

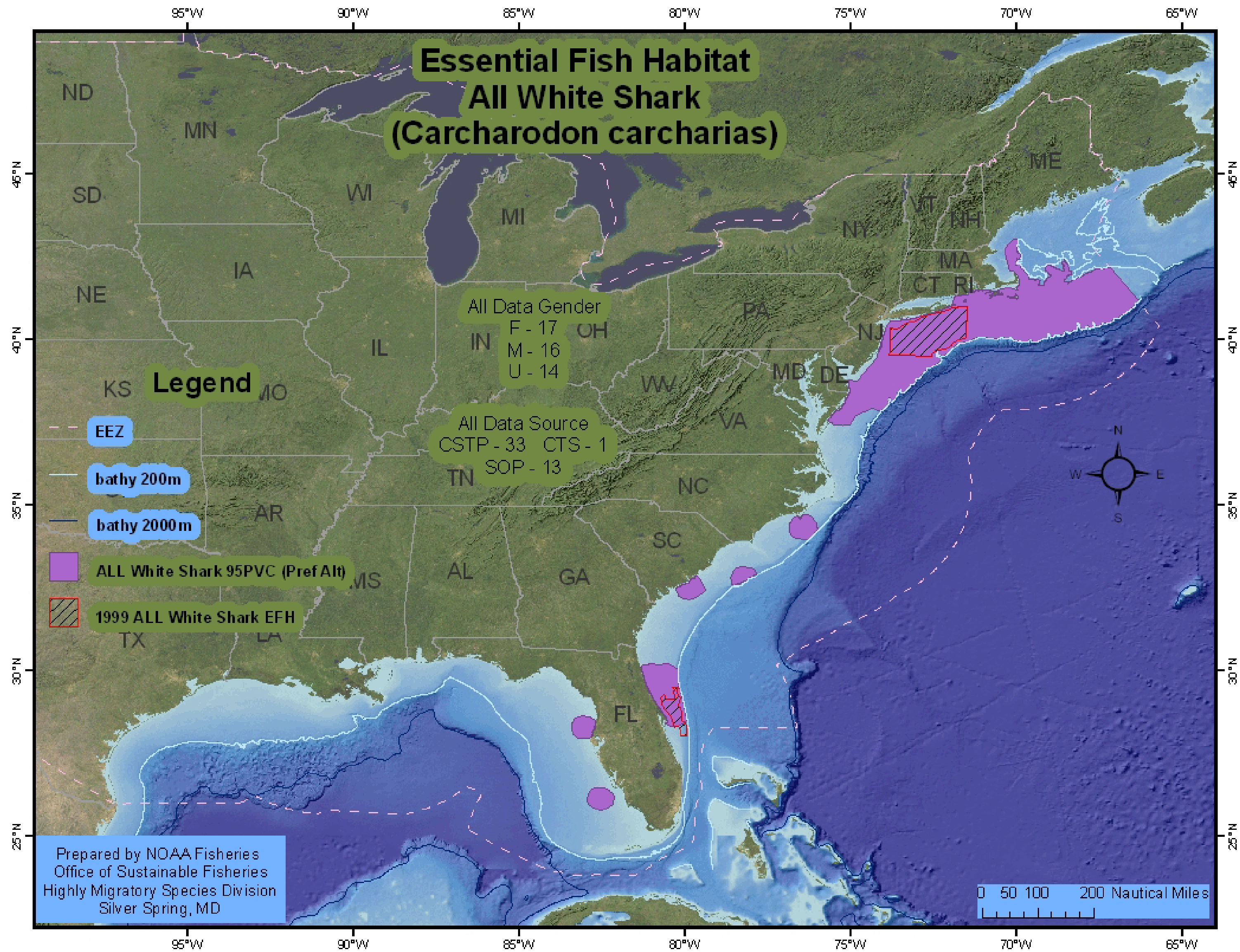

Figure 5.34 **White Shark: All Life Stages Combined.**

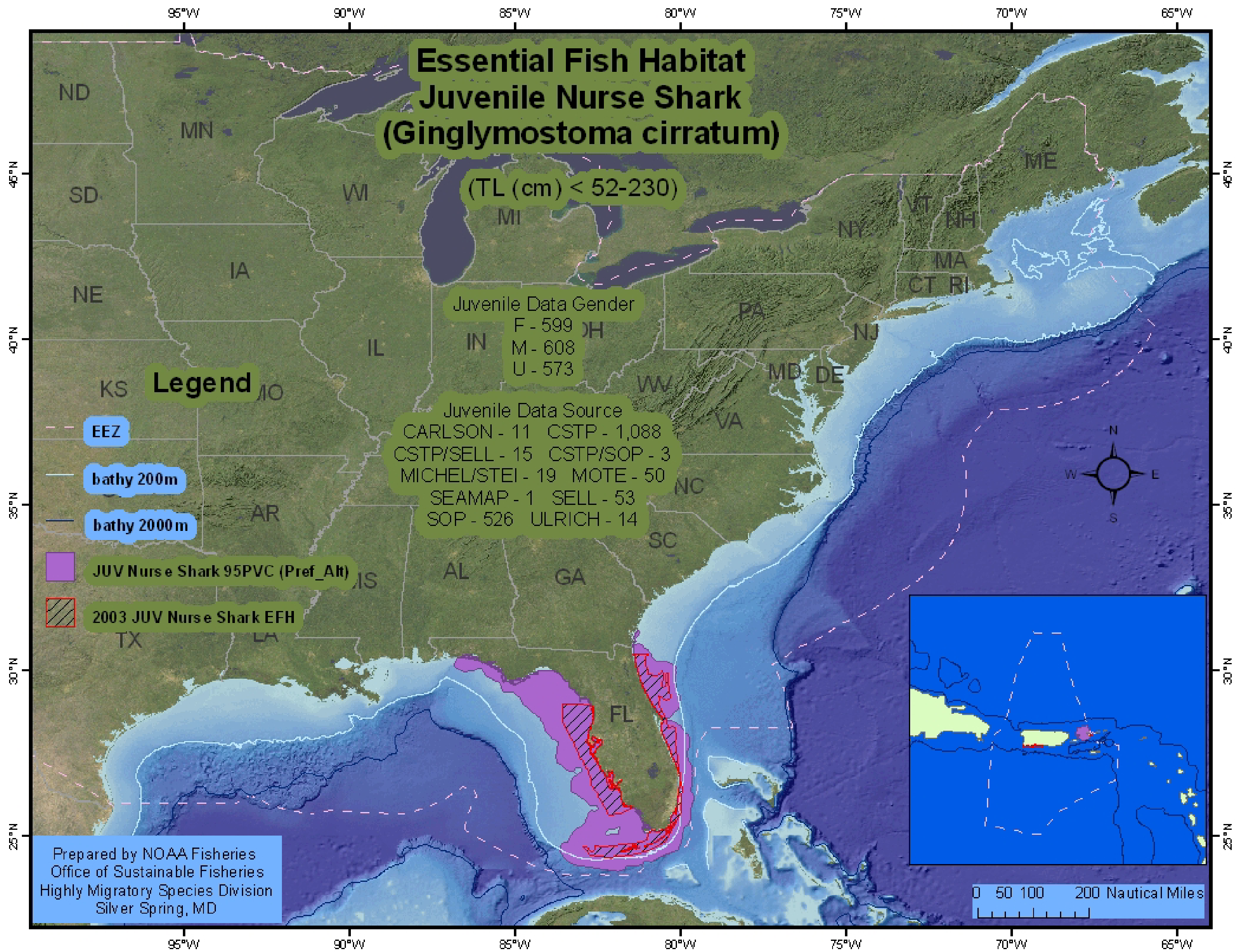

Figure 5.35 **Nurse Shark: Juvenile.**

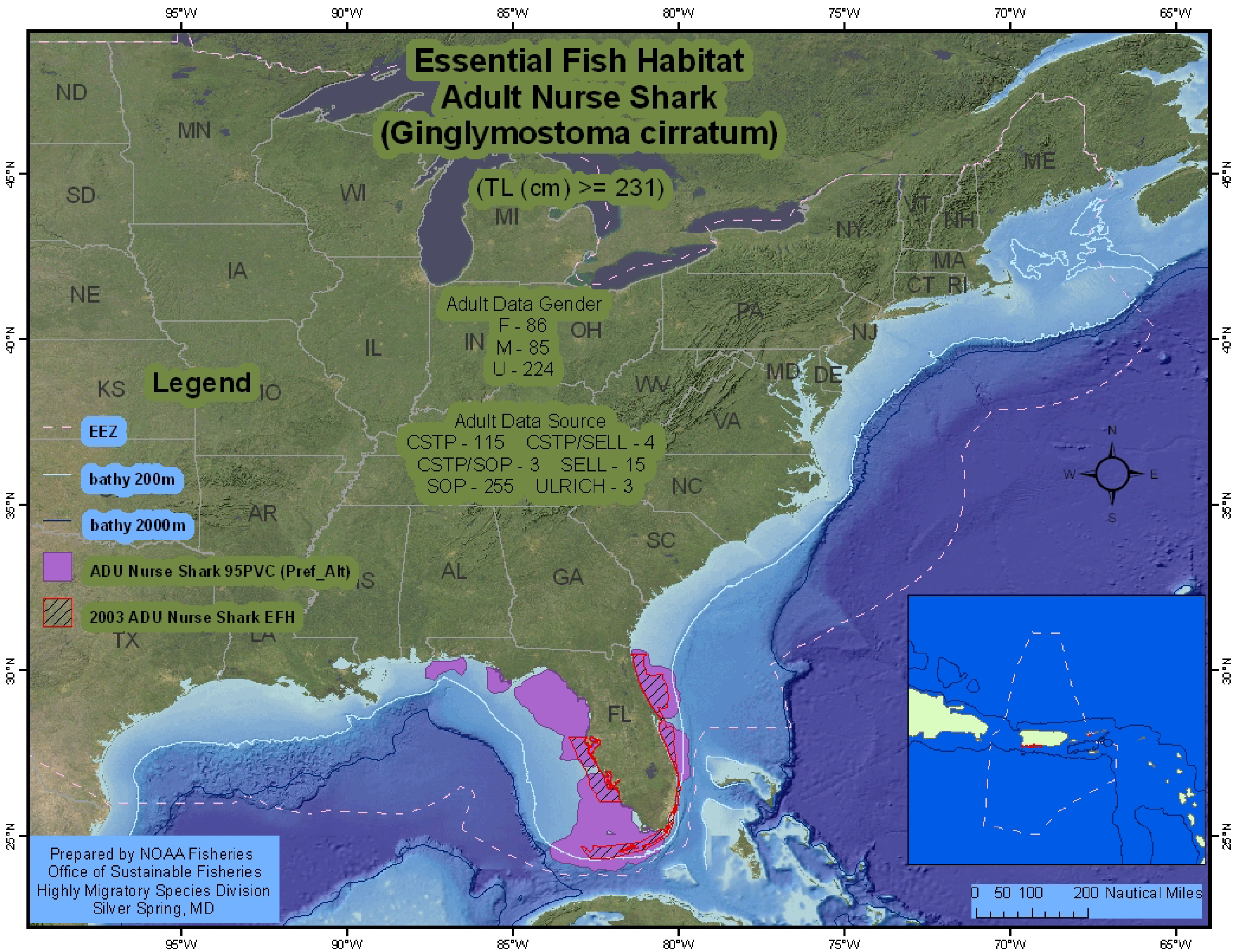

Figure 5.36 **Nurse Shark: Adult.**

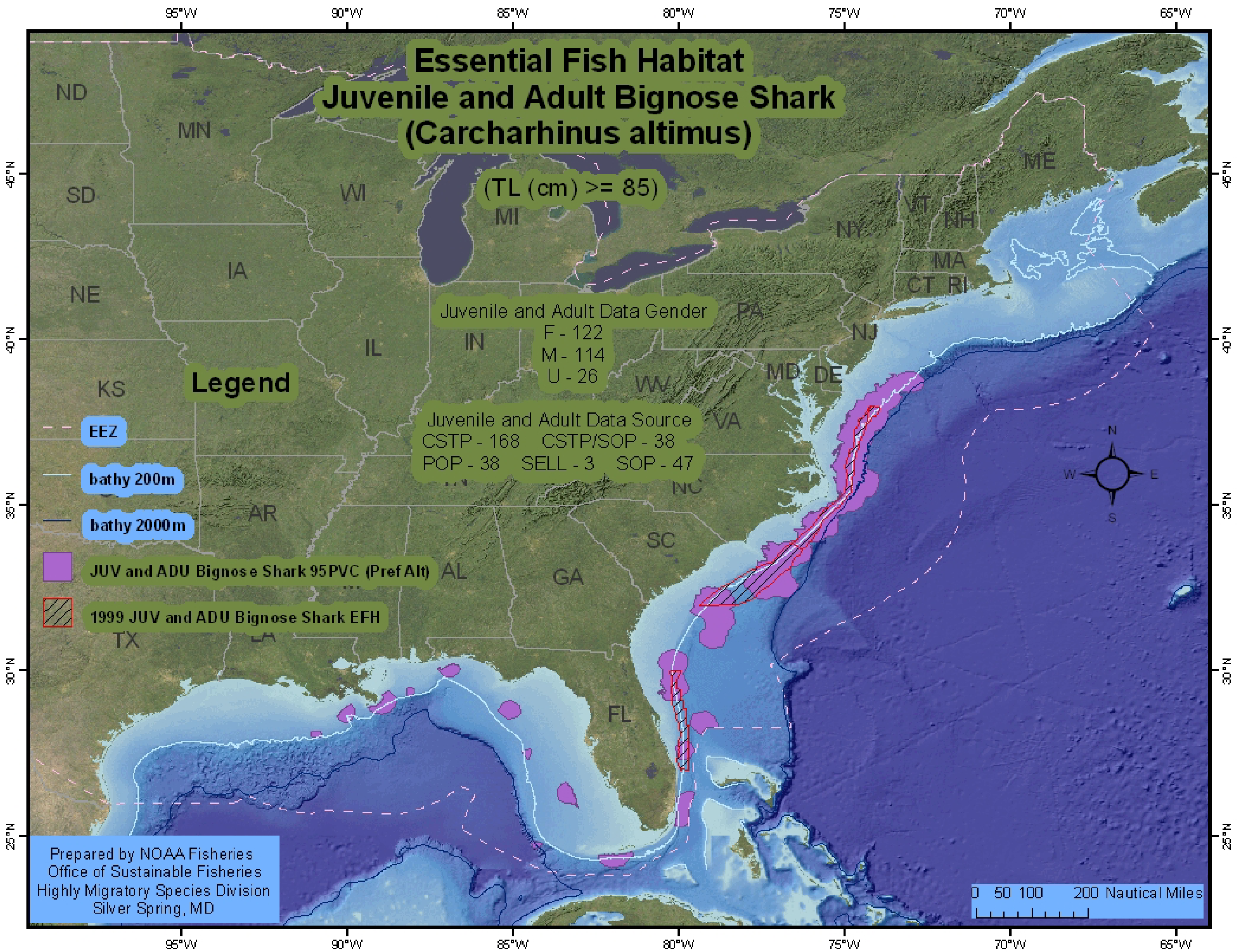

Figure 5.37 Bignose Shark: Juvenile and Adult Combined.

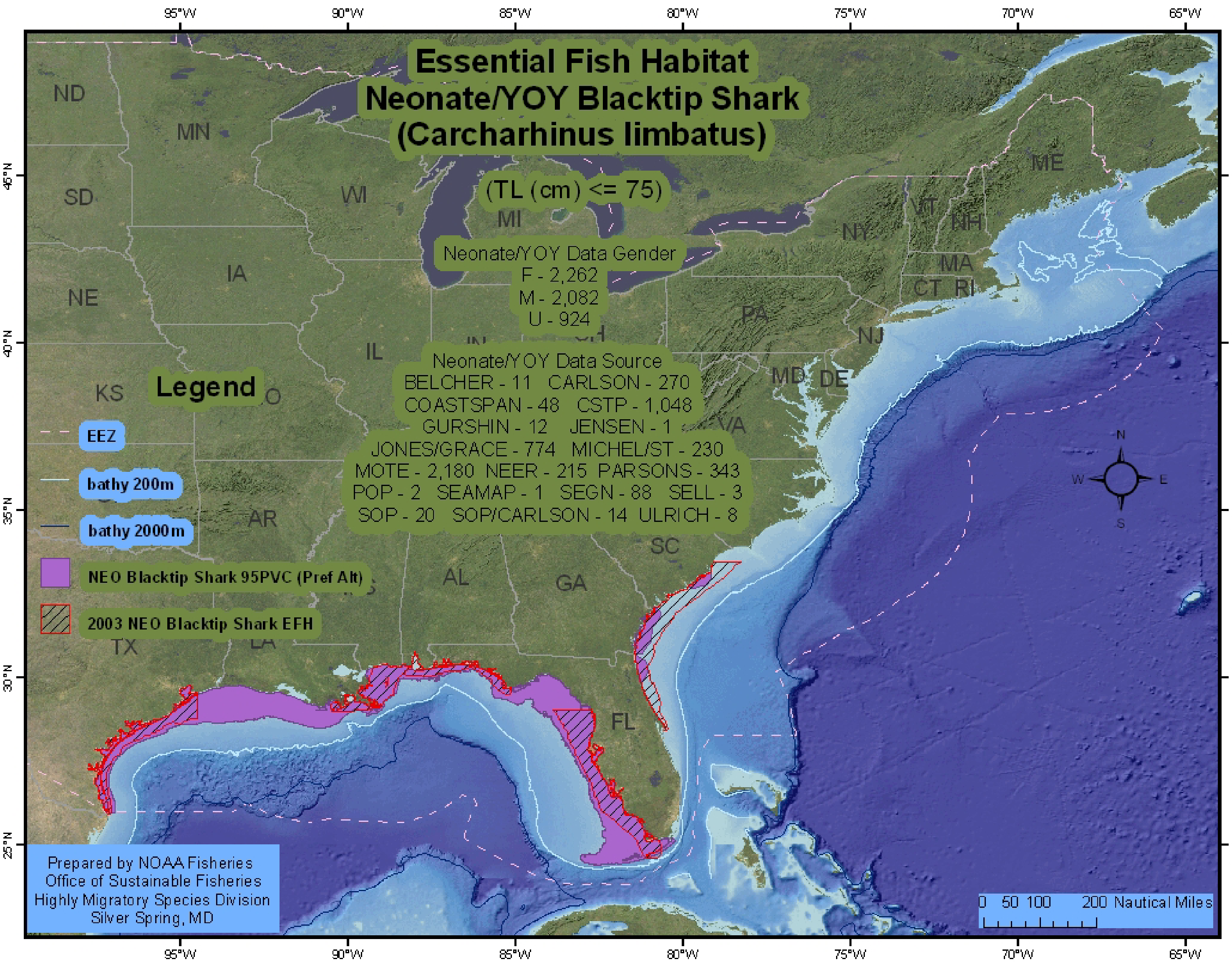

Figure 5.38 **Blacktip Shark: Neonate.**

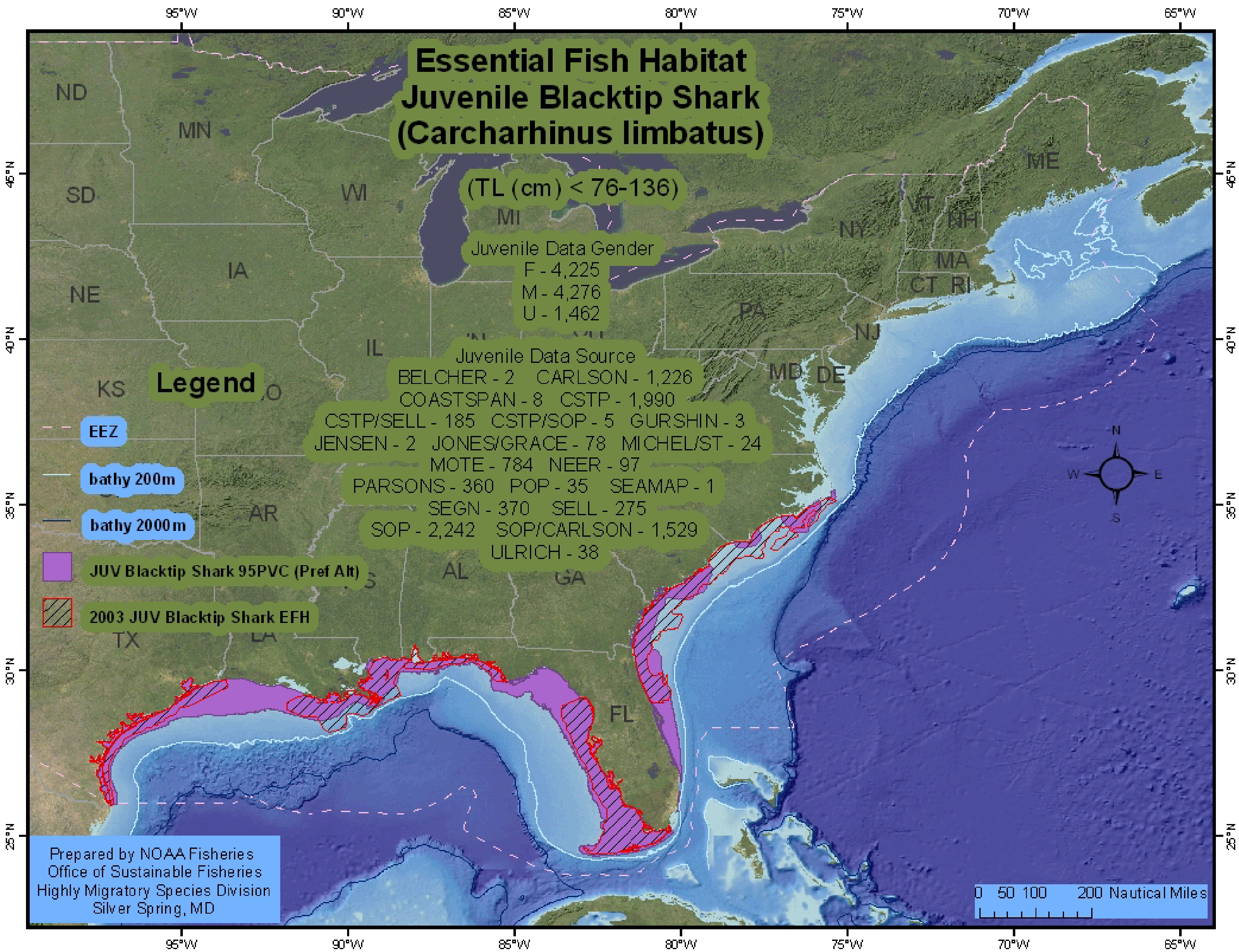

Figure 5.39 Blacktip Shark: Juvenile.

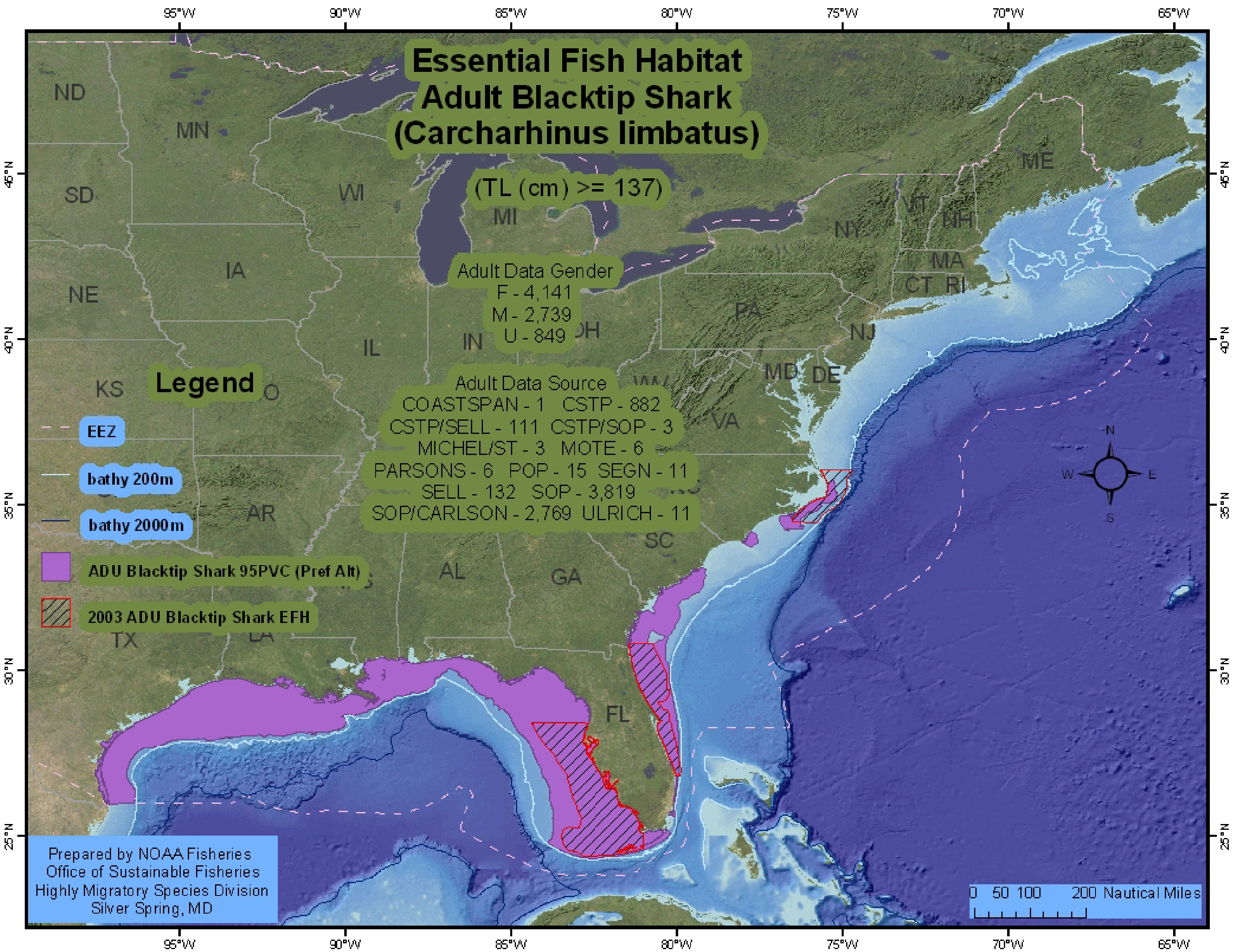

Figure 5.40 **Blacktip Shark: Adult.**

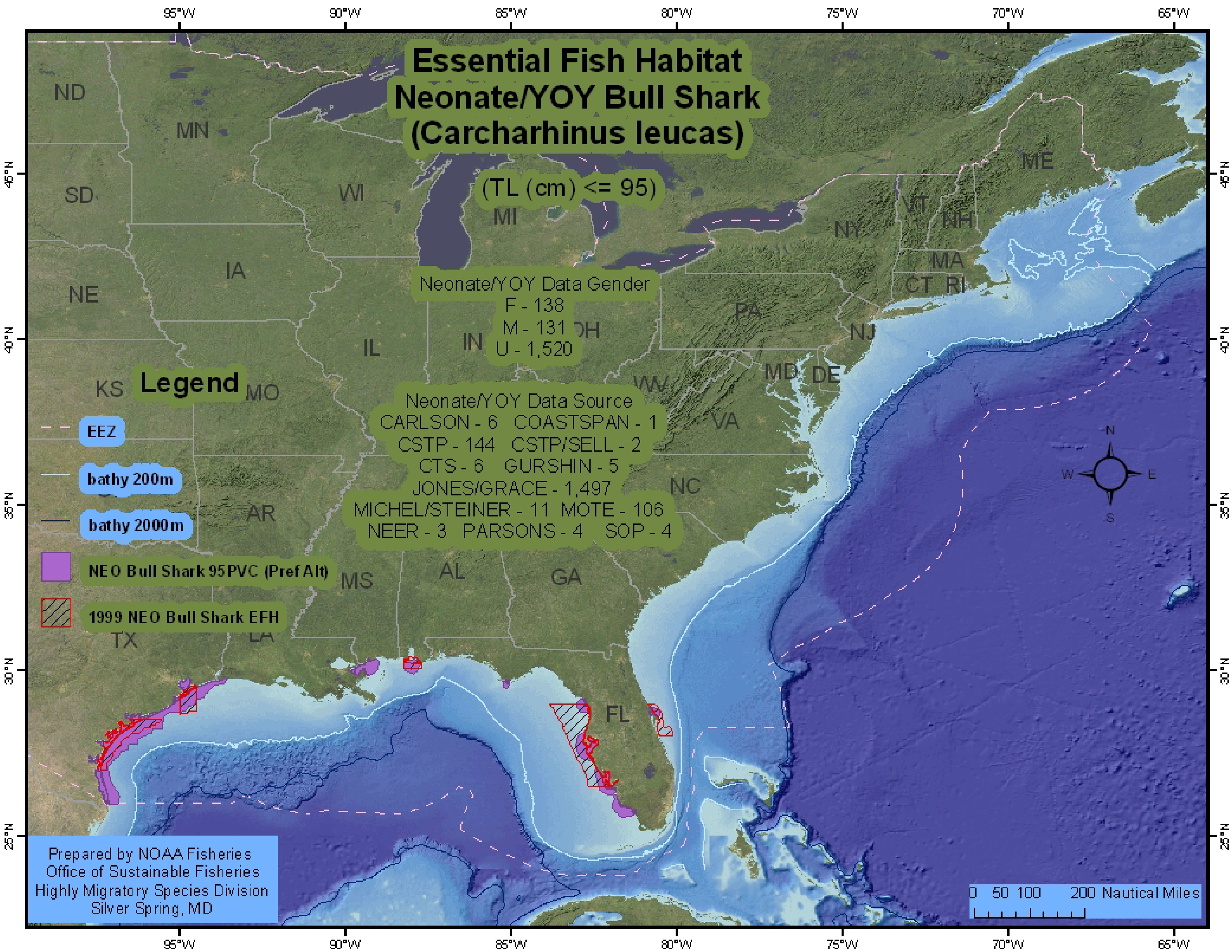

Figure 5.41 **Bull Shark: Neonate.**

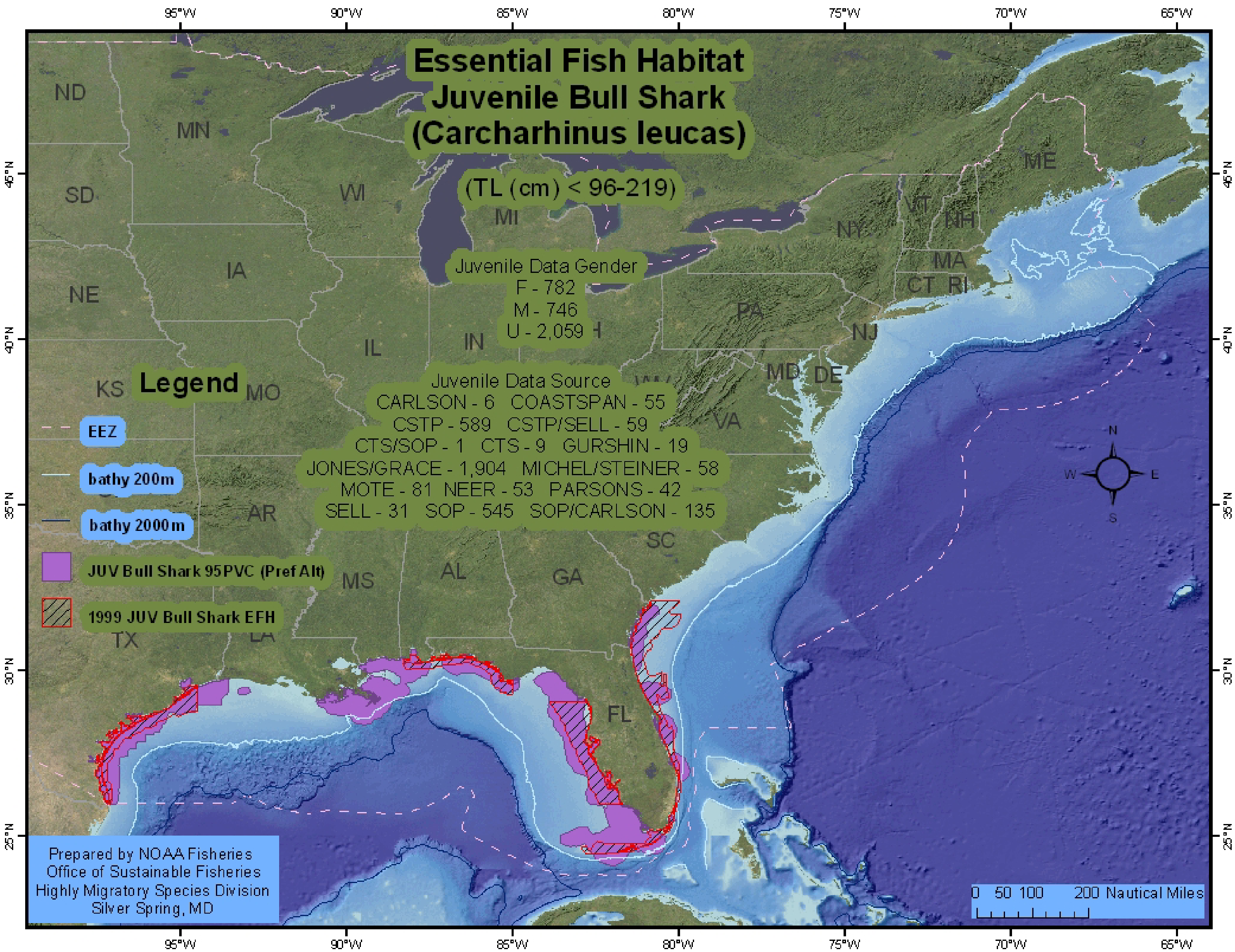

Figure 5.42 Bull Shark: Juvenile.

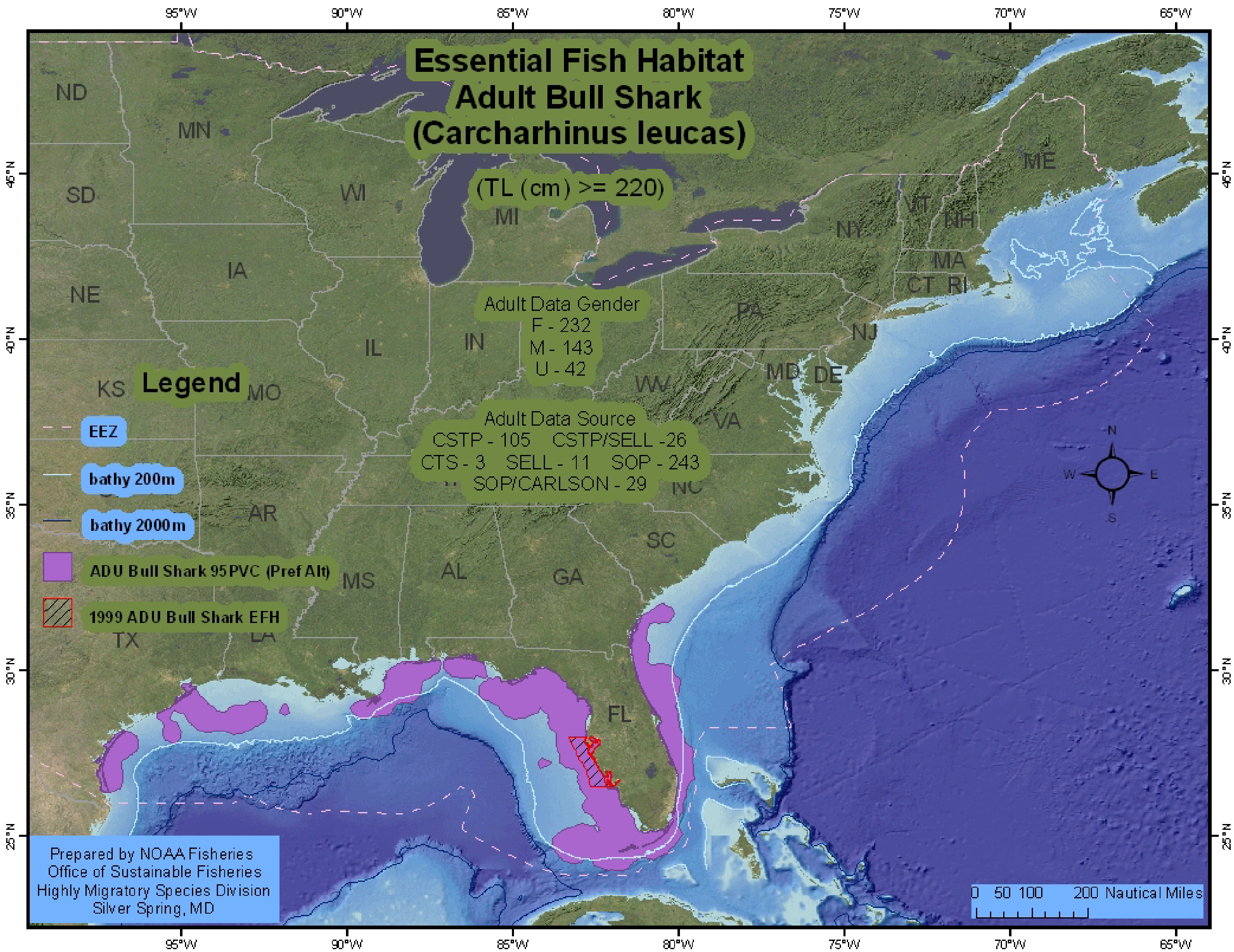

Figure 5.43 Bull Shark: Adult.

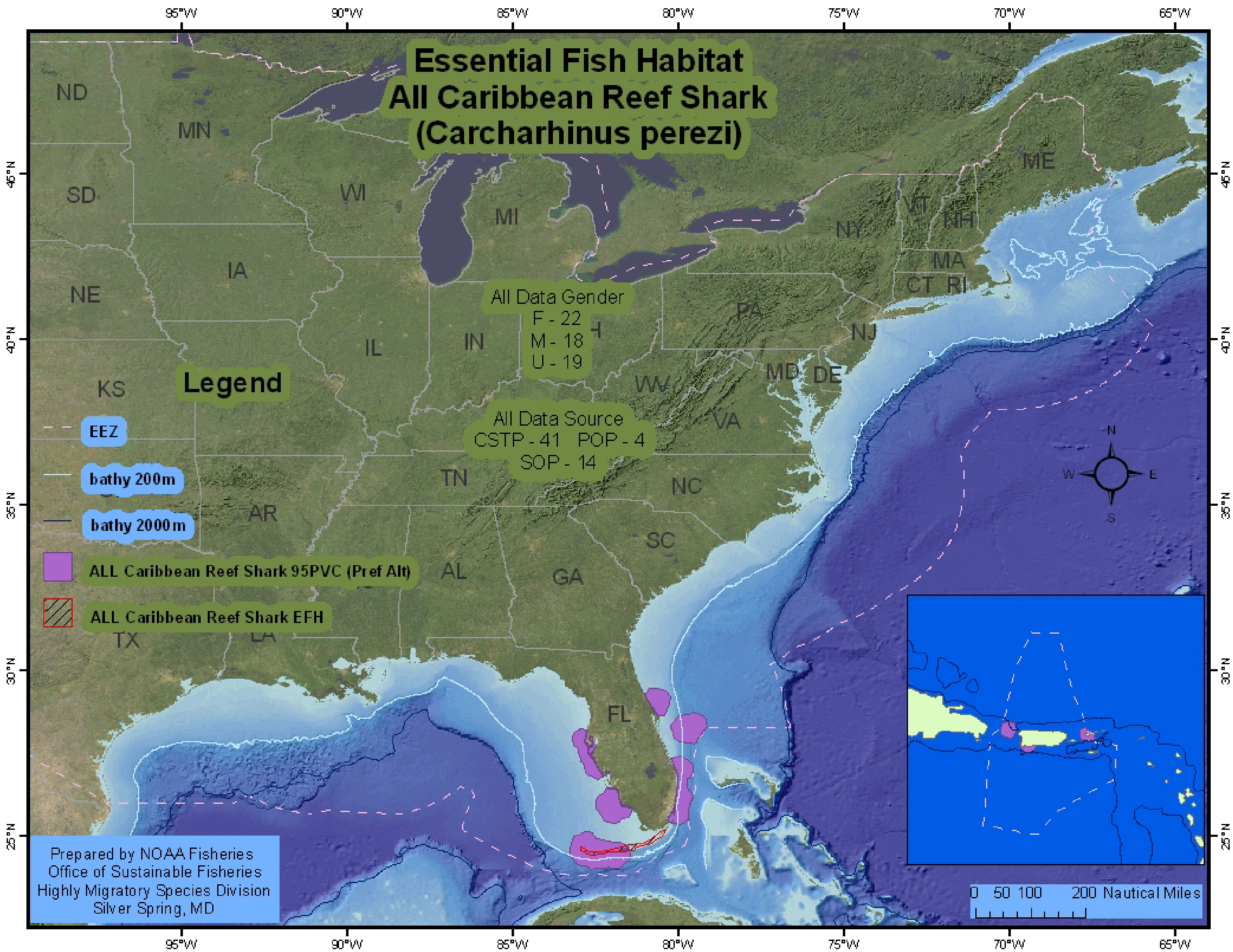

Figure 5.44 Caribbean Reef Shark: All Life Stages Combined.

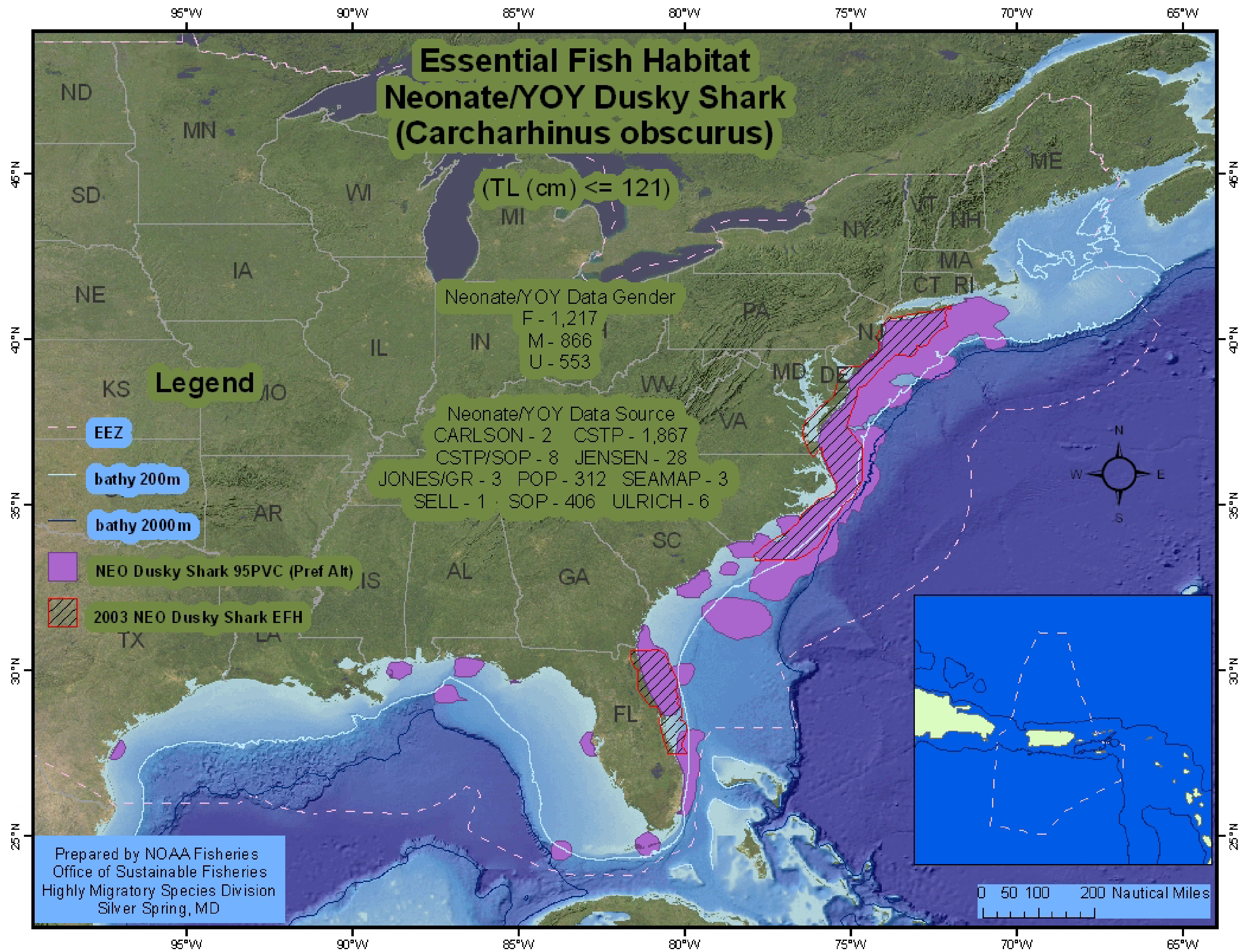

Figure 5.45 Dusky Shark: Neonate.

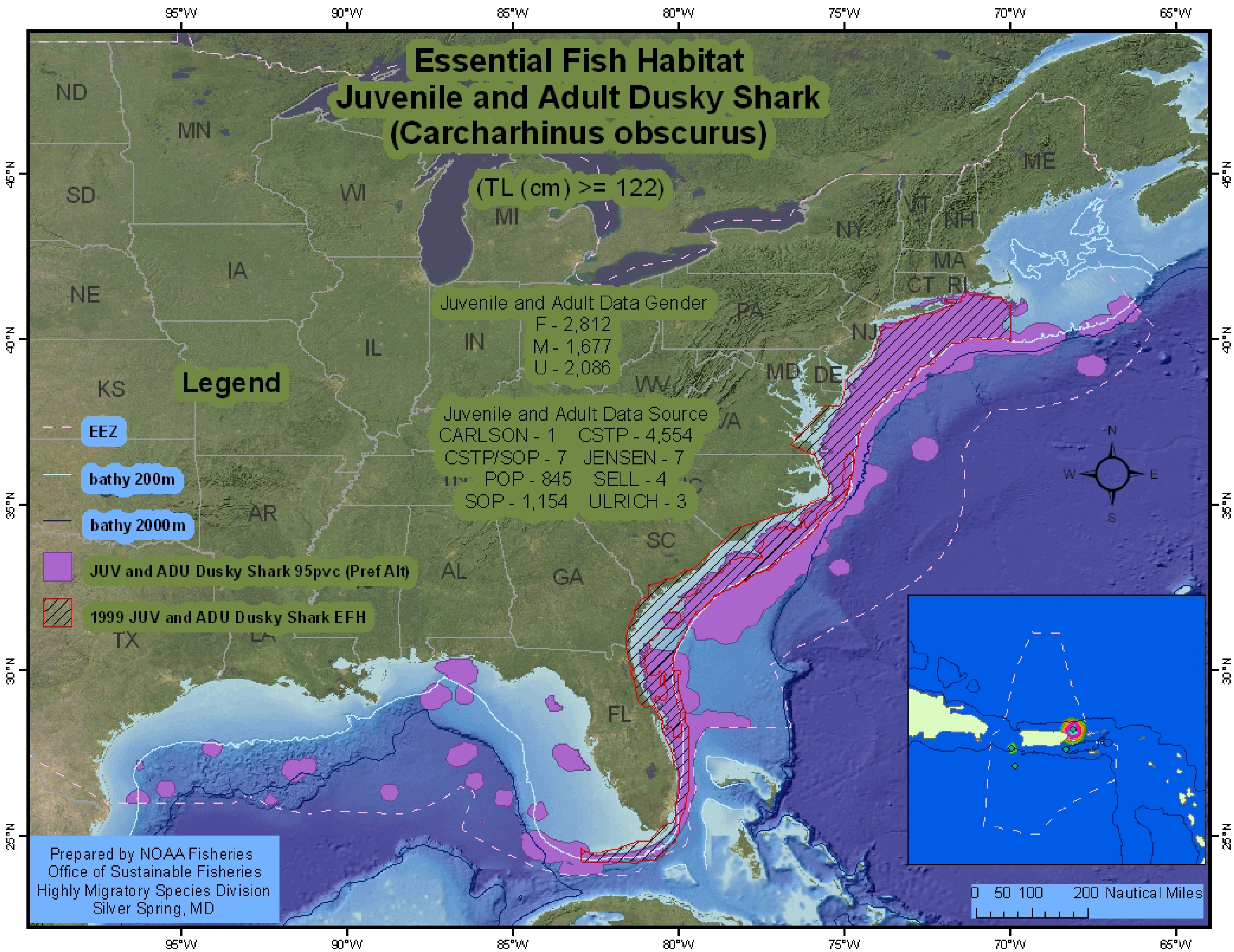

Figure 5.46 Dusky Shark: Juvenile and Adult Combined.

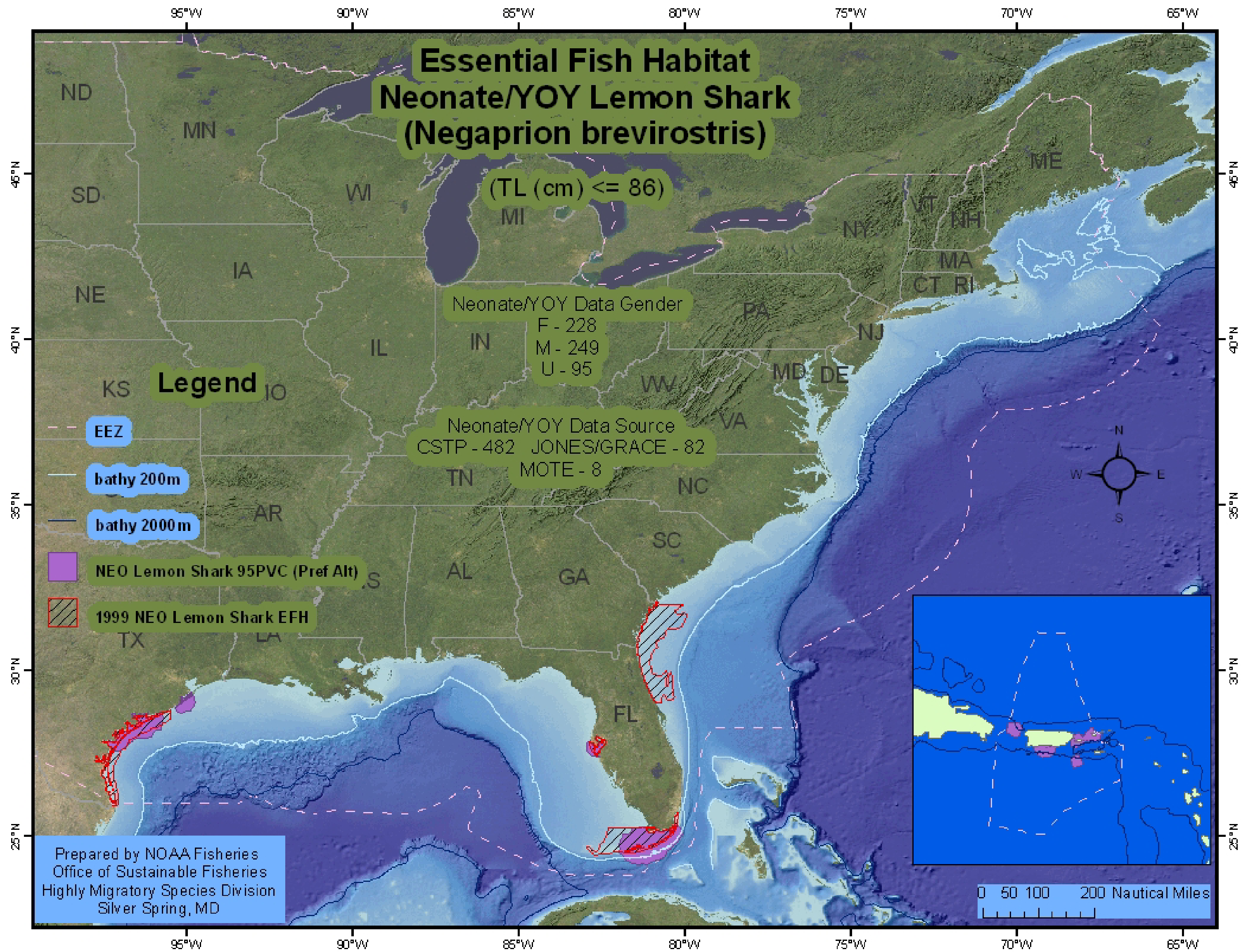

Figure 5.47 Lemon Shark: Neonate.

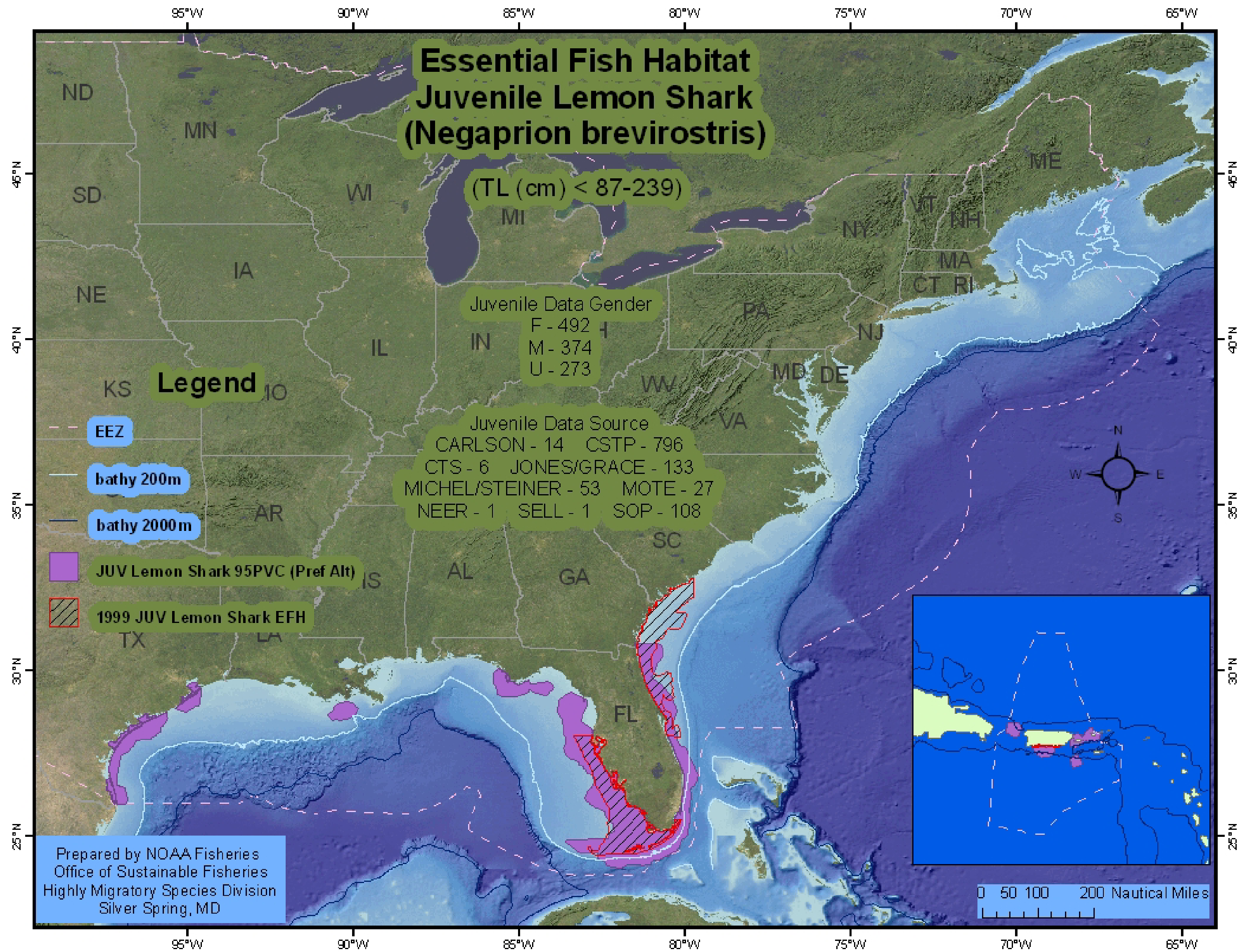

Figure 5.48 **Lemon Shark: Juvenile.**

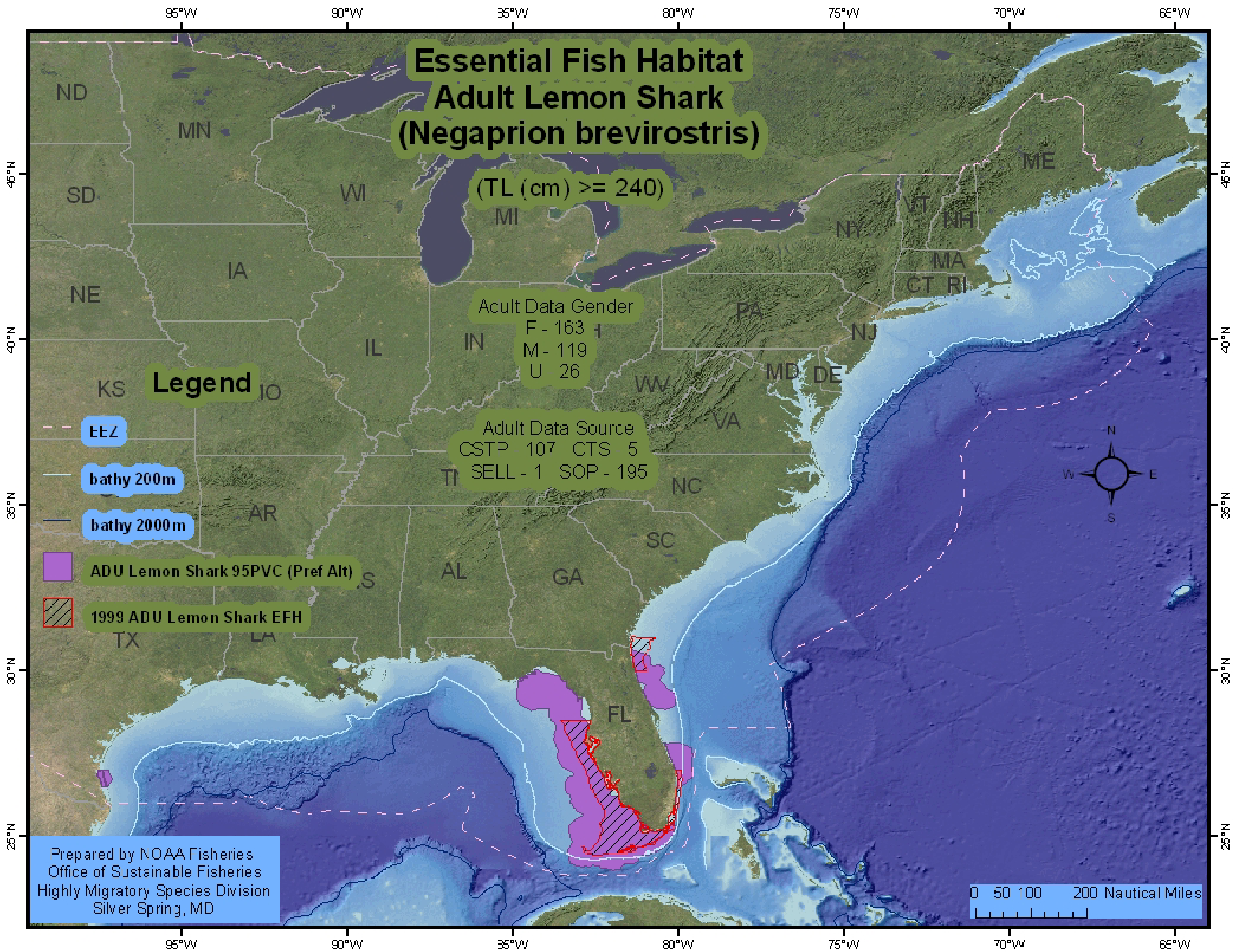

Figure 5.49 Lemon Shark: Adult.

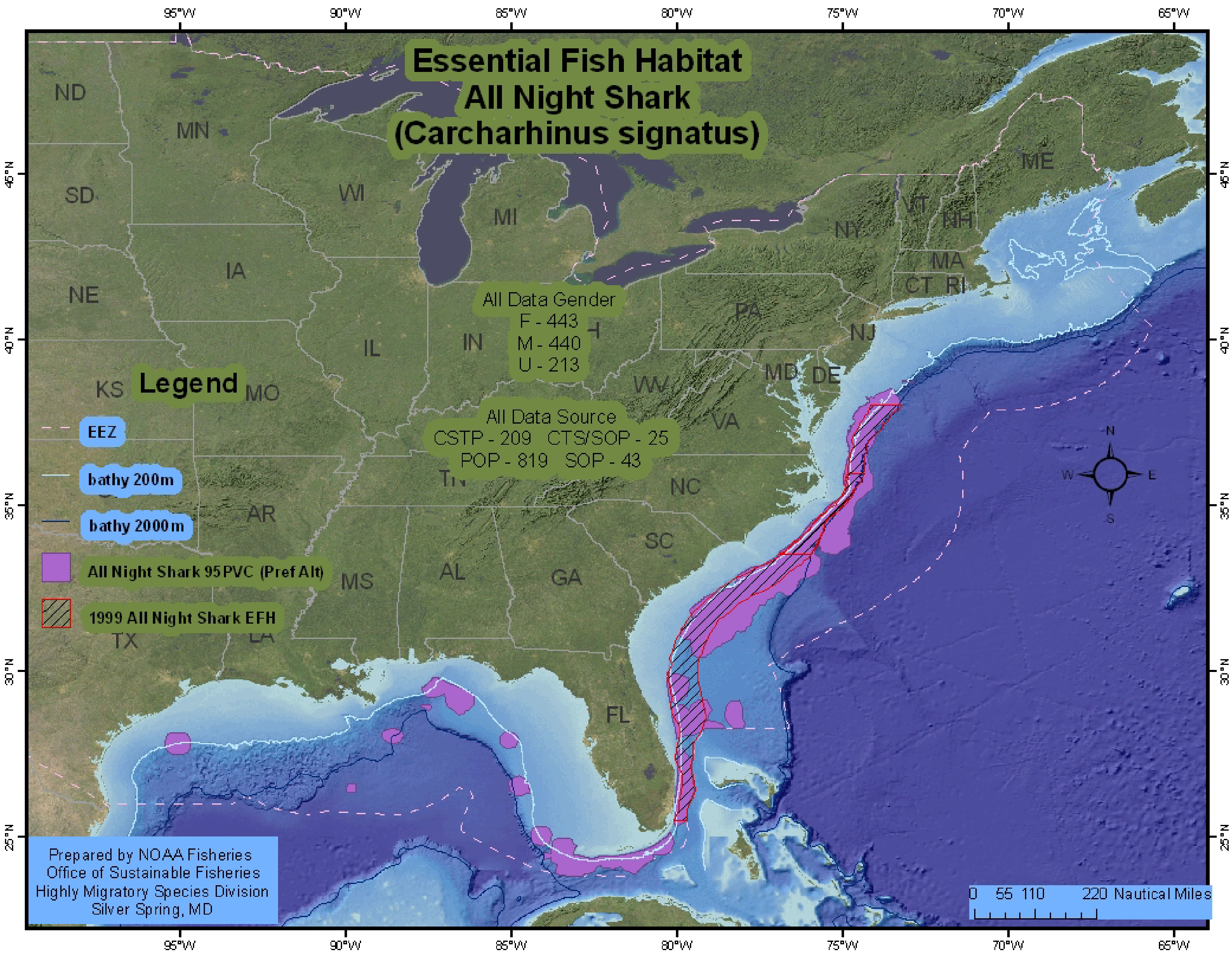

Figure 5.50 **Night Shark: All Life Stages Combined.**

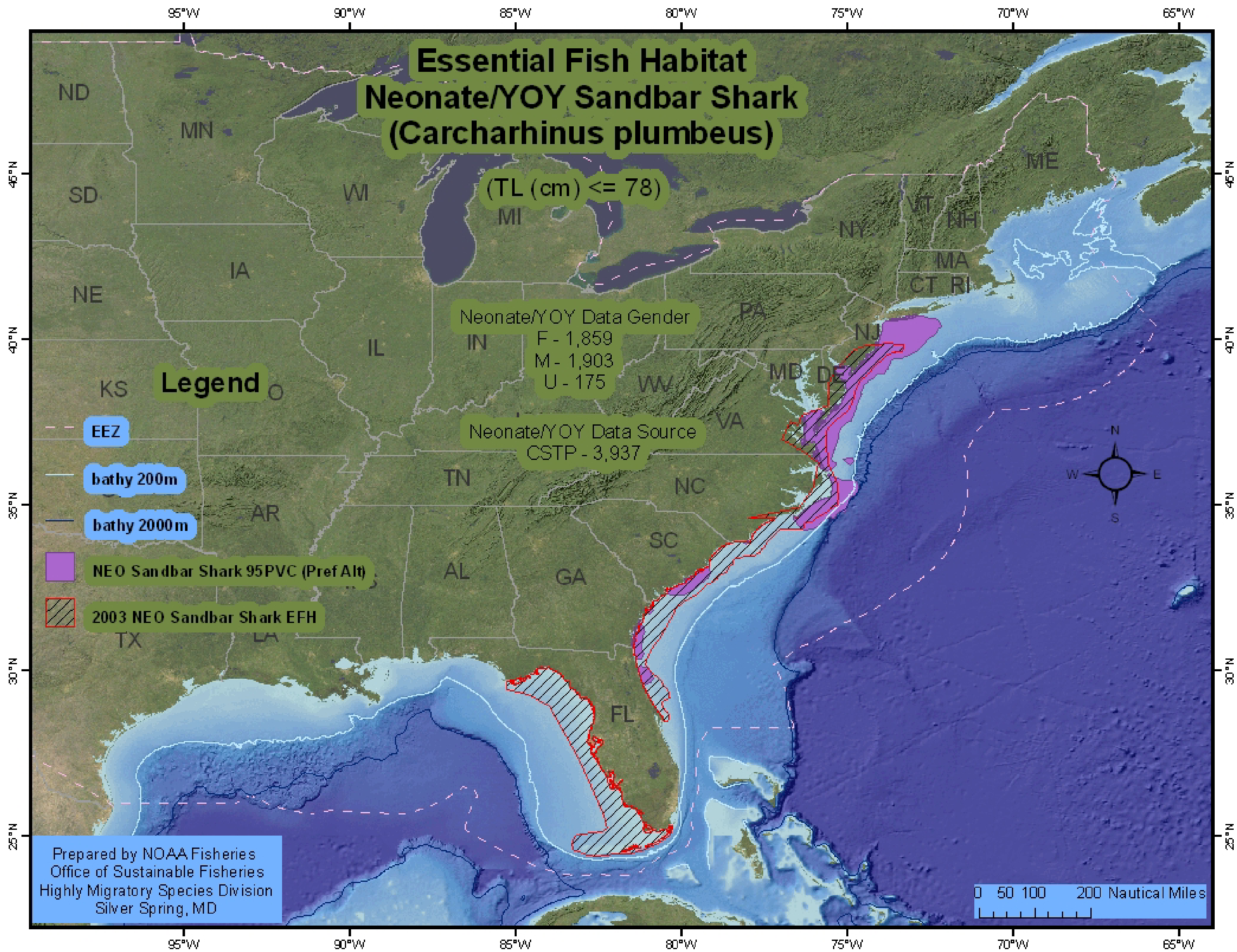

Figure 5.51 **Sandbar Shark: Neonate.**

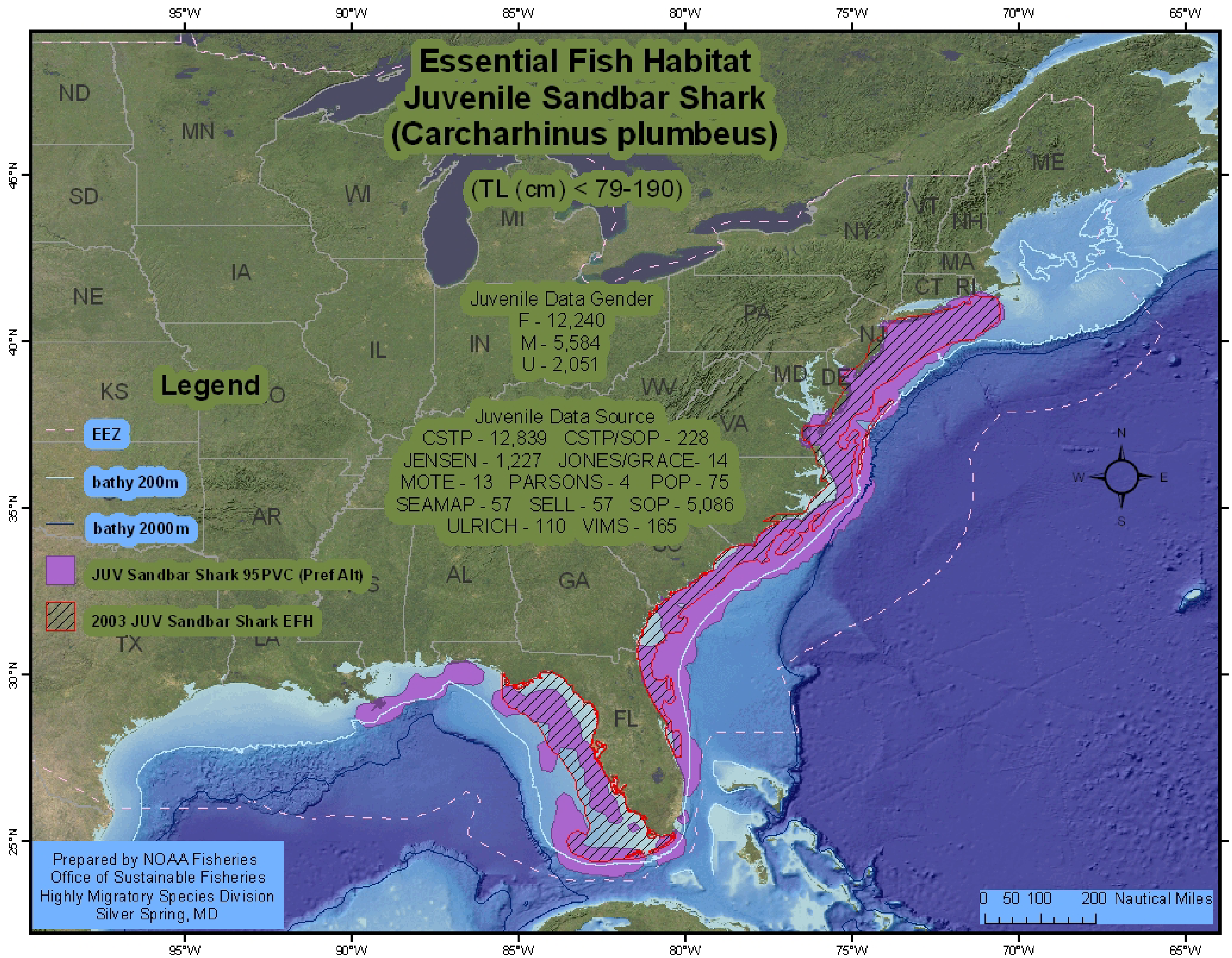

Figure 5.52 Sandbar Shark: Juvenile.

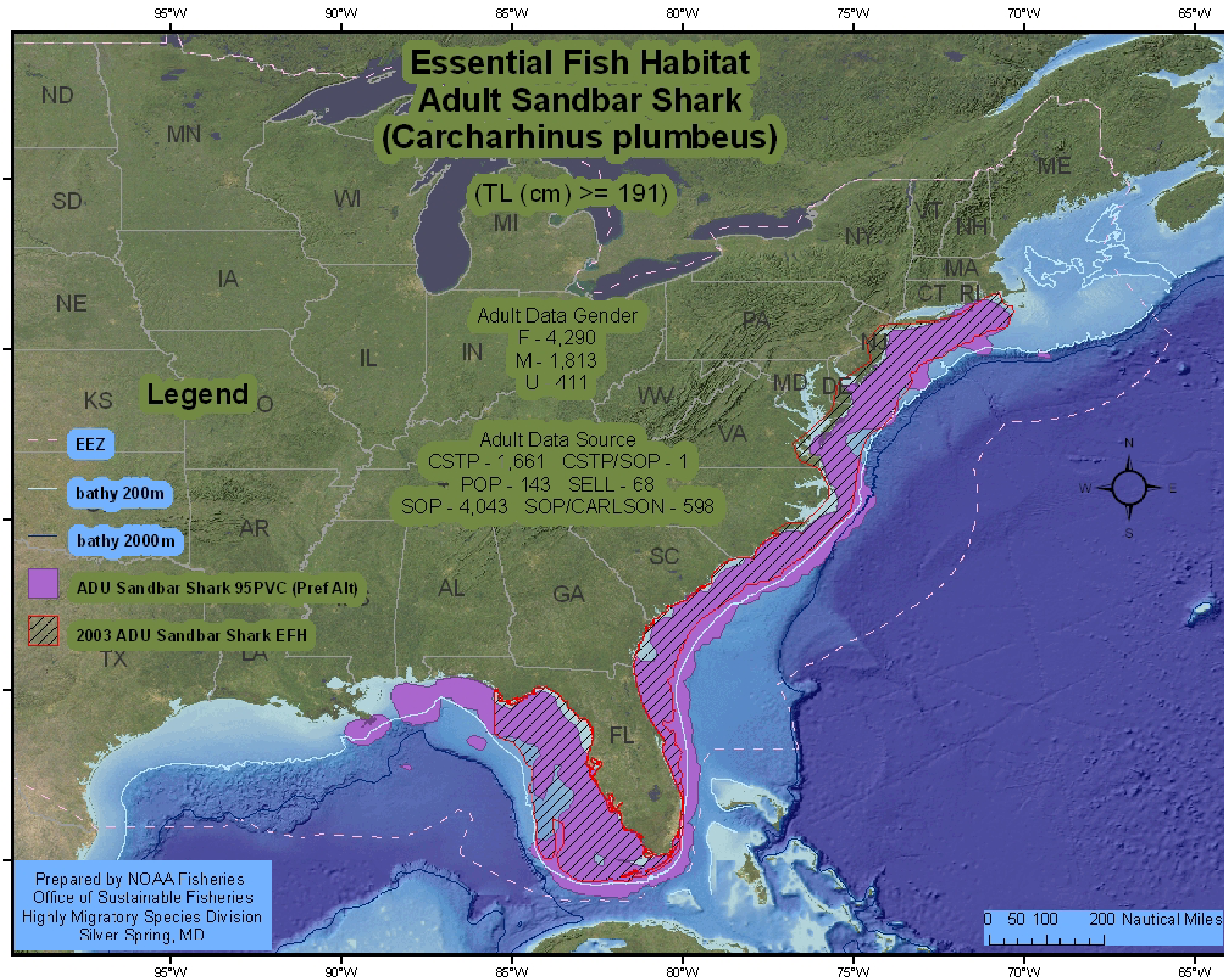

Figure 5.53 **Sandbar Shark: Adult.**

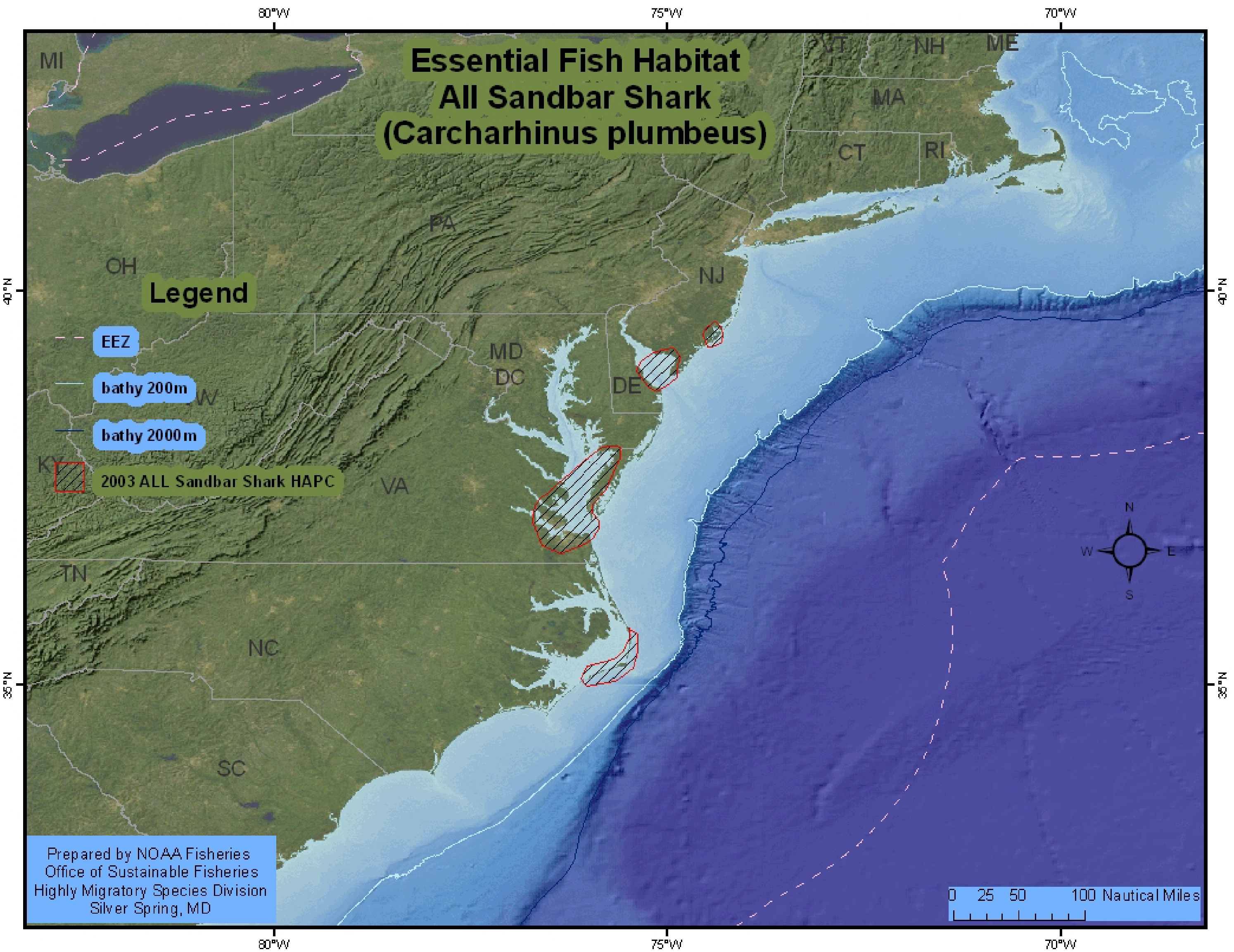

Figure 5.54 Sandbar Shark Habitat Area of Particular Concern.

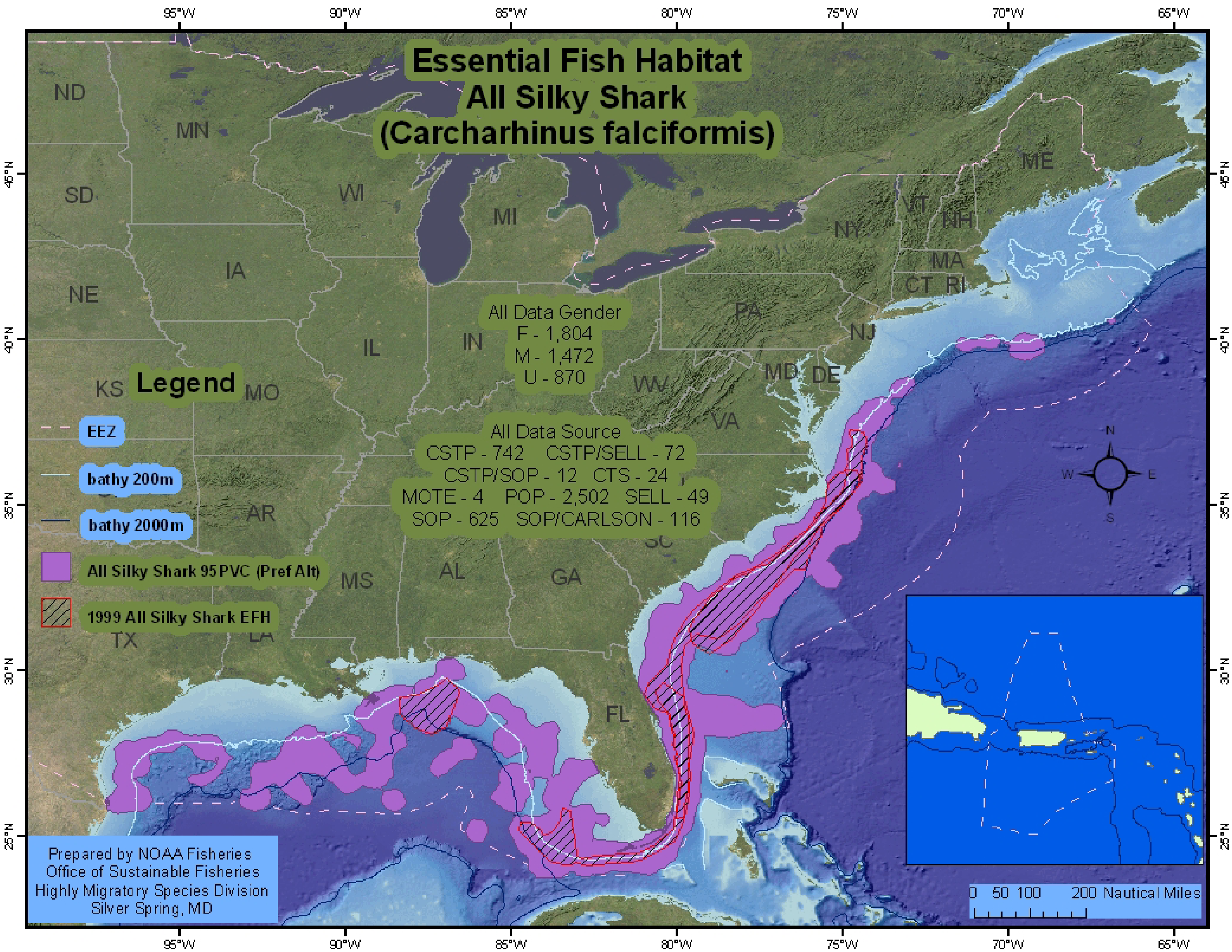

Figure 5.55 Silky Shark: All Life Stages Combined.

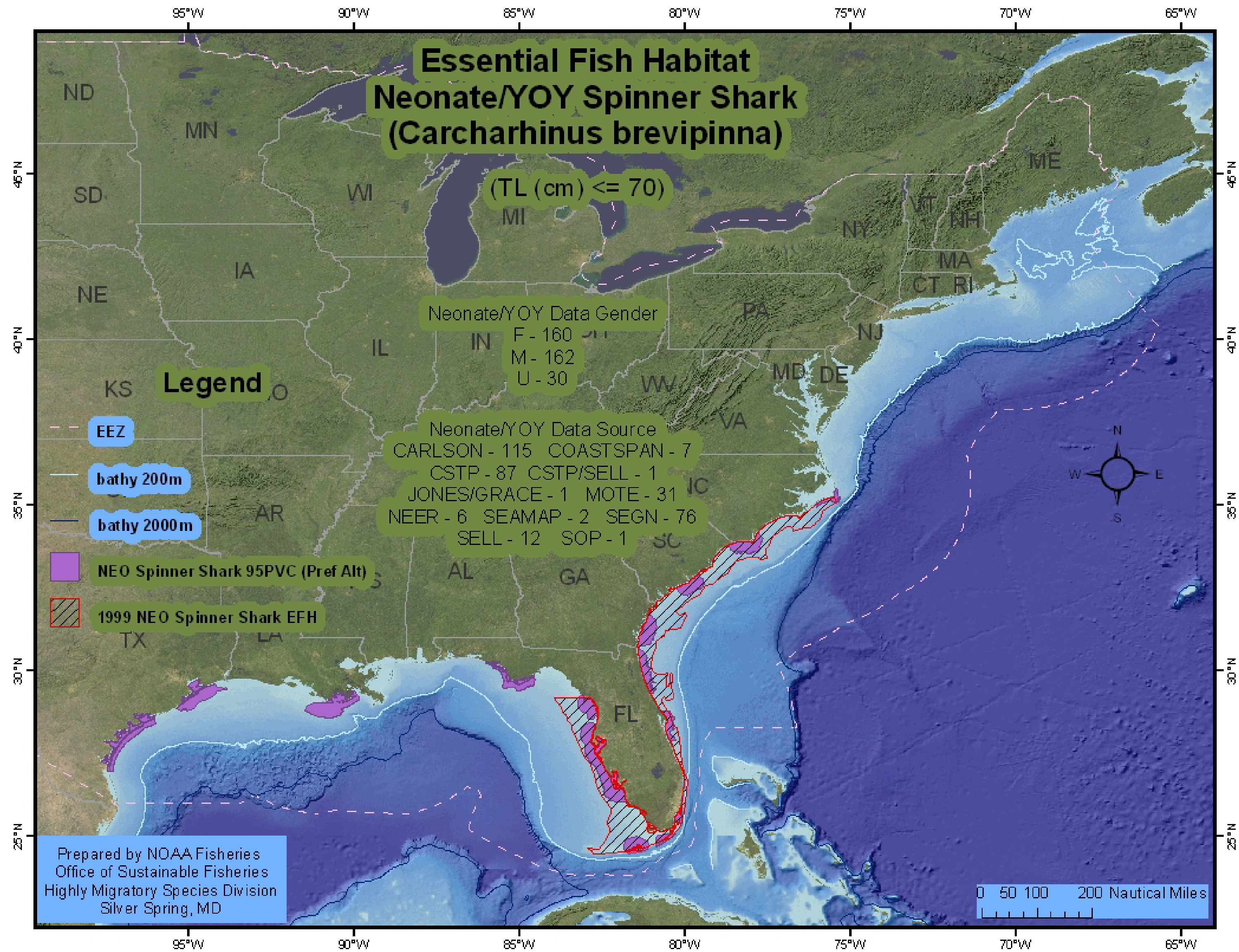

Figure 5.56 Spinner Shark: Neonate.

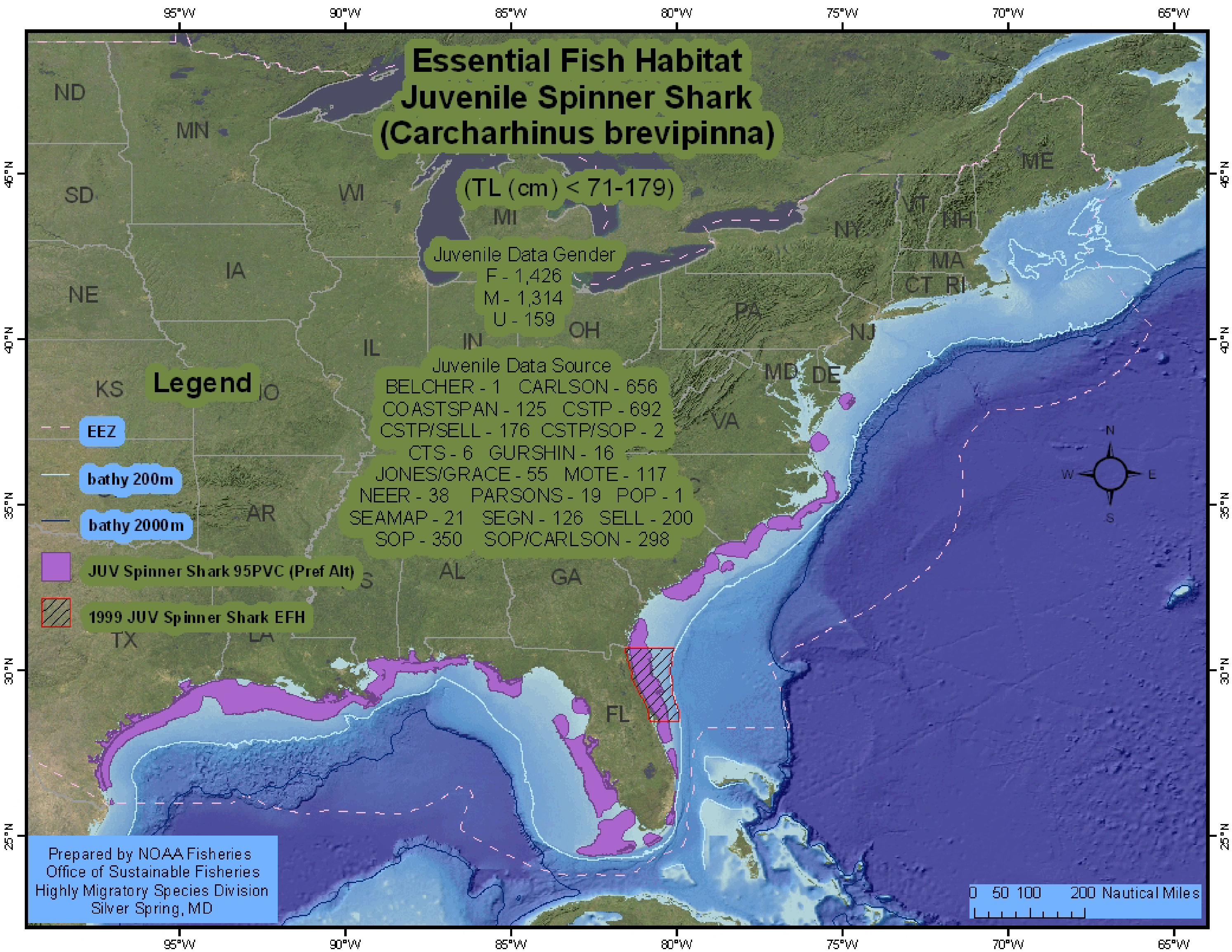

Figure 5.57 **Spinner Shark: Juvenile.**

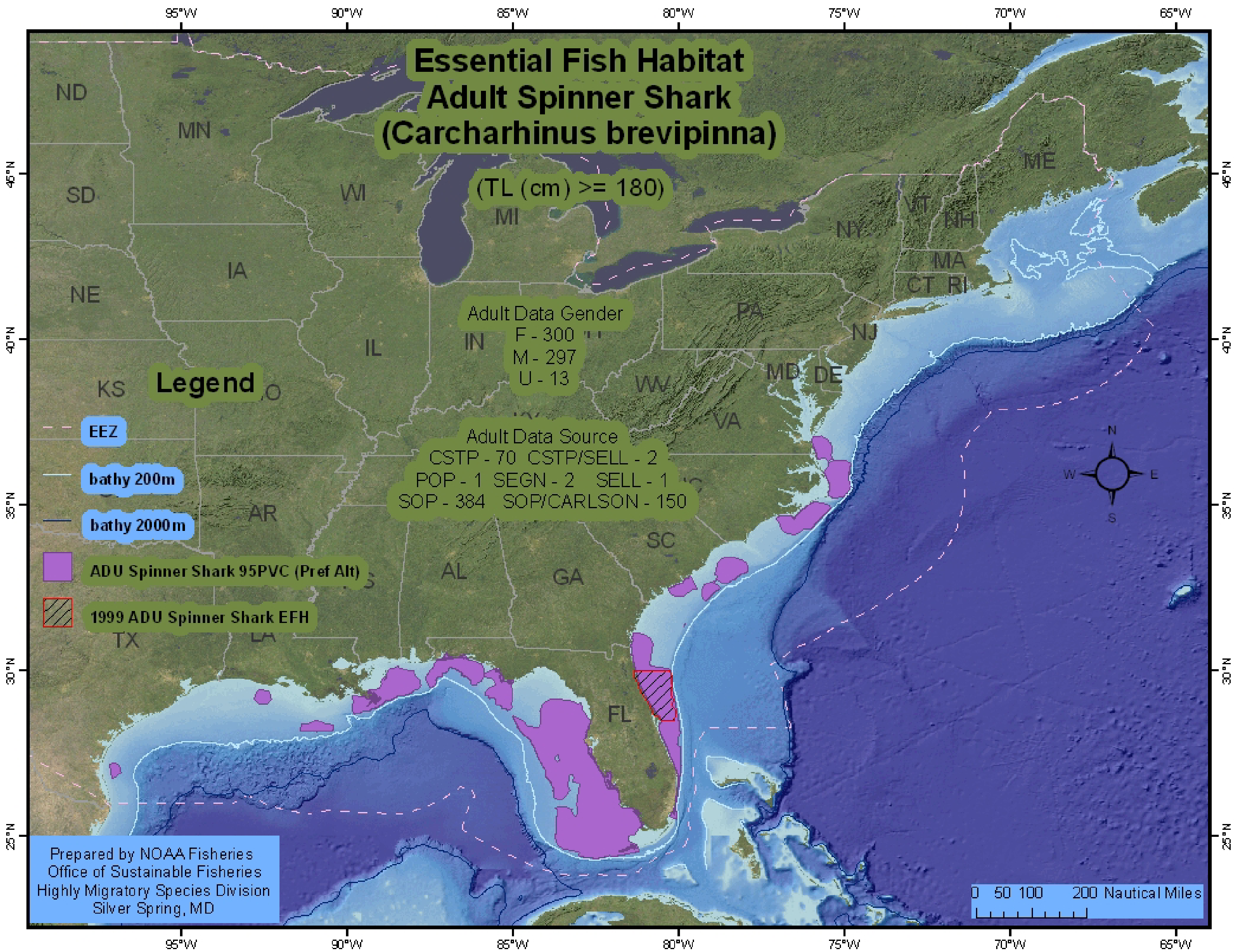

Figure 5.58 **Spinner Shark: Adult.**

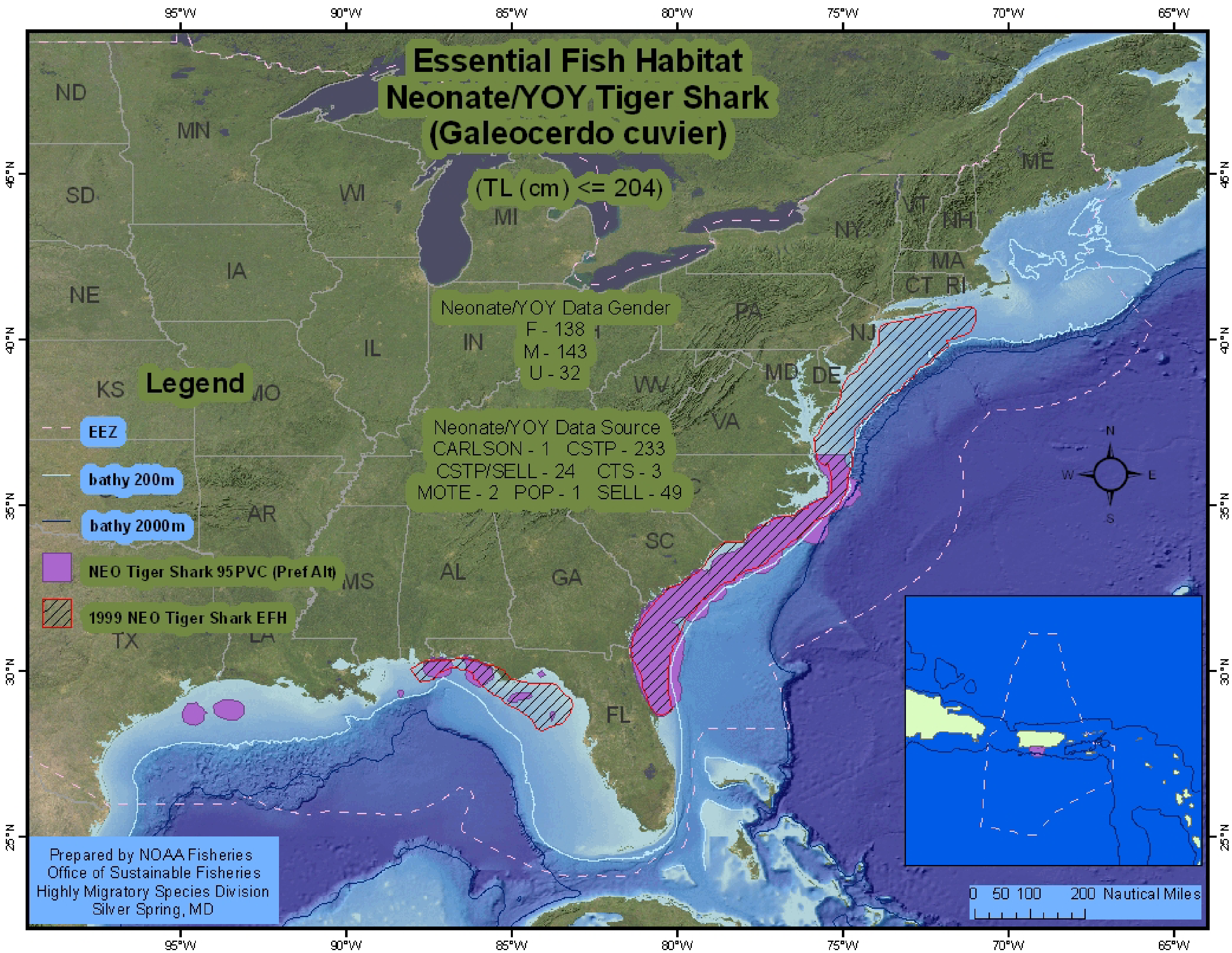

Figure 5.59 **Tiger Shark: Neonate.**

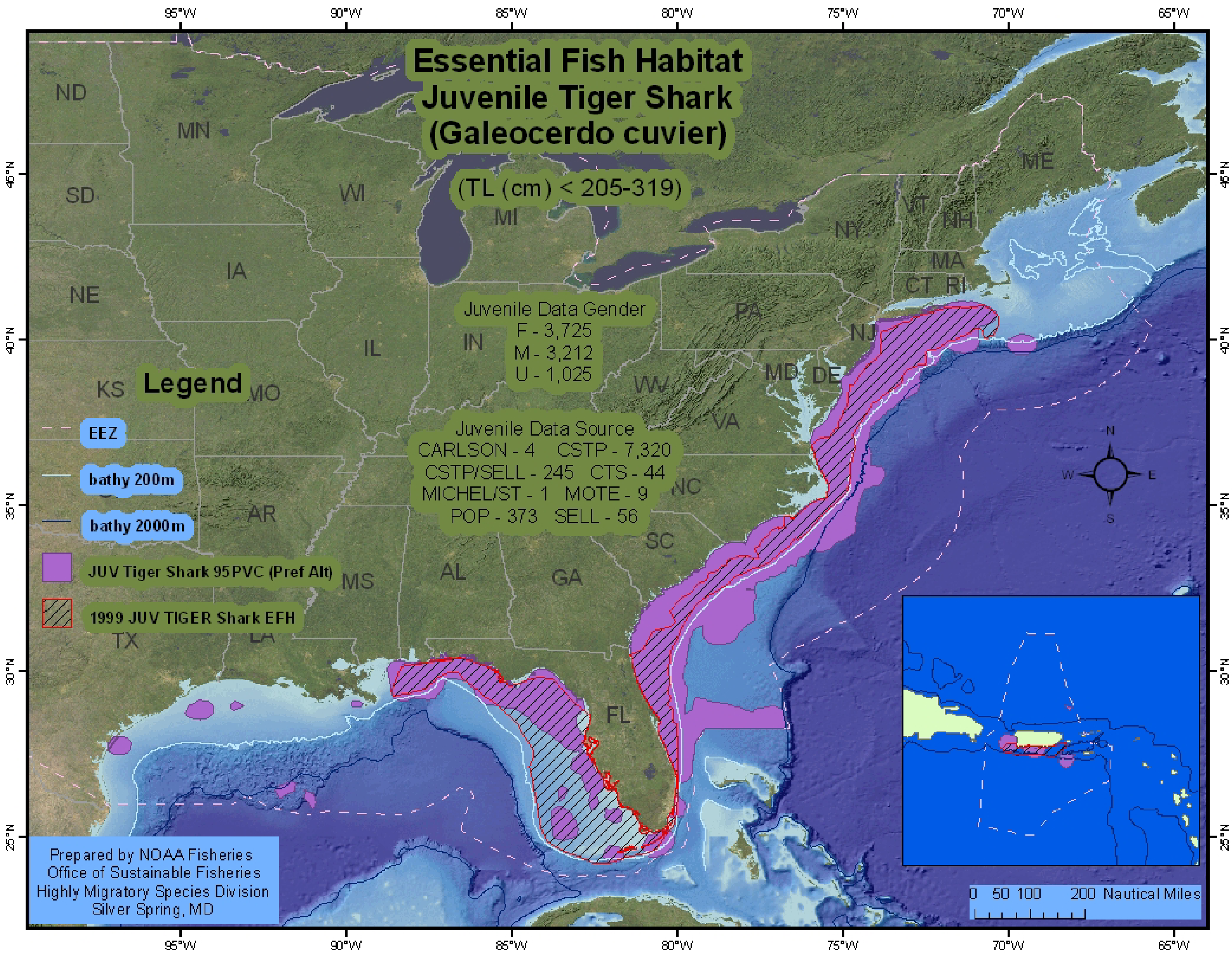

Figure 5.60 **Tiger Shark: Juvenile.**

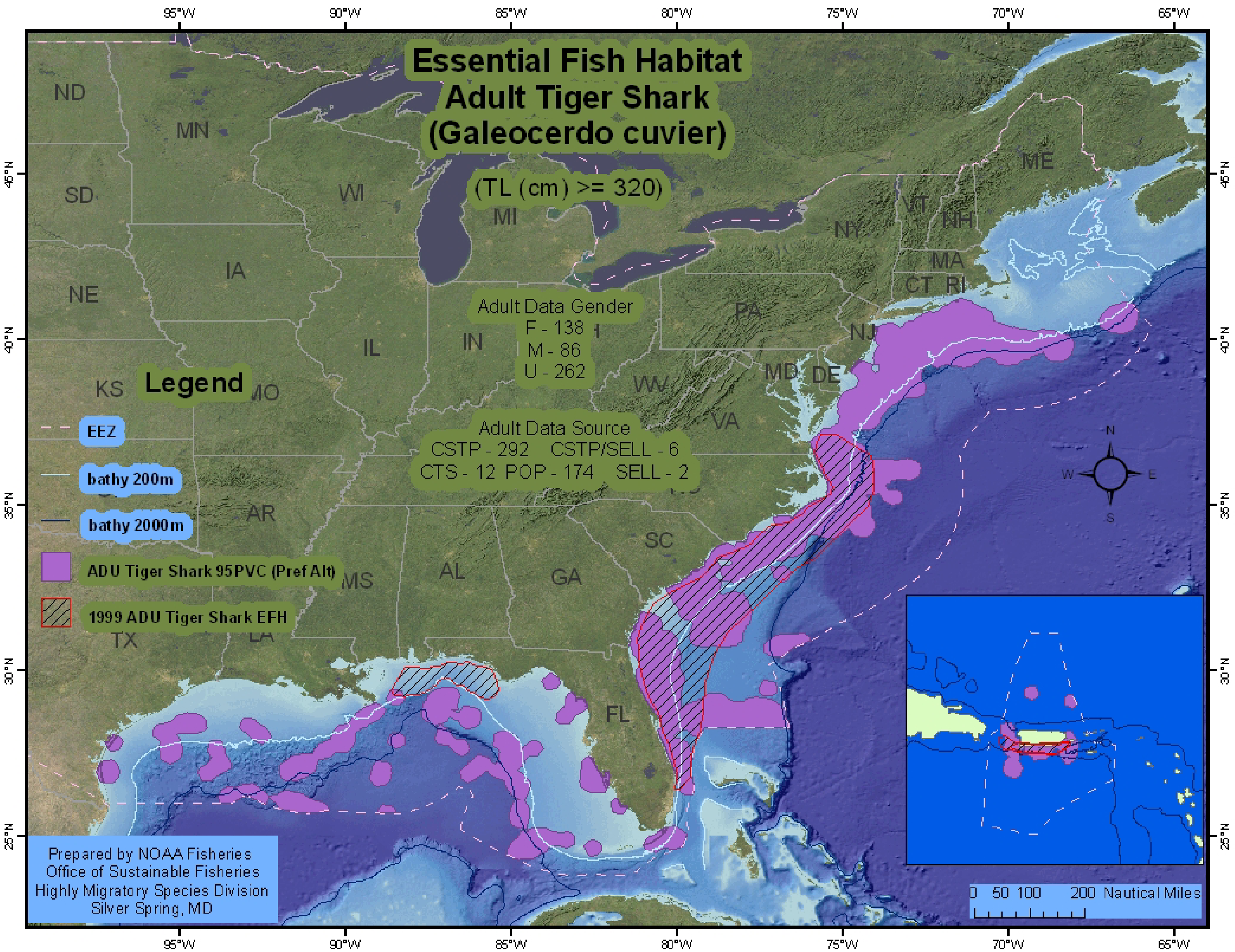

Figure 5.61 Tiger Shark: Adult.

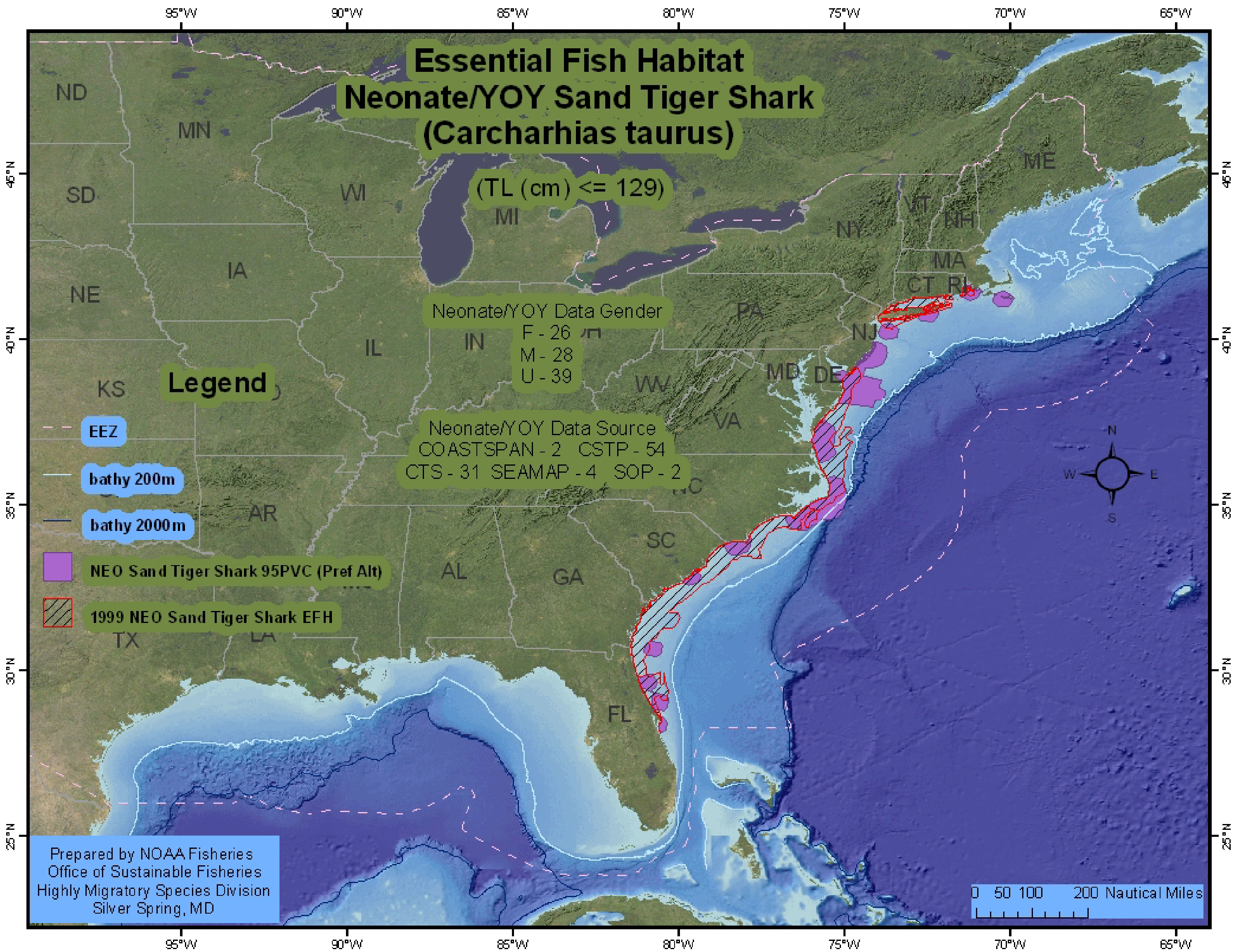

Figure 5.62 **Sand Tiger Shark: Neonate.**

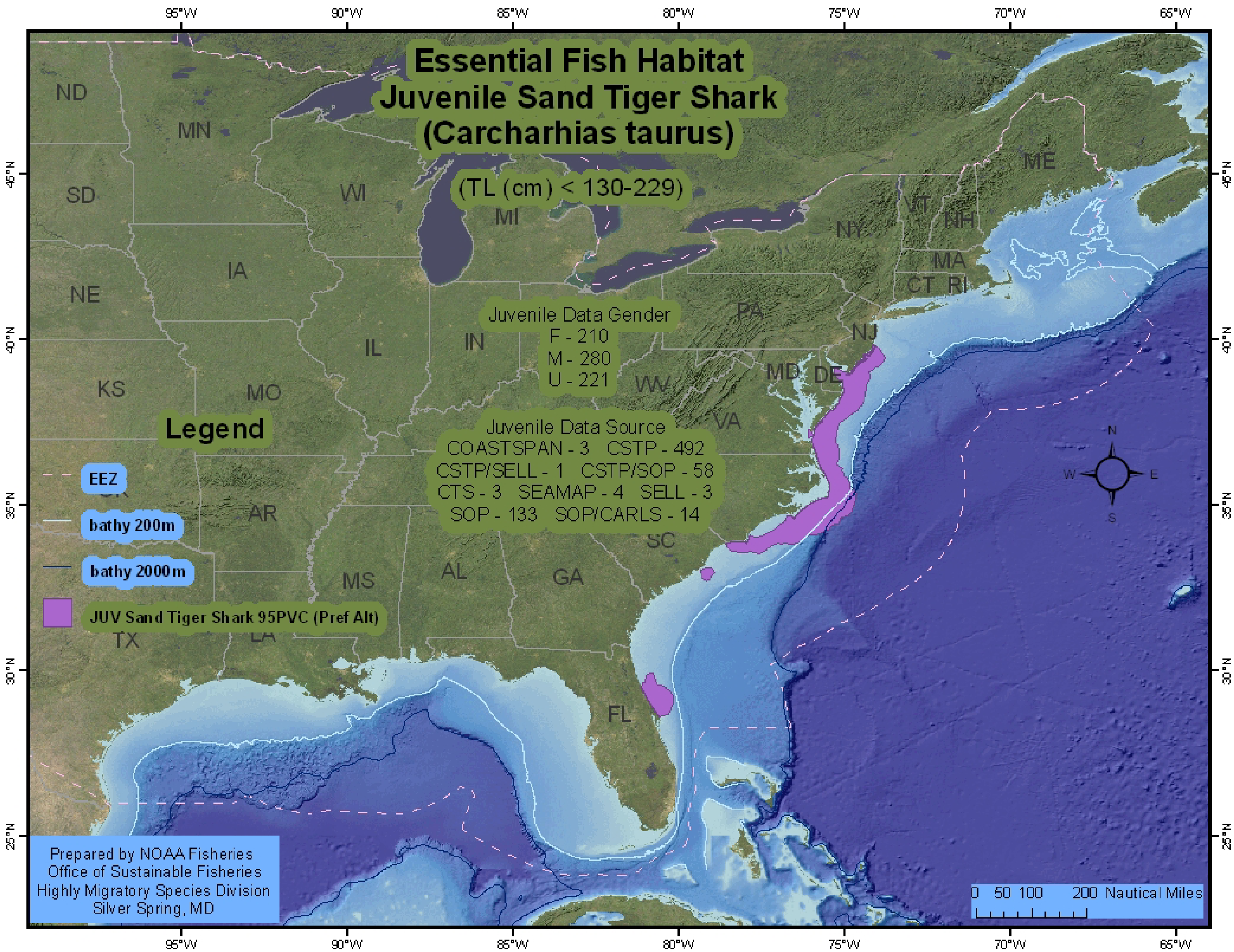

Figure 5.63 Sand Tiger Shark: Juvenile.

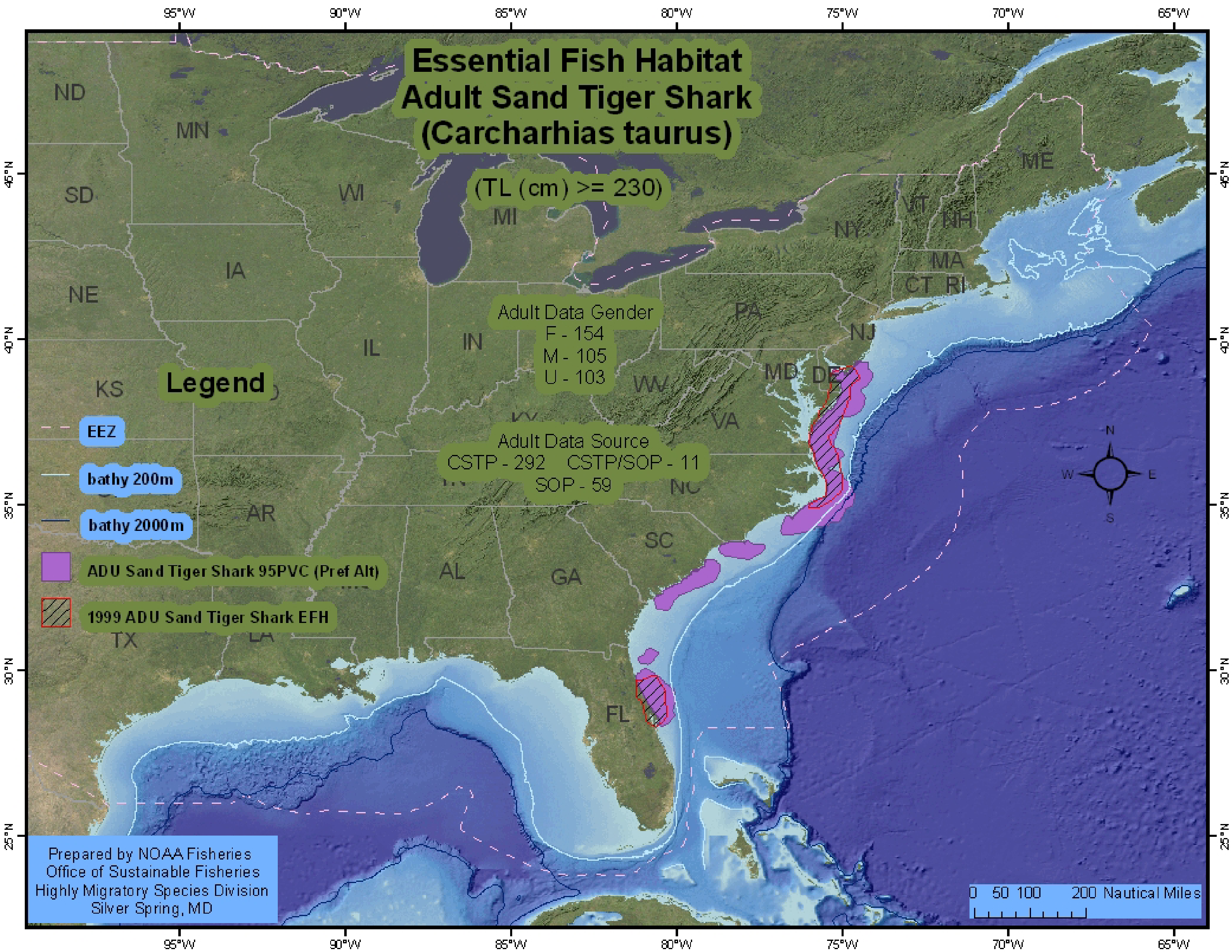

Figure 5.64 **Sand Tiger Shark: Adult.**

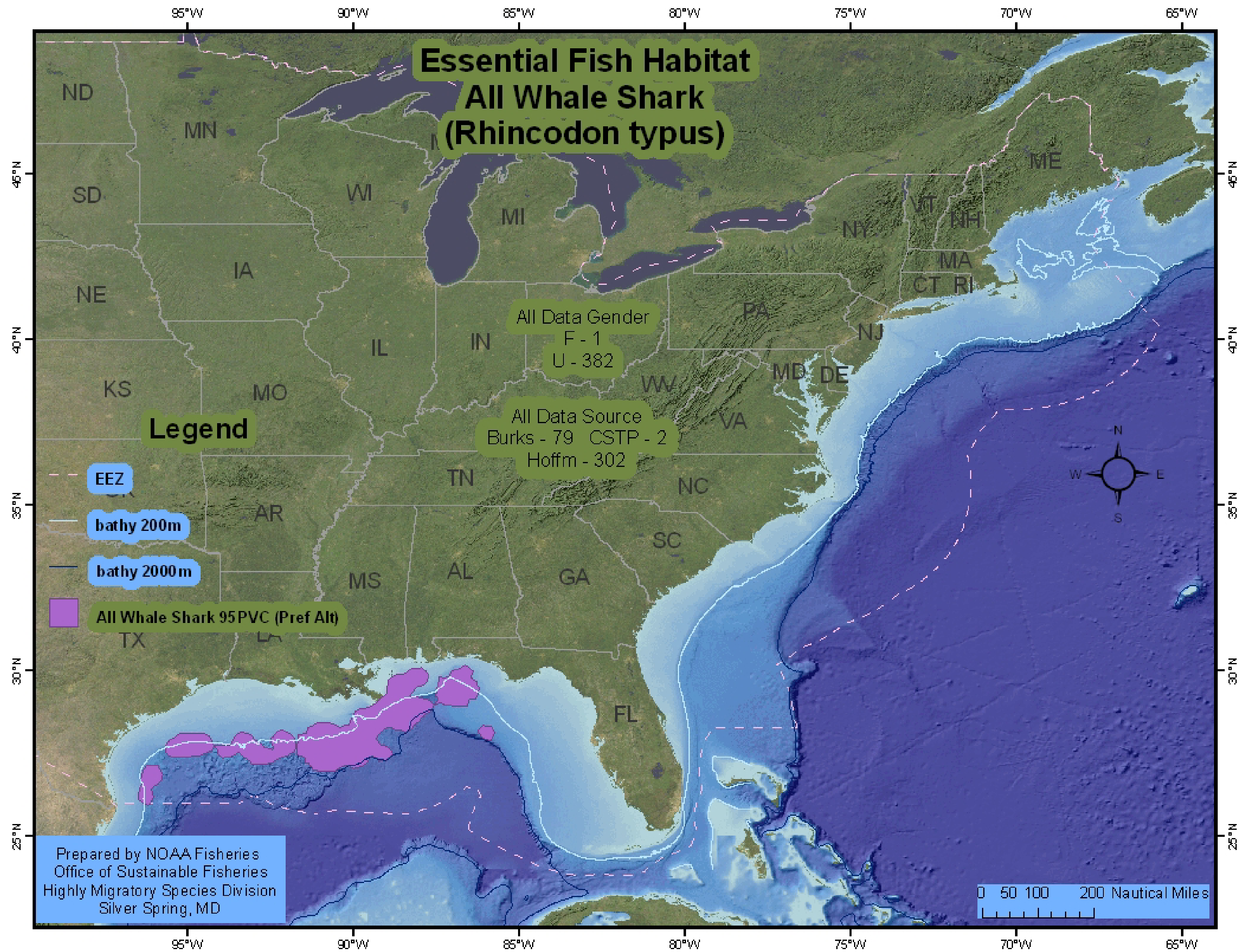

Figure 5.65 **Whale Shark: All Life Stages Combined.**

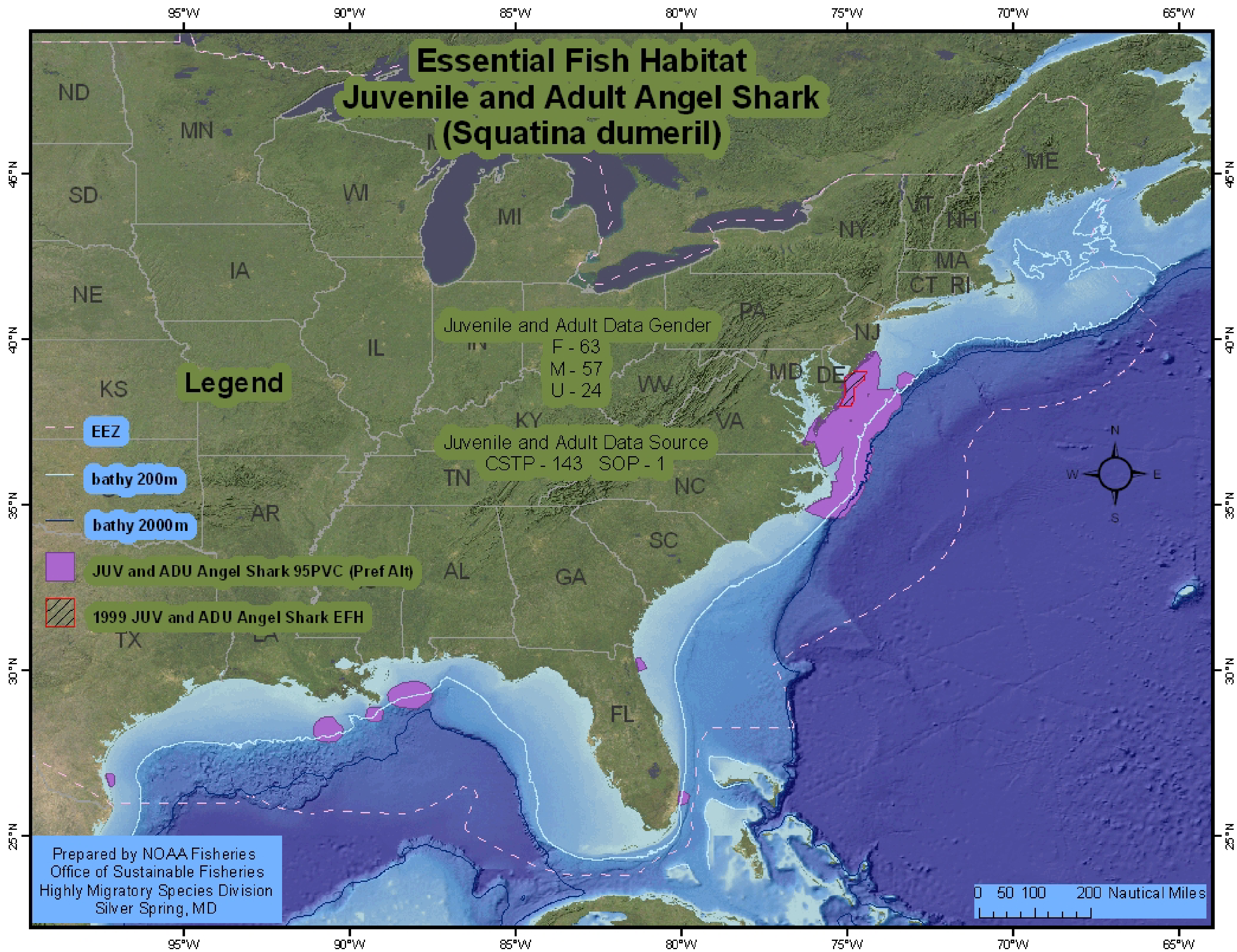

Figure 5.66 **Angel Shark: Juvenile and Adult Combined.**

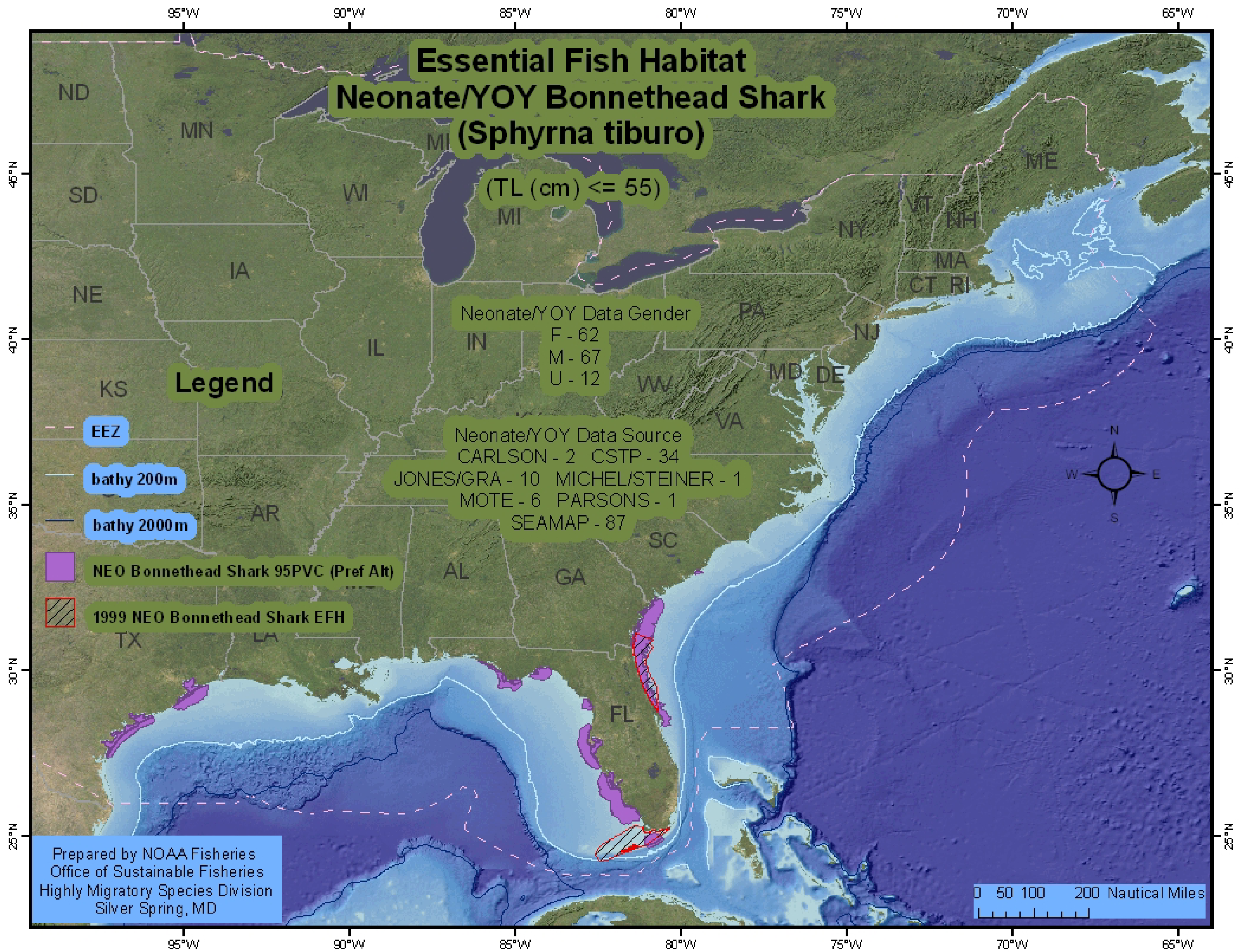

Figure 5.67 **Bonnethead Shark: Neonate.**

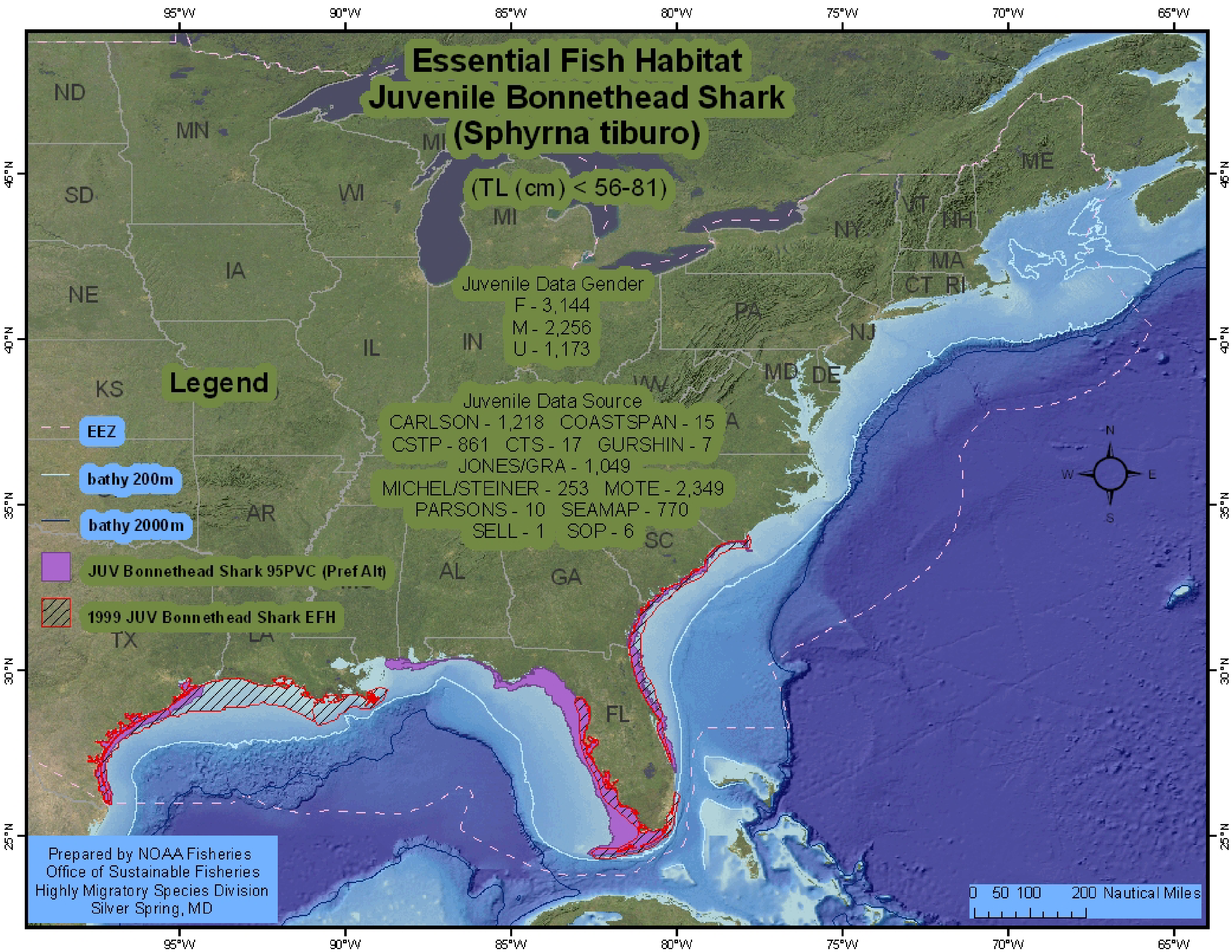

Figure 5.68 **Bonnethead Shark: Juvenile.**

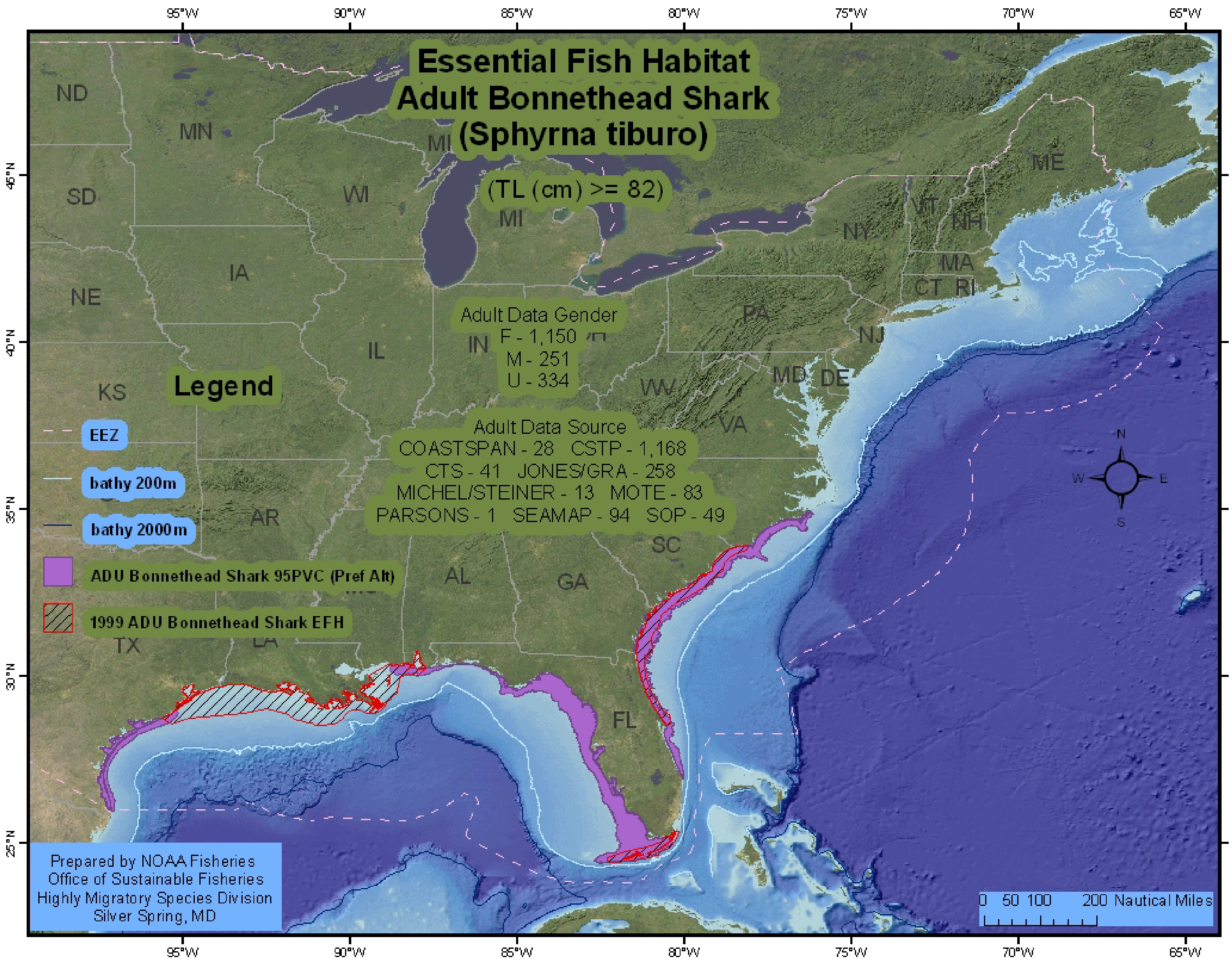

Figure 5.69 Bonnethead Shark: Adult.

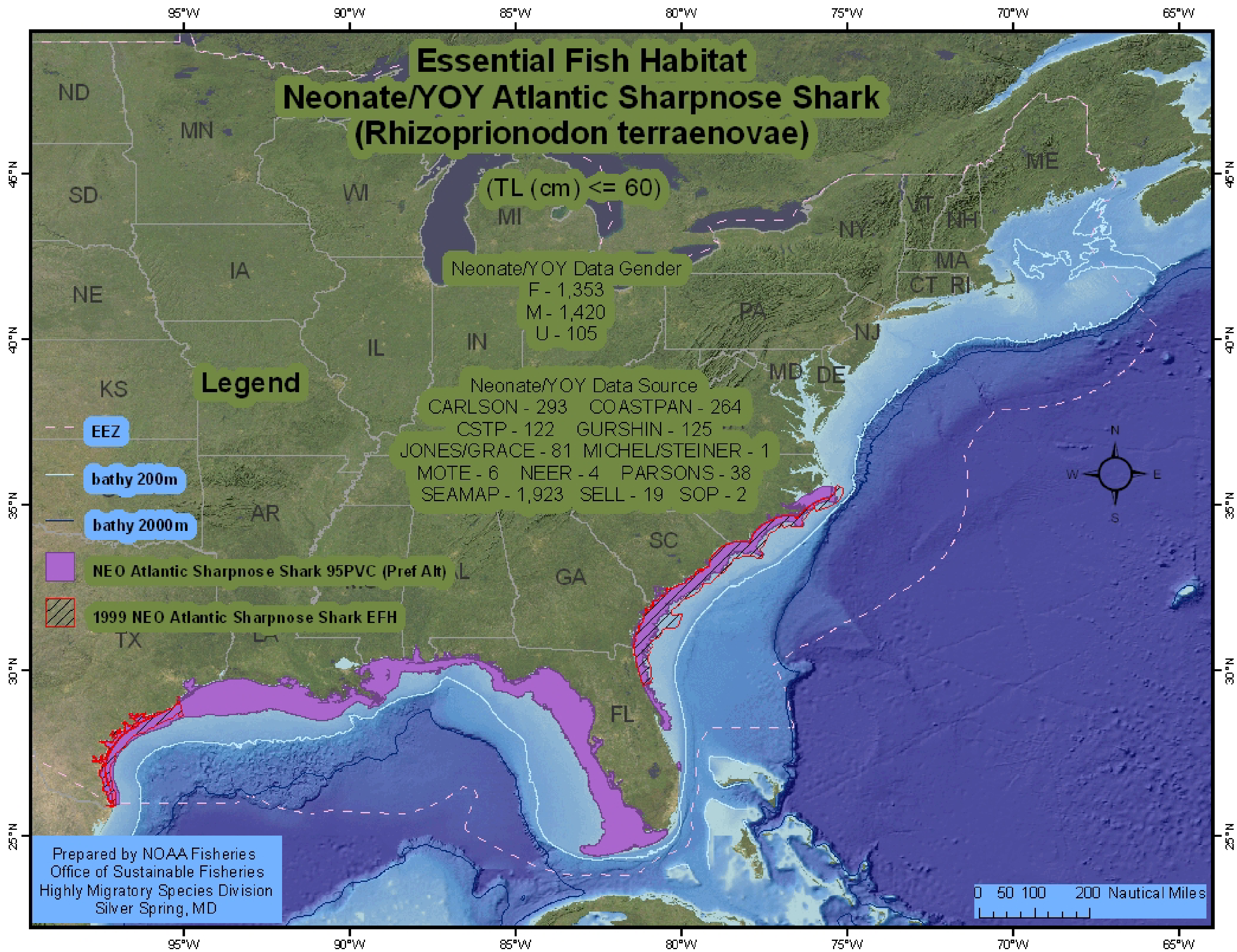

Figure 5.70 **Altantic Sharpnose: Neonate.**

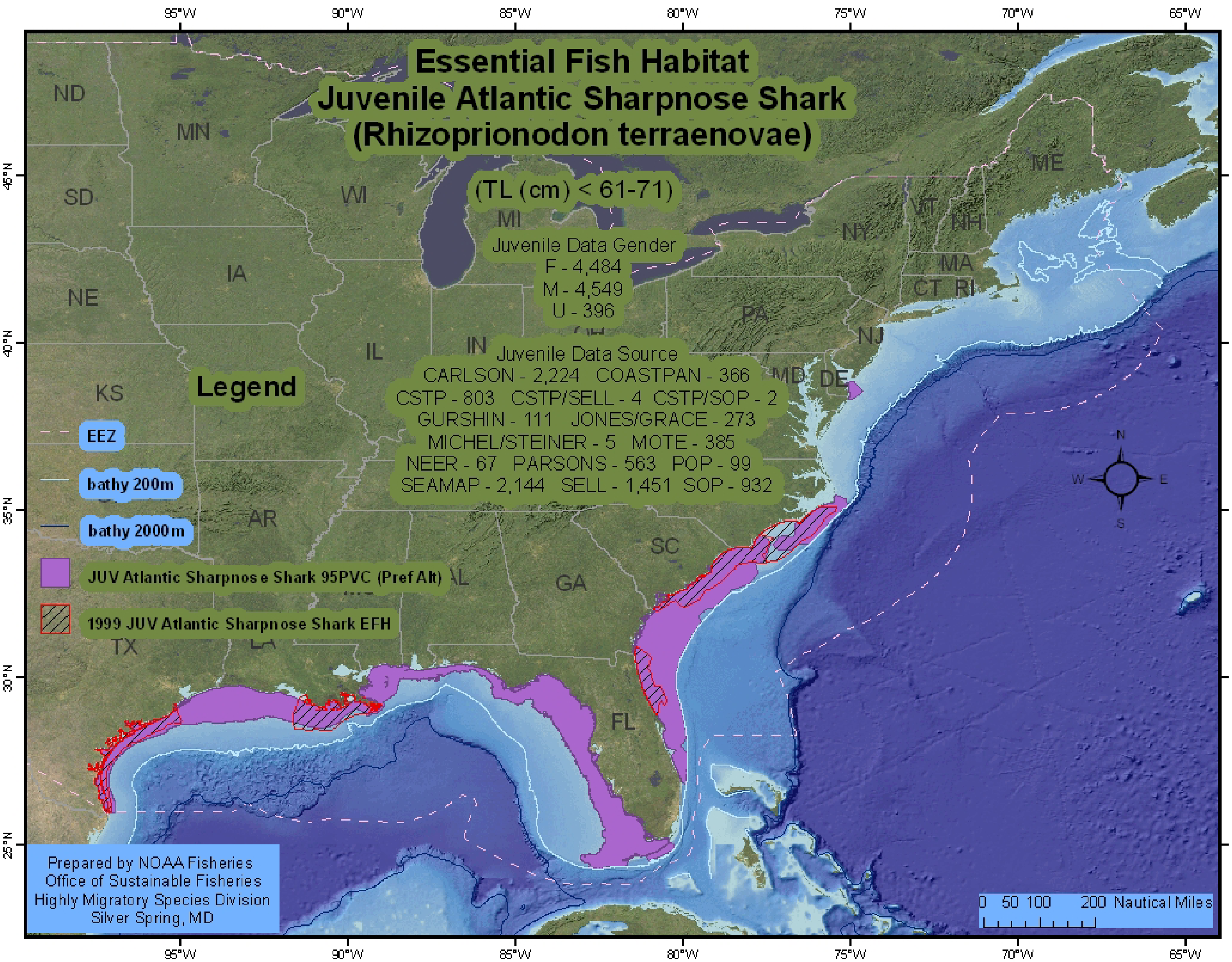

Figure 5.71 **Atlantic Sharpnose: Juvenile.**

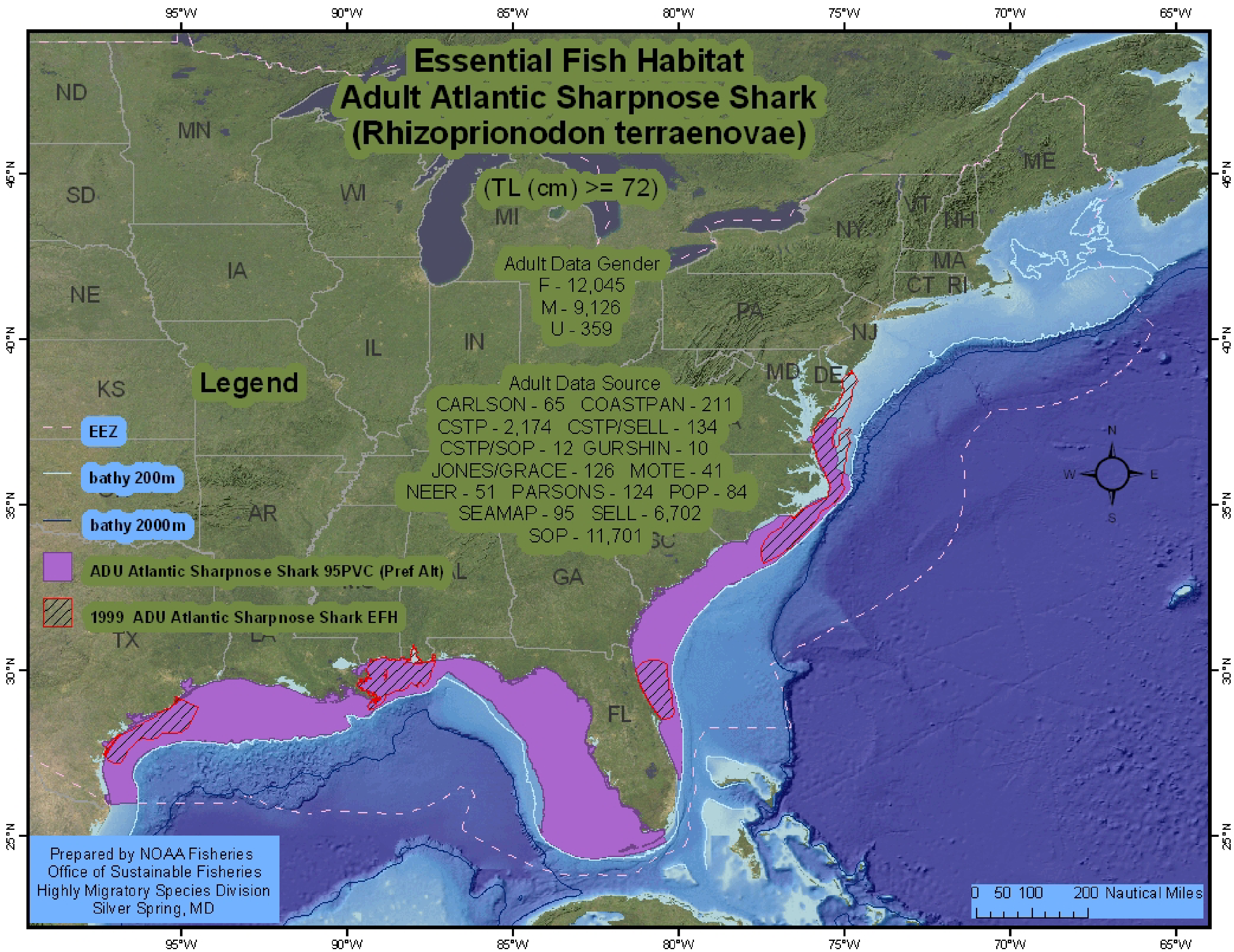

Figure 5.72 **Atlantic Sharpnose Shark: Adult.**

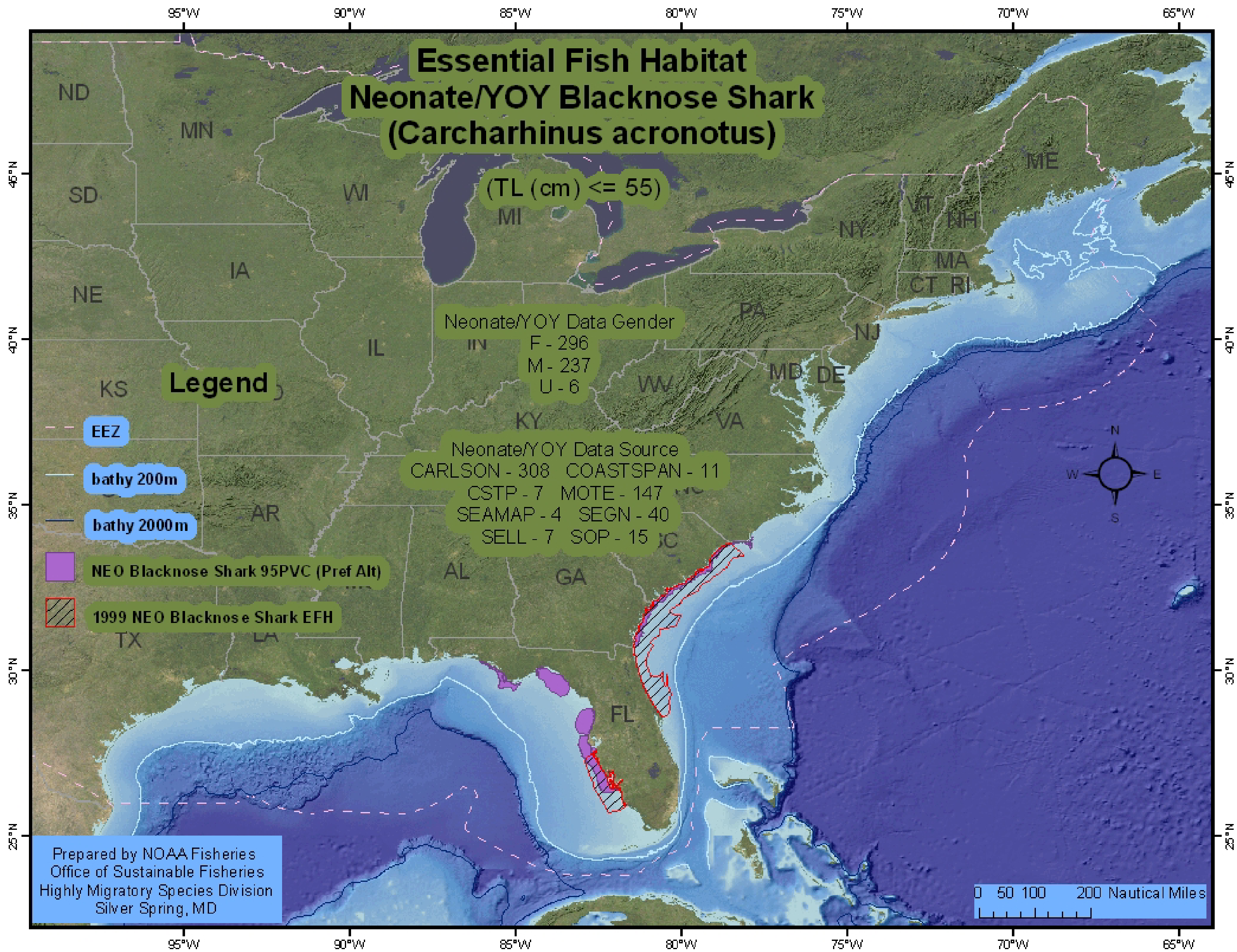

Figure 5.73 **Blacknose Shark: Neonoate.**

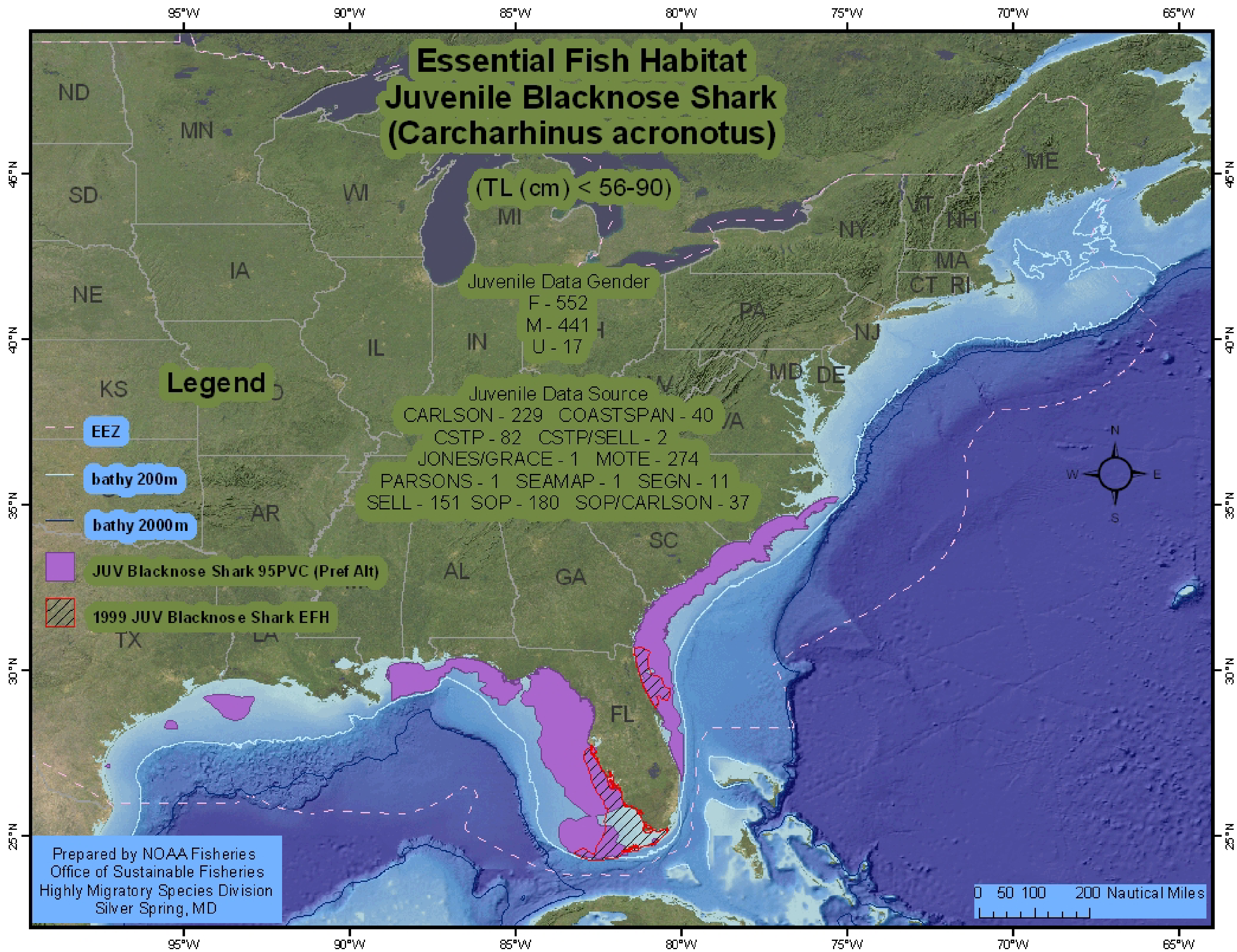

Figure 5.74 **Blacknose Shark: Juvenile.**

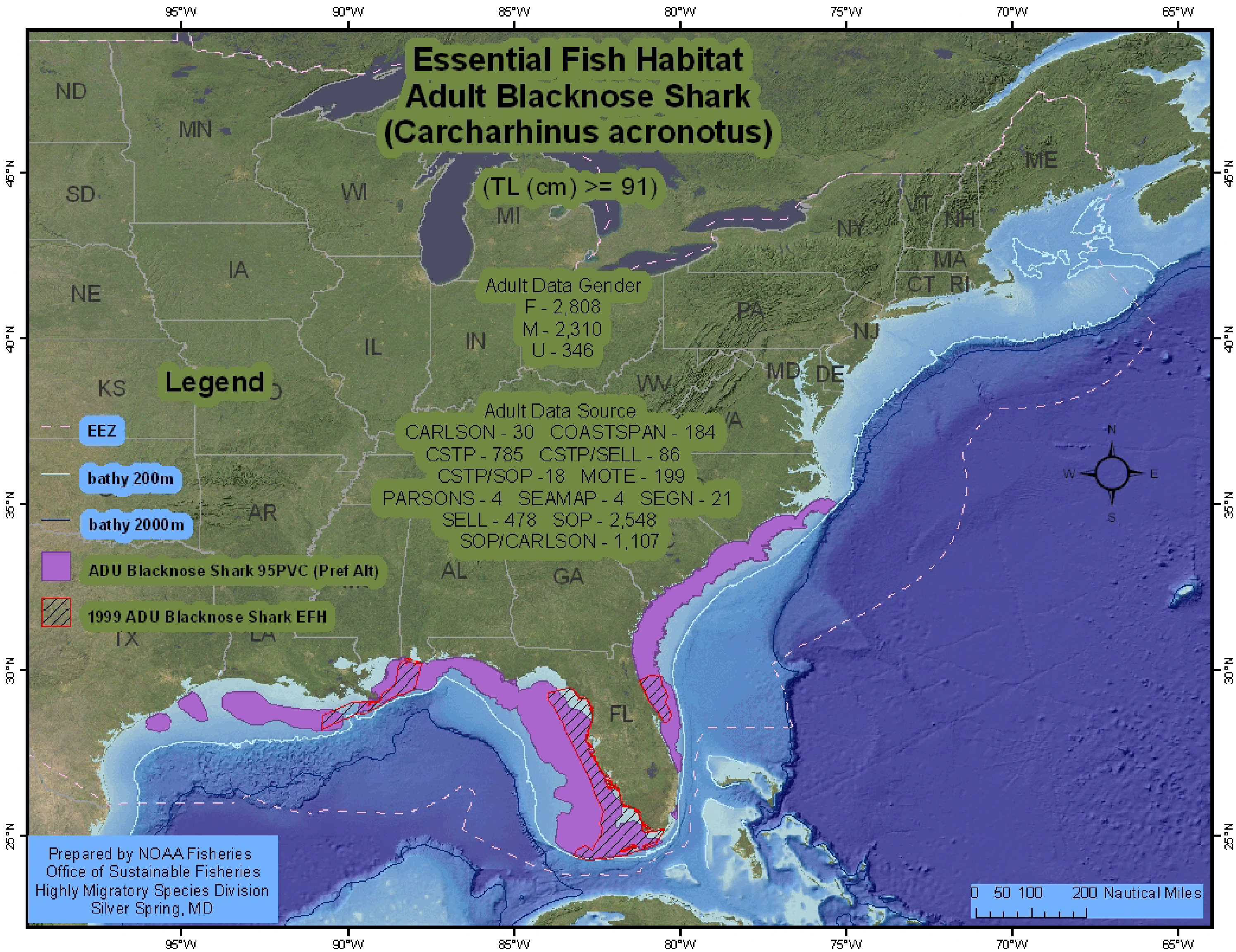

Figure 5.75 Blacknose Shark: Adult.

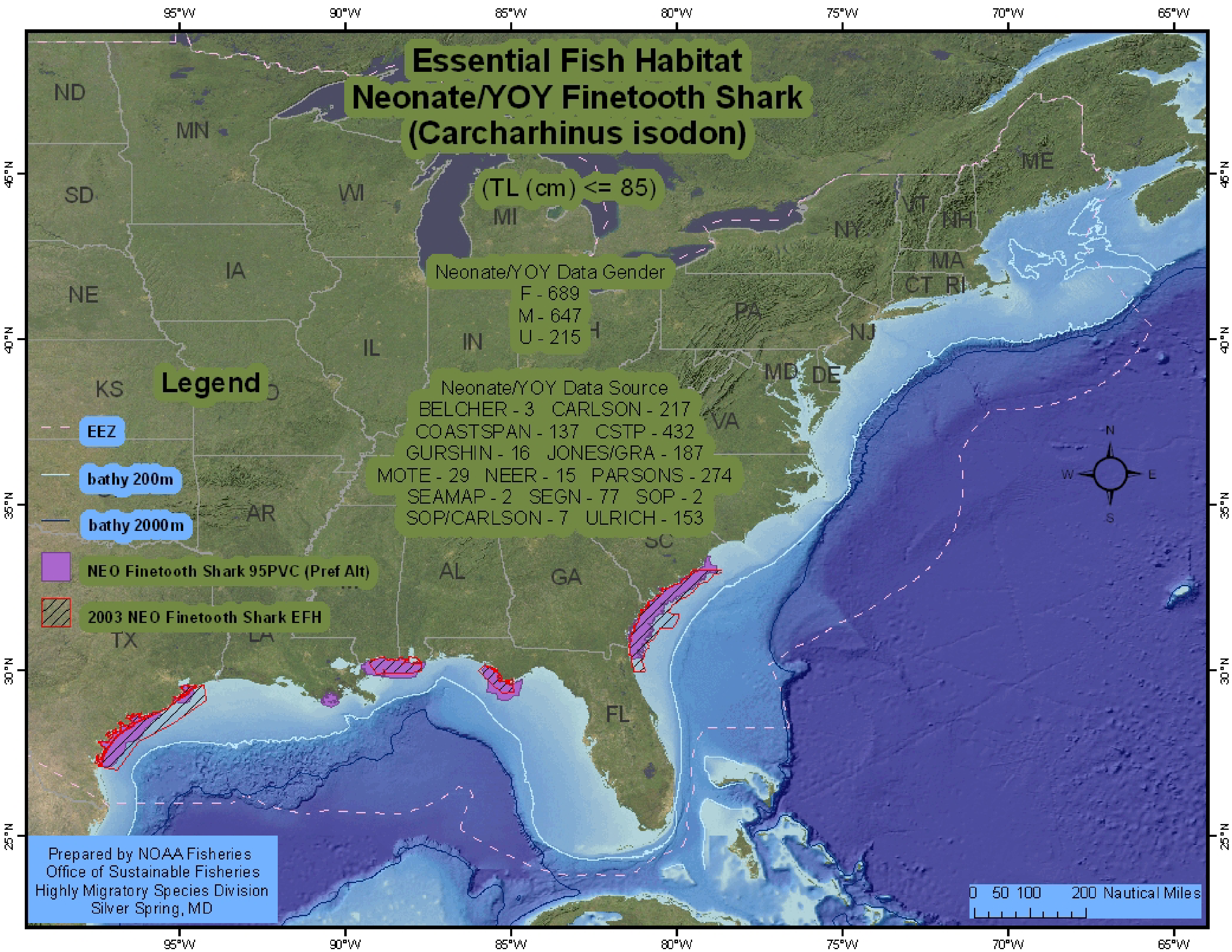

Figure 5.76 **Finetooth Shark: Neonate.**

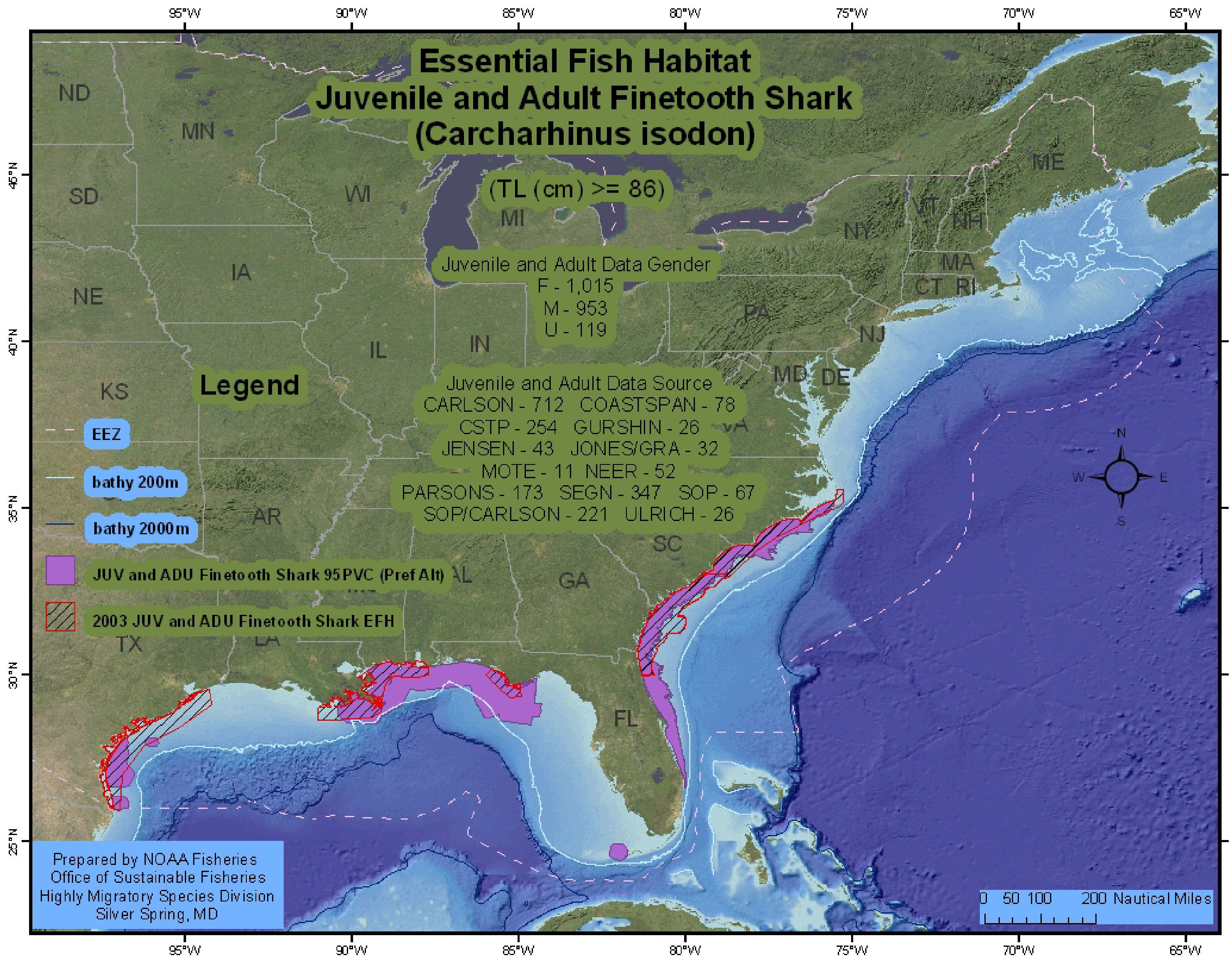

Figure 5.77 Finetooth Shark: Juvenile and Adult Combined.

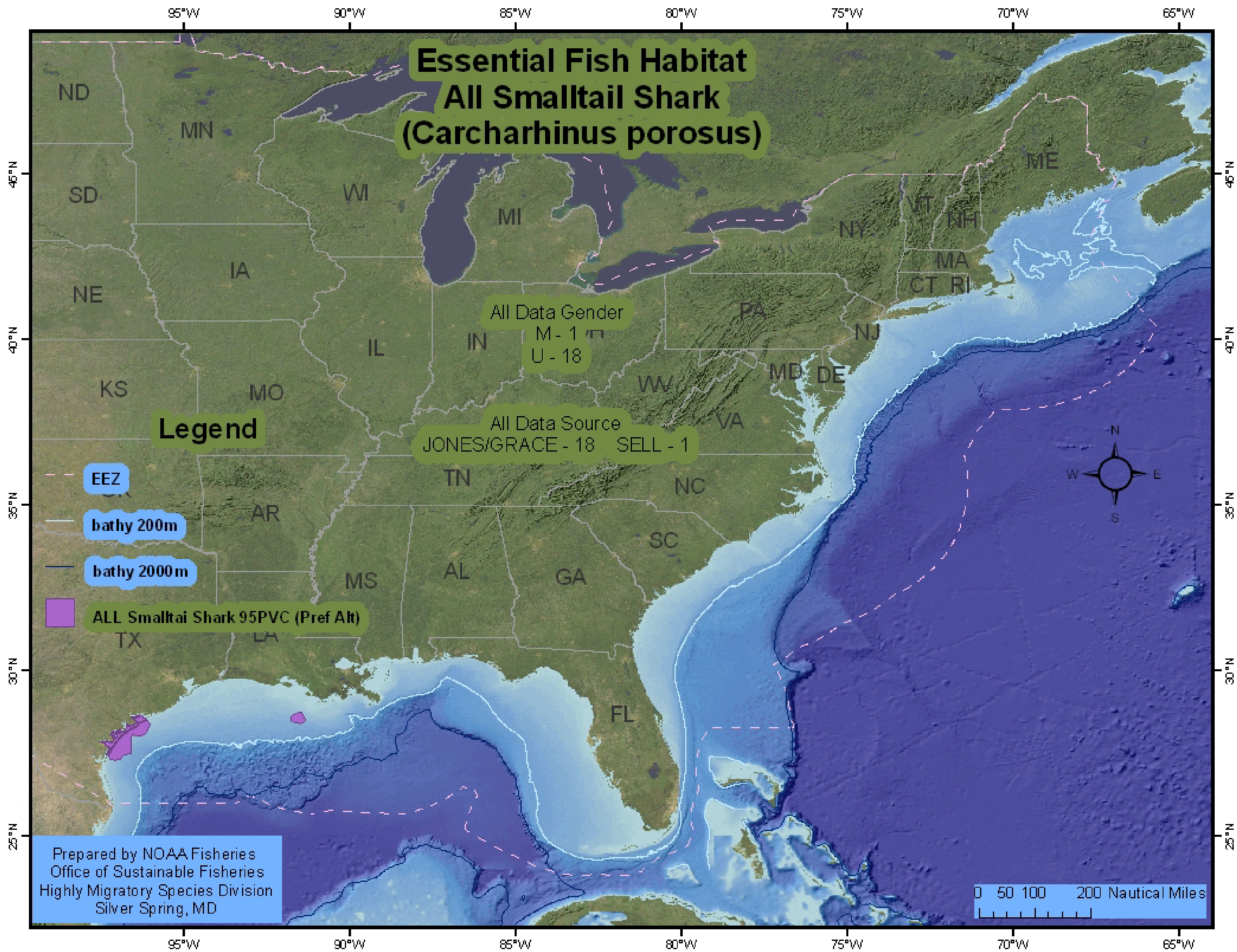

Figure 5.78 Smalltail Shark: All Life Stages Combined. No EFH was designated in 1999.

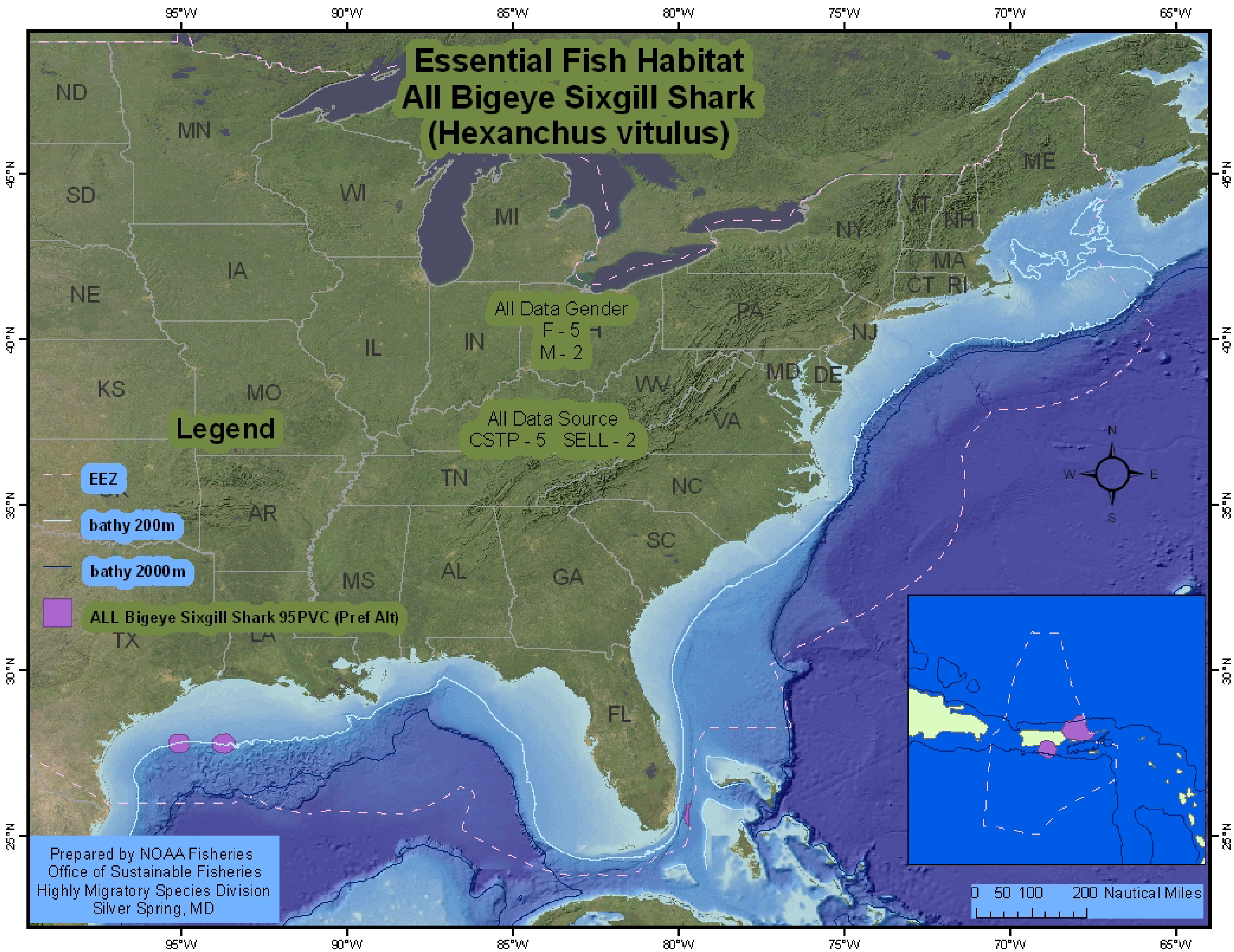

Figure 5.79 Bigeye Sixgill Shark: All Life Stages Combined. No EFH was designated in 1999.

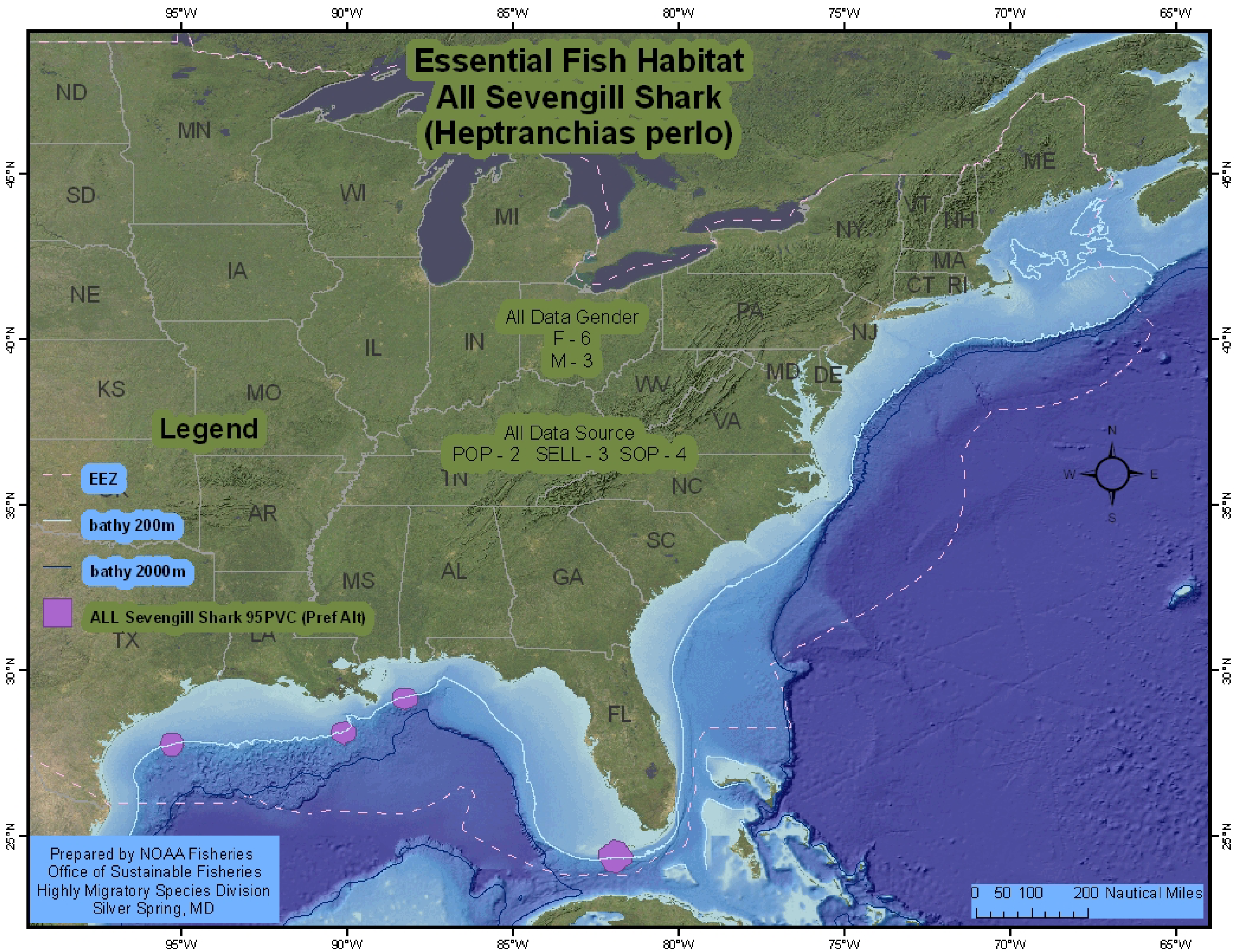

Figure 5.80 **Sevengill Shark: All Life Stages Combined. No EFH was designated in 1999.**

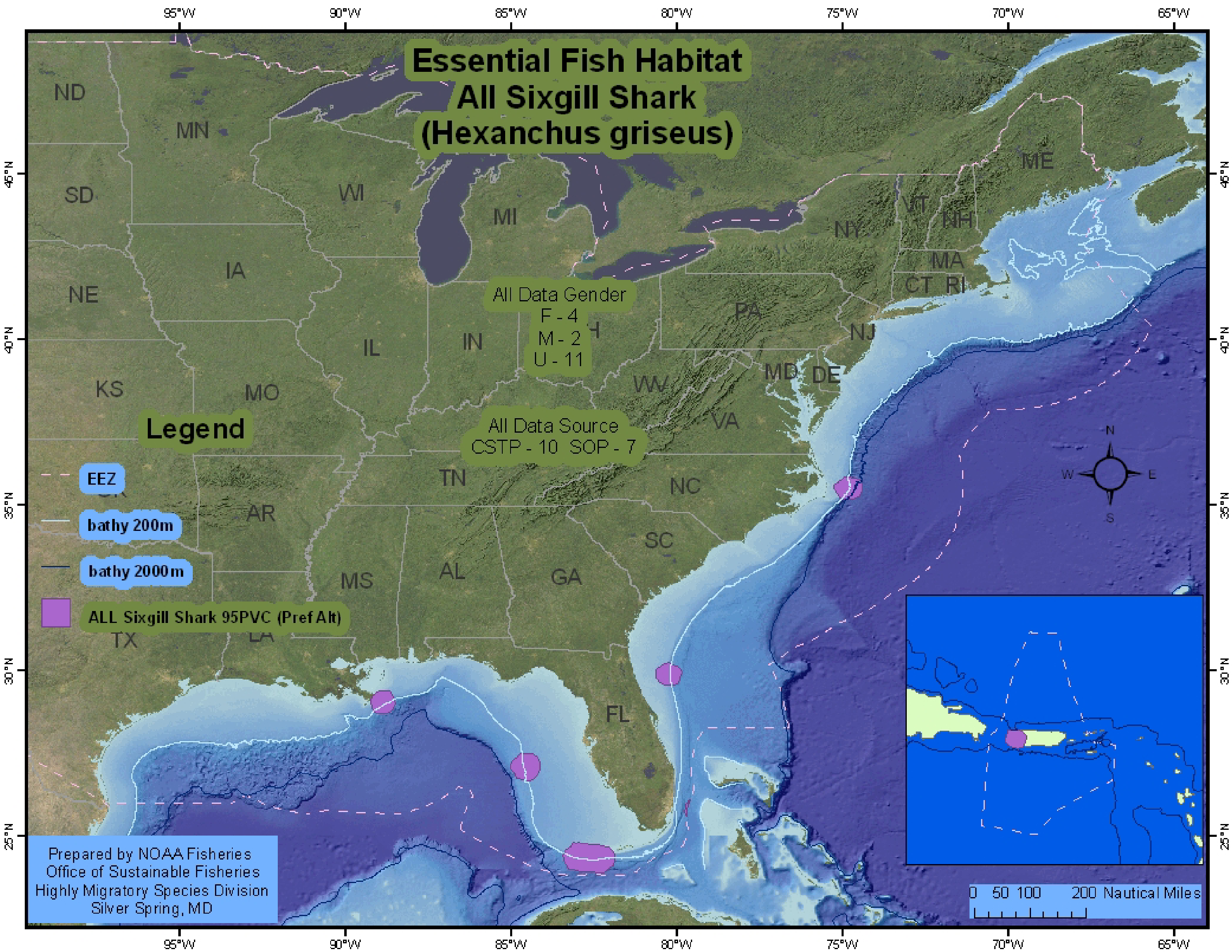

Figure 5.81 Sixgill Shark: All Life Stages Combined. No EFH was designated in 1999.

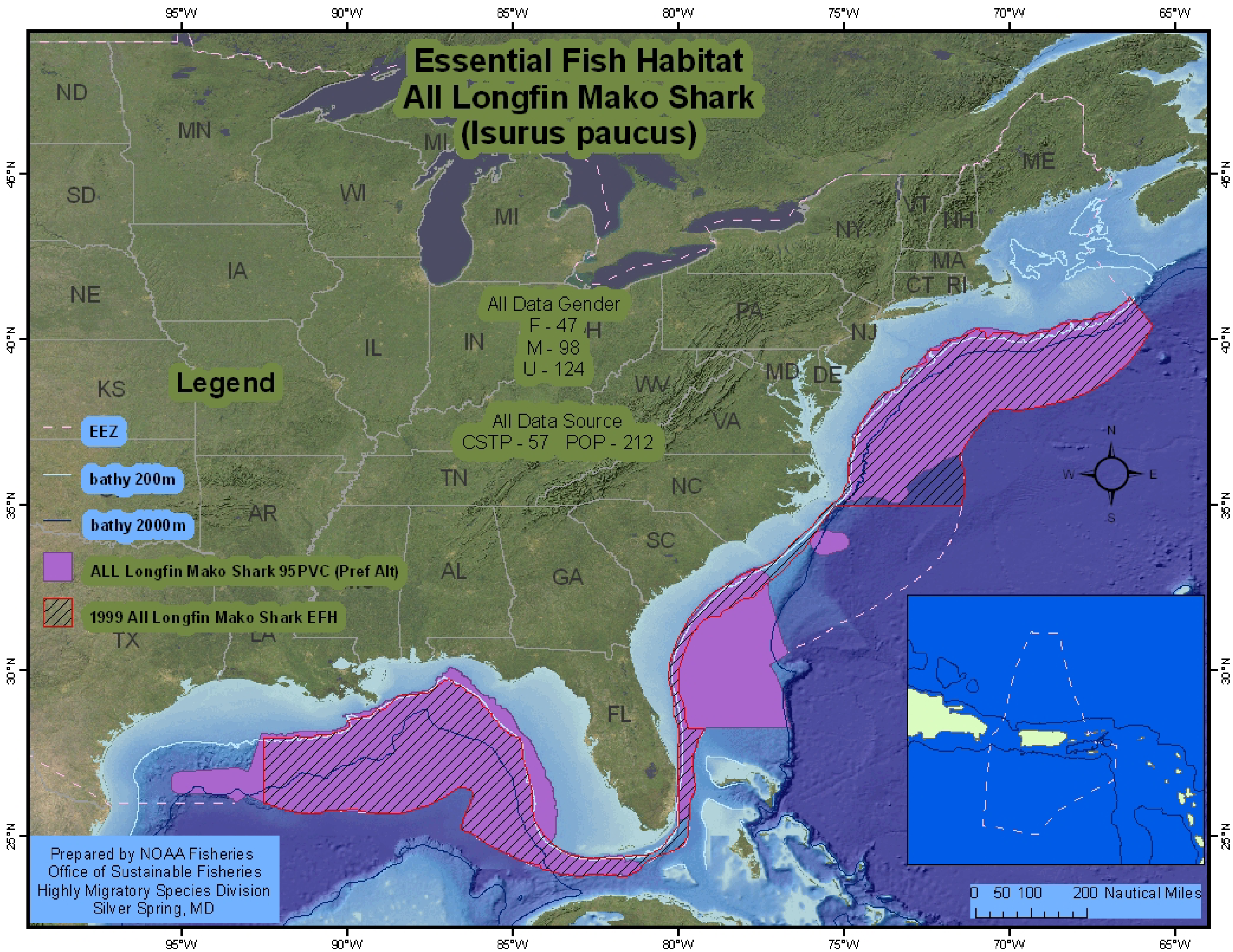

Figure 5.82 Longfin Mako Shark: All Life Stages Combined.

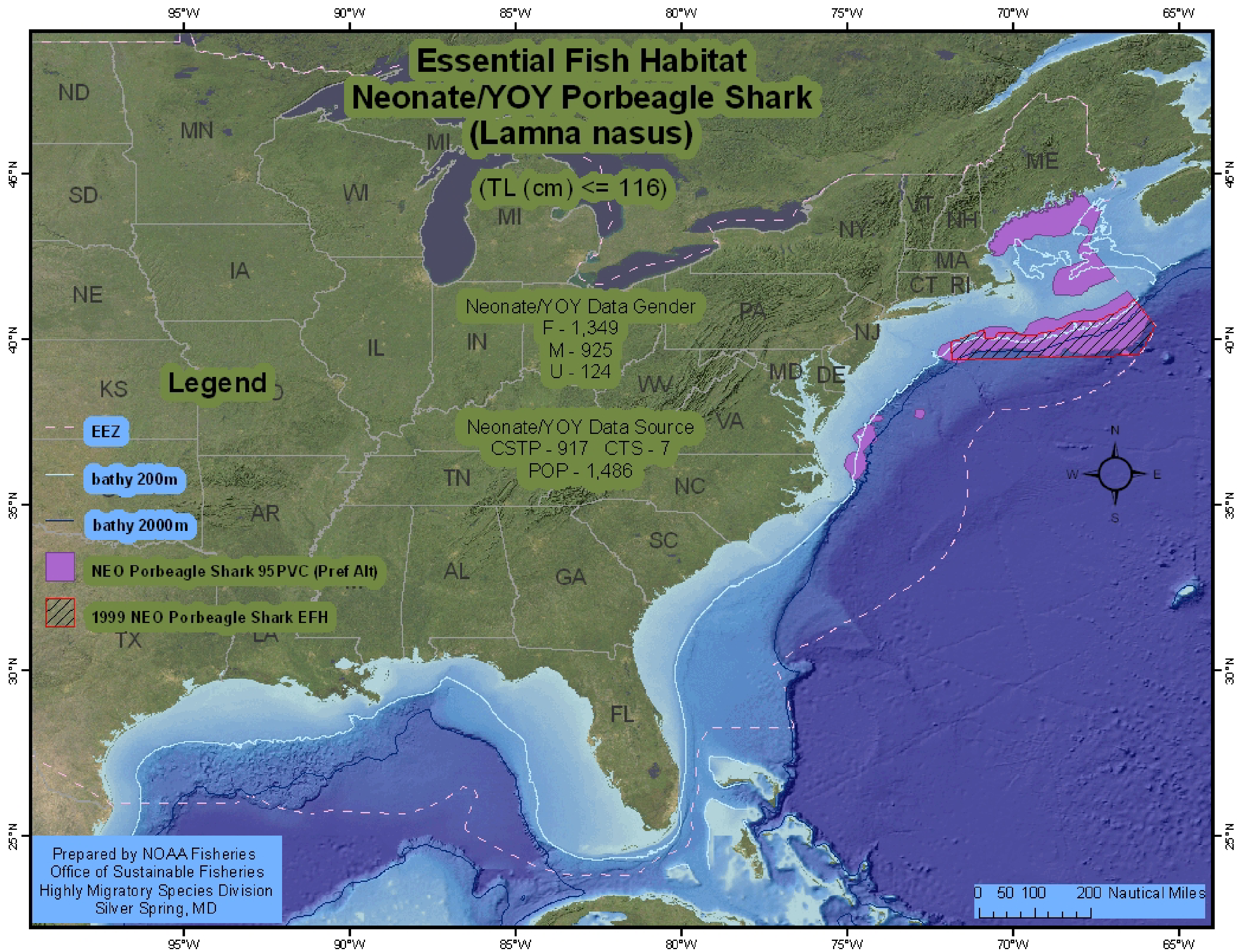

Figure 5.83 **Porbeagle Shark: Neonate.**

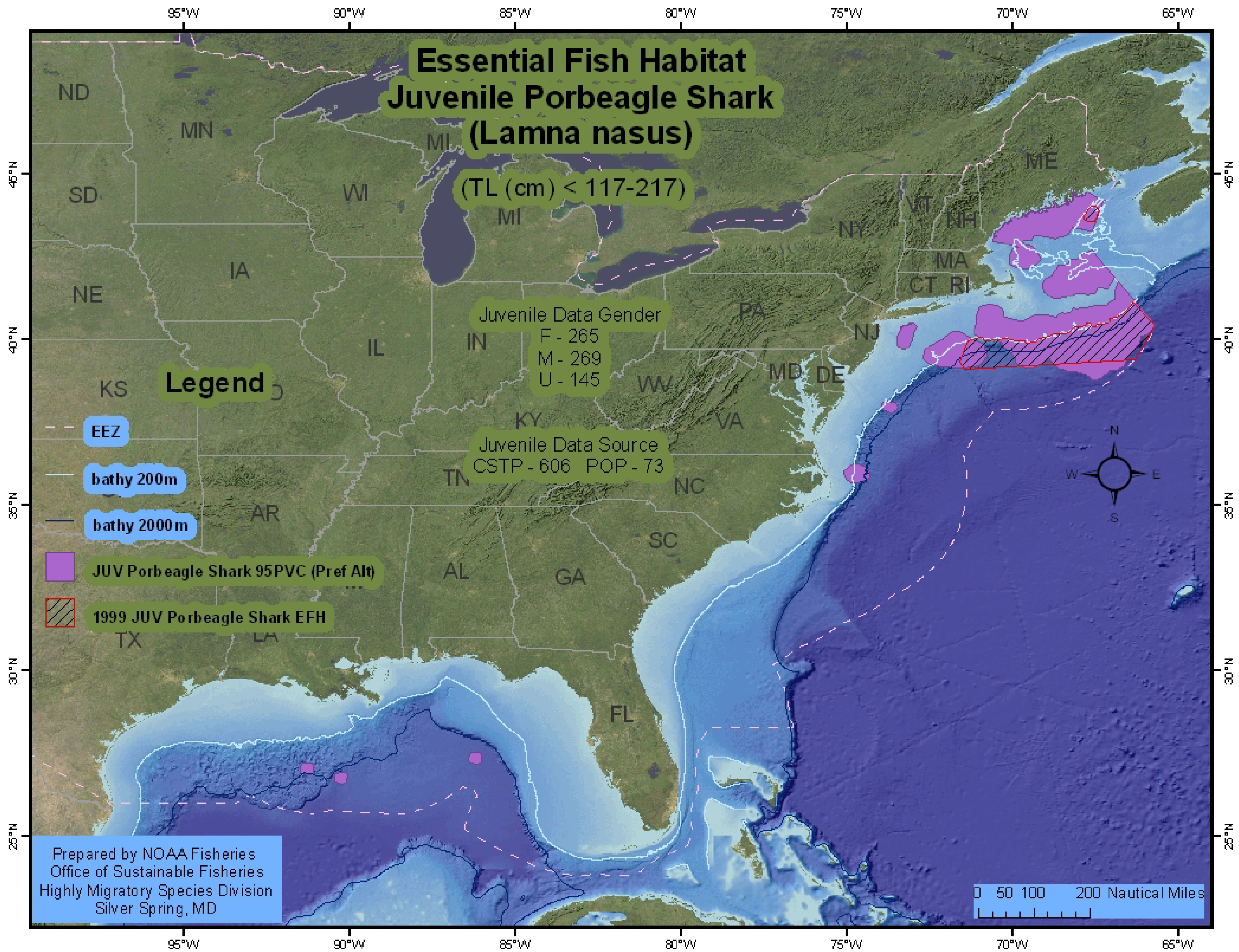

Figure 5.84 Porbeagle Shark: Juvenile.

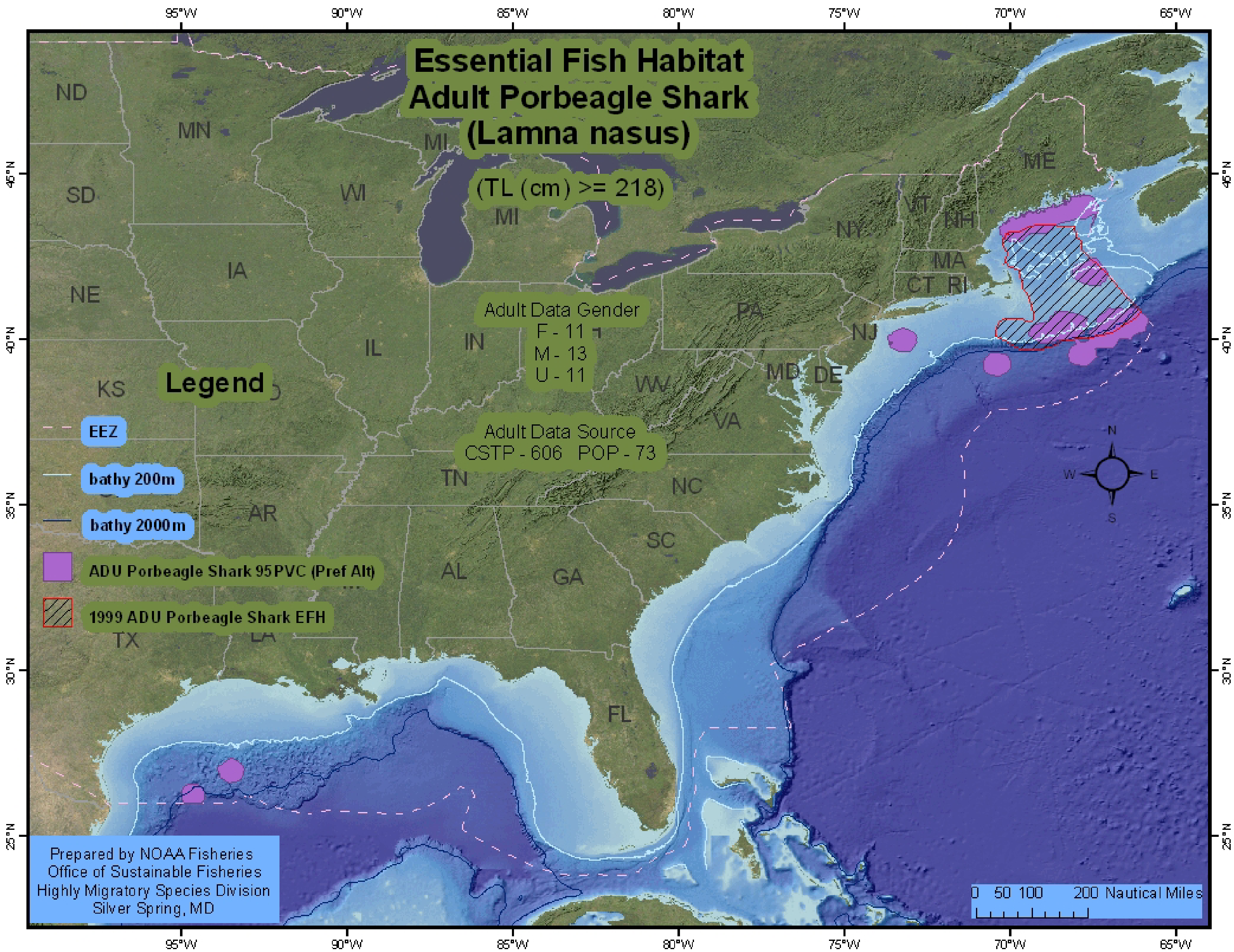

Figure 5.85 Porbeagle Shark: Adult.

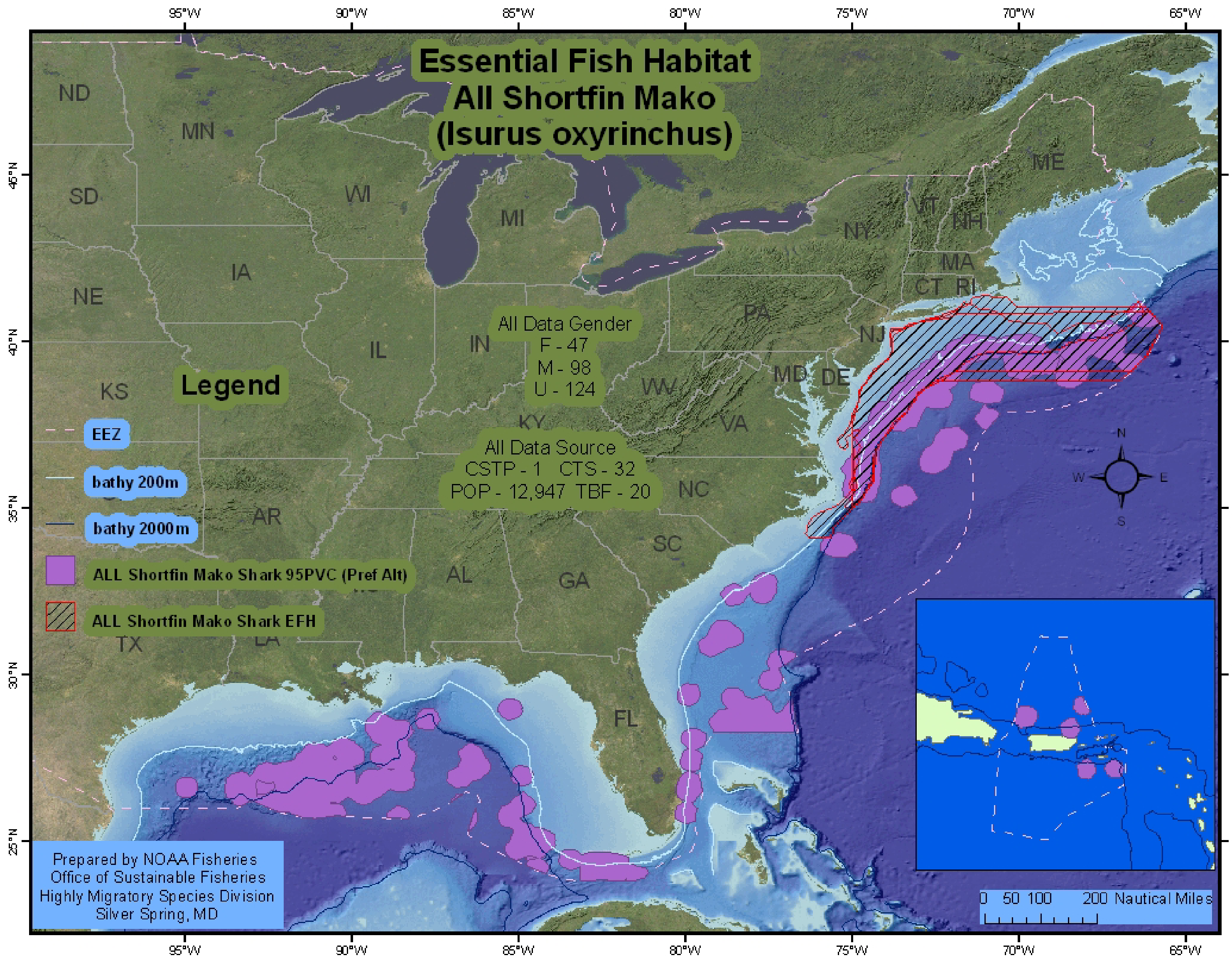

Figure 5.86 Shortfin Mako Shark: All Life Stages Combined.

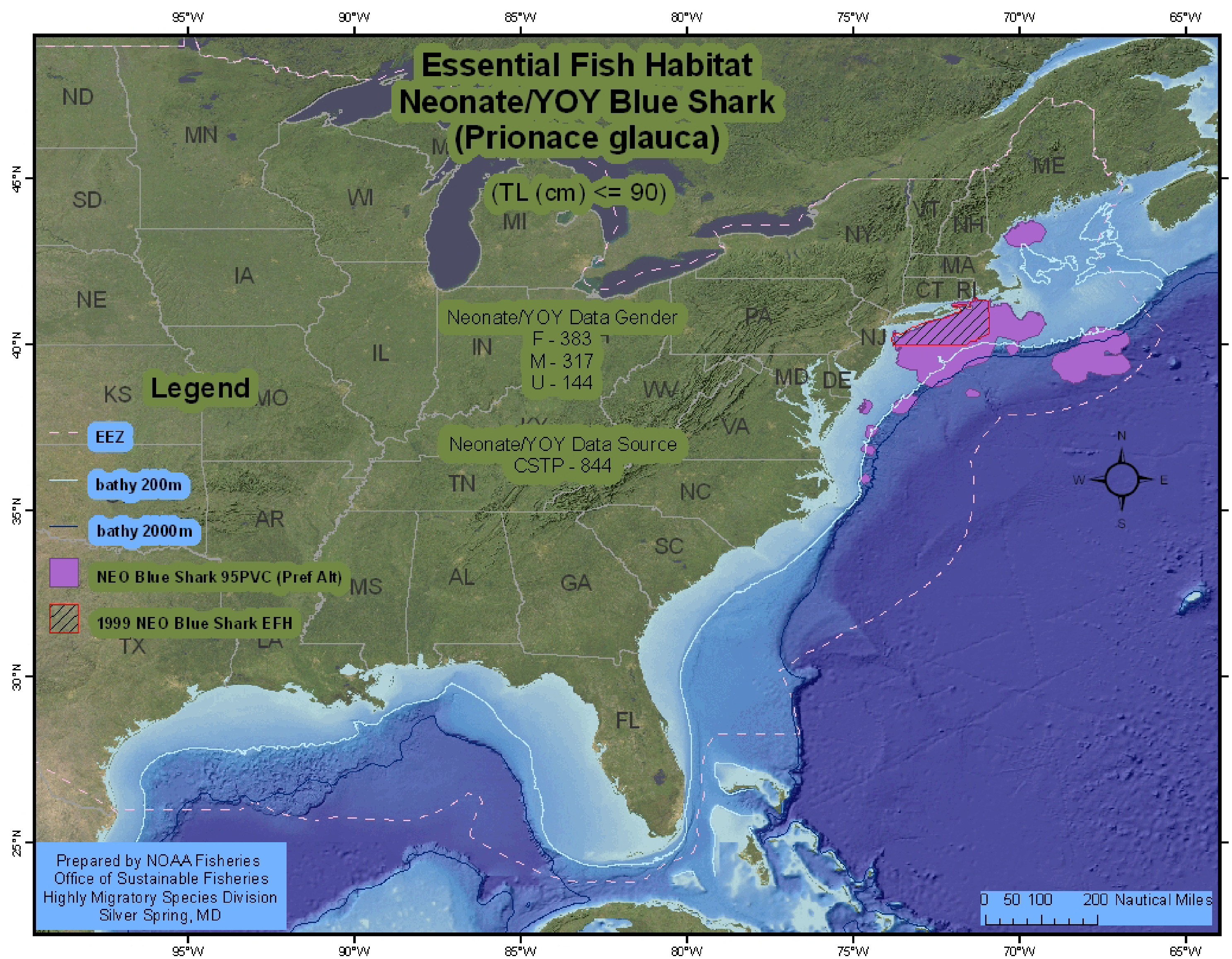

Figure 5.87 Blue Shark: Neonate.

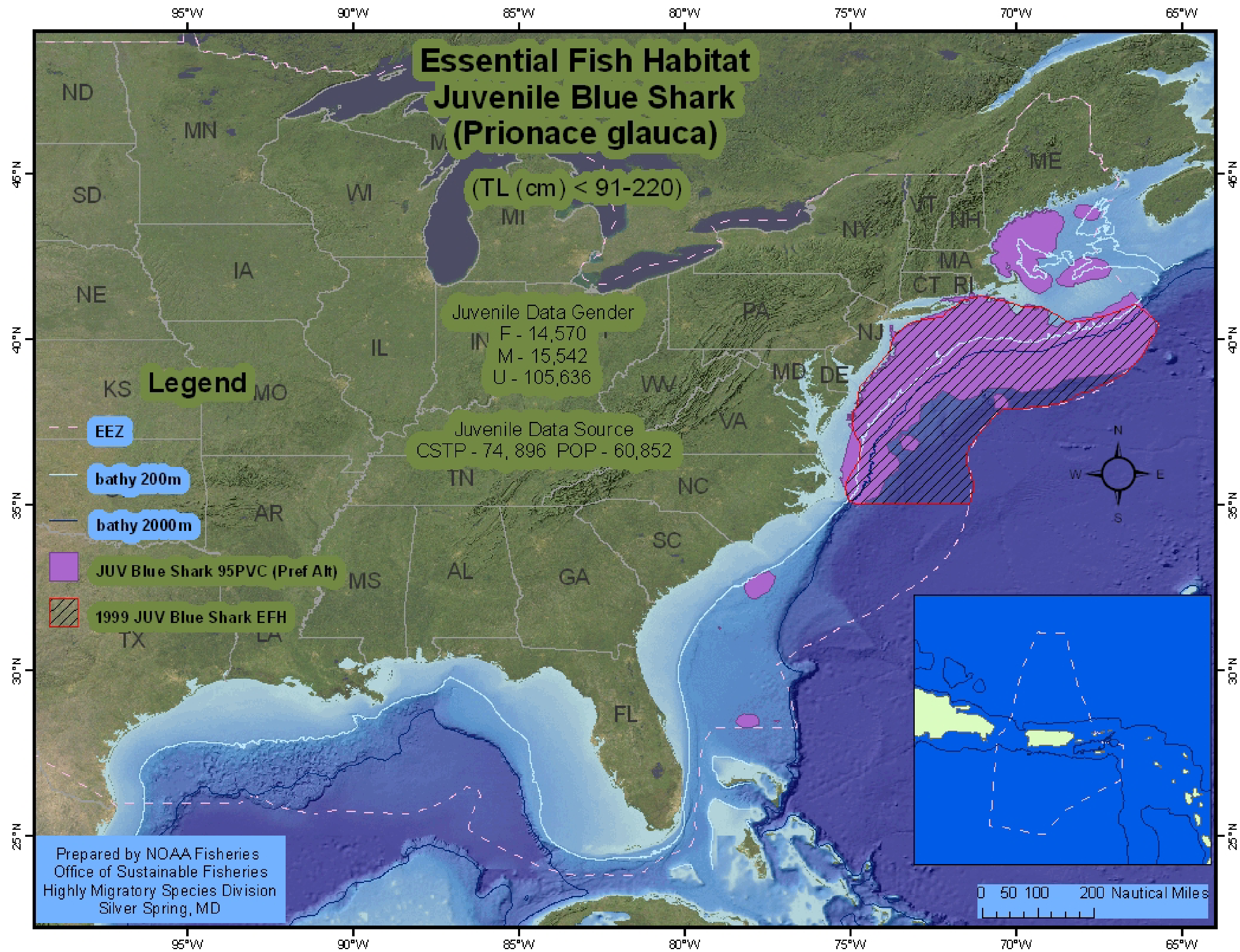

Figure 5.88 **Blue Shark: Juvenile.**

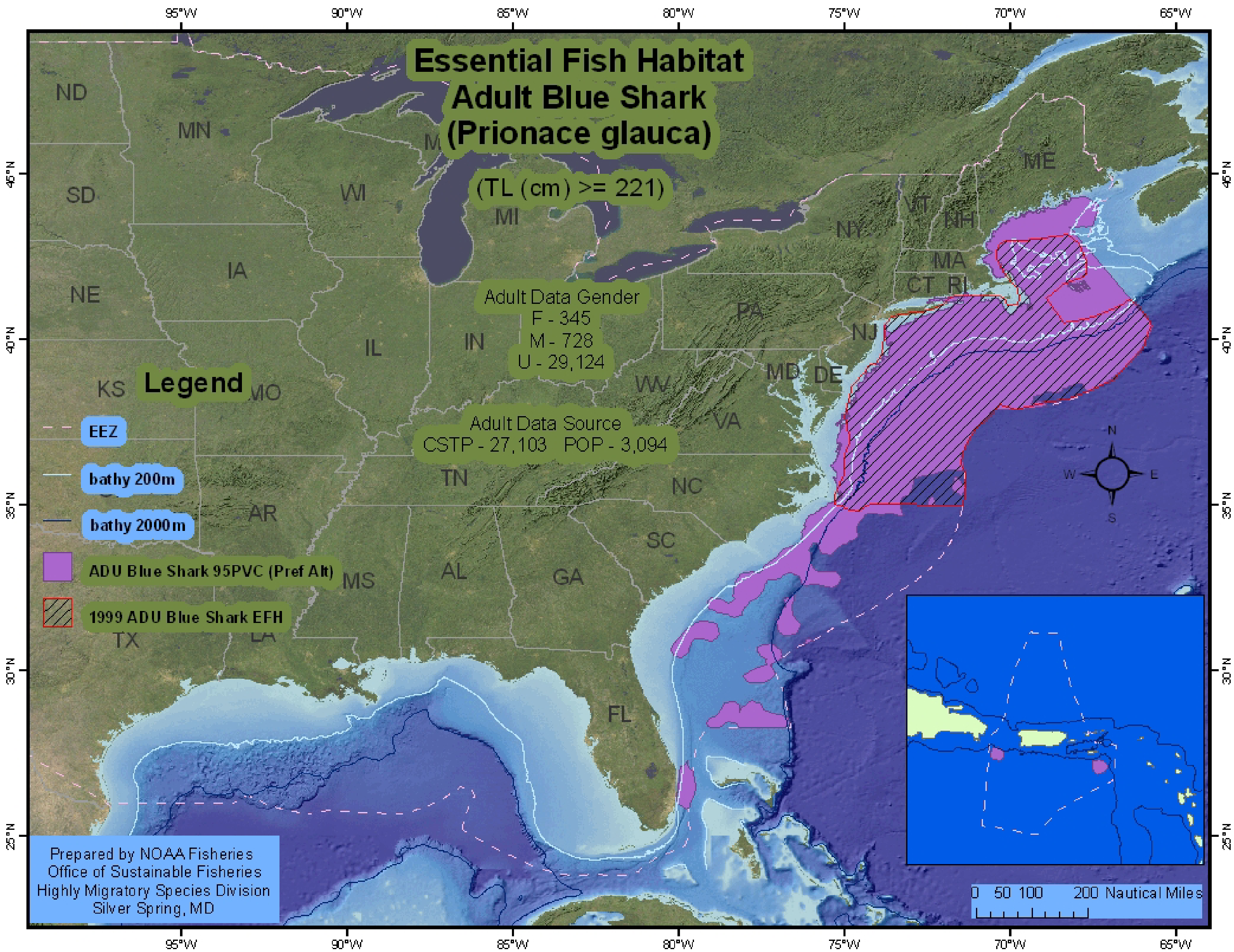

Figure 5.89 Blue Shark: Adult.

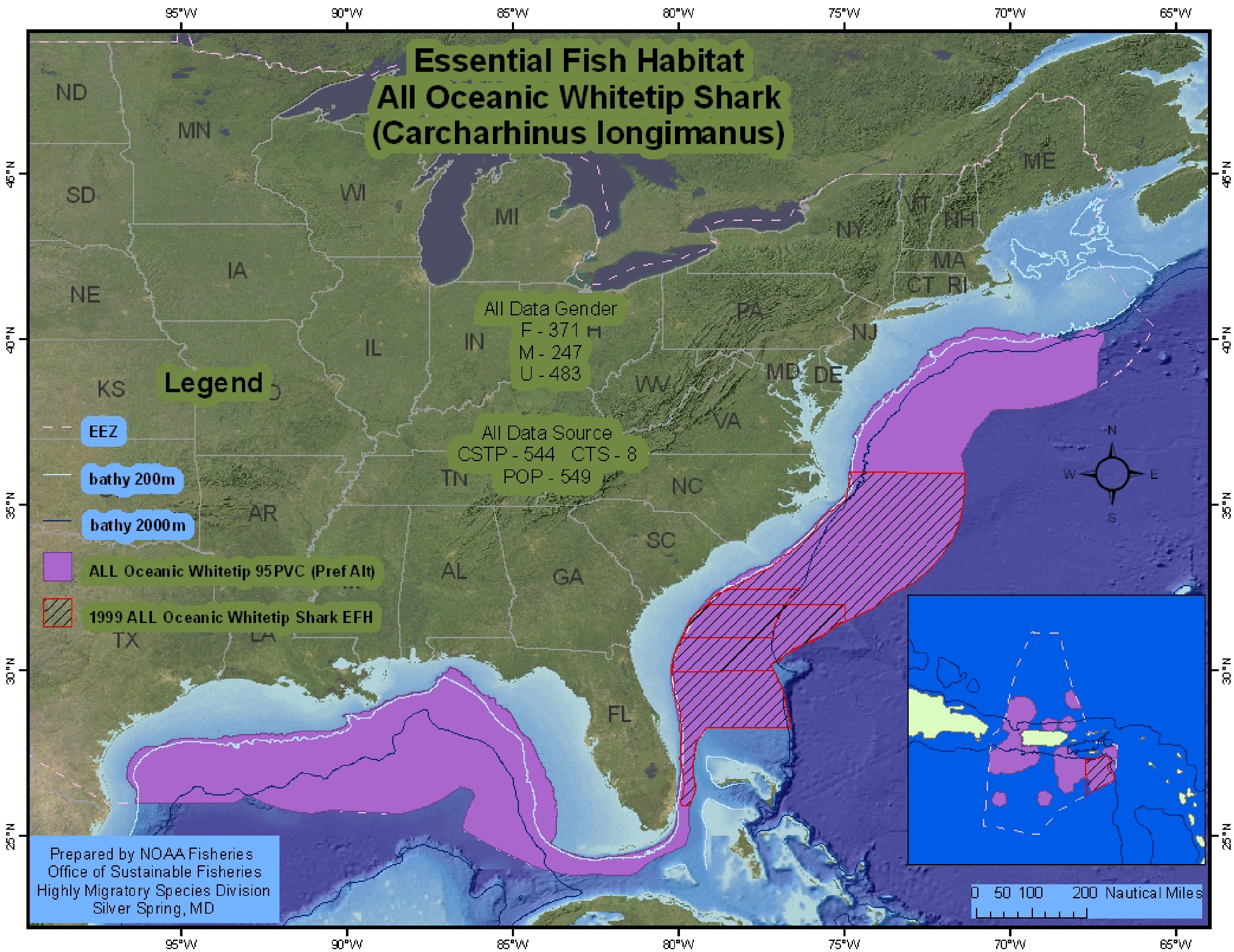

Figure 5.90 Oceanic Whitetip Shark: All Life Stages Combined.

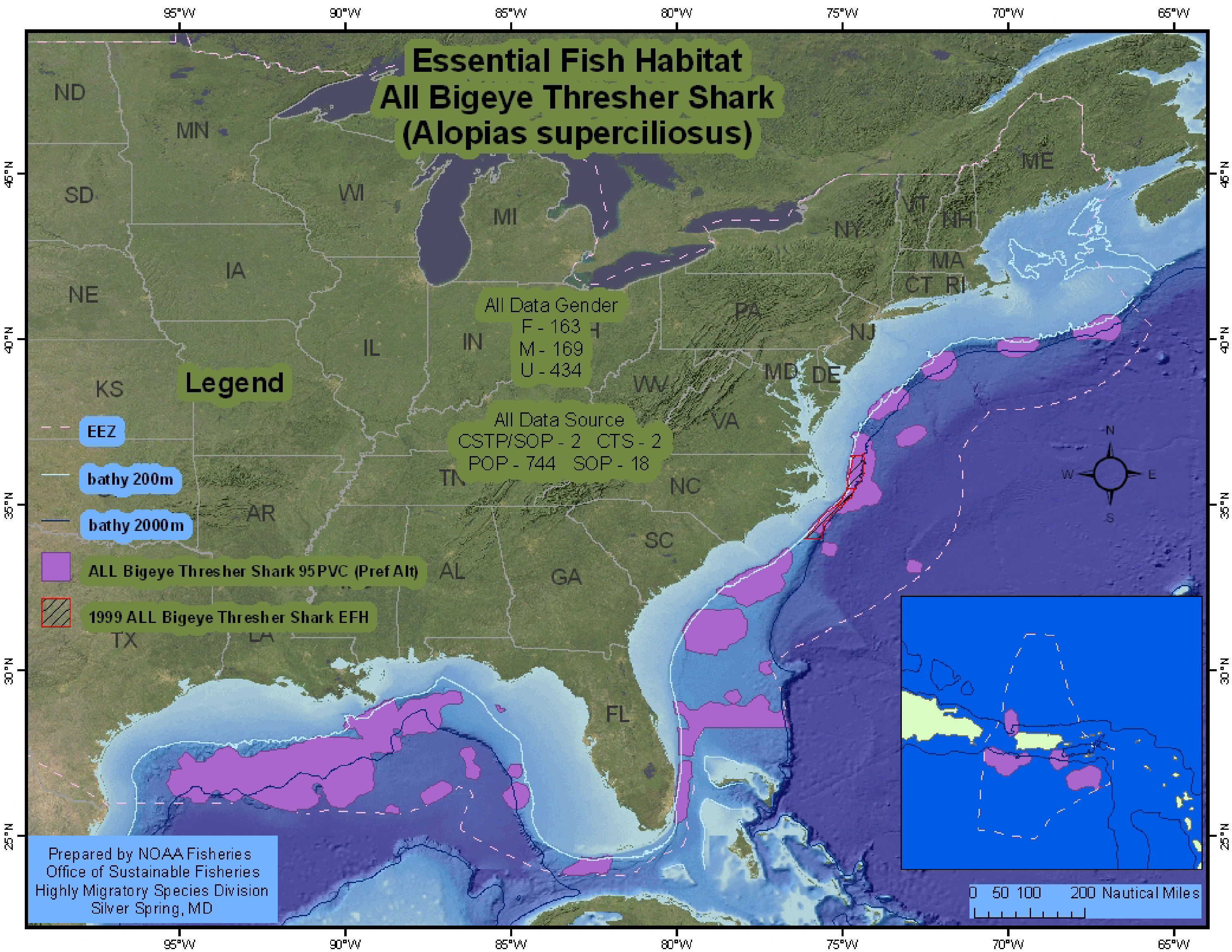

Figure 5.91 **Bigeye Thresher Shark: All Life Stages Combined.**

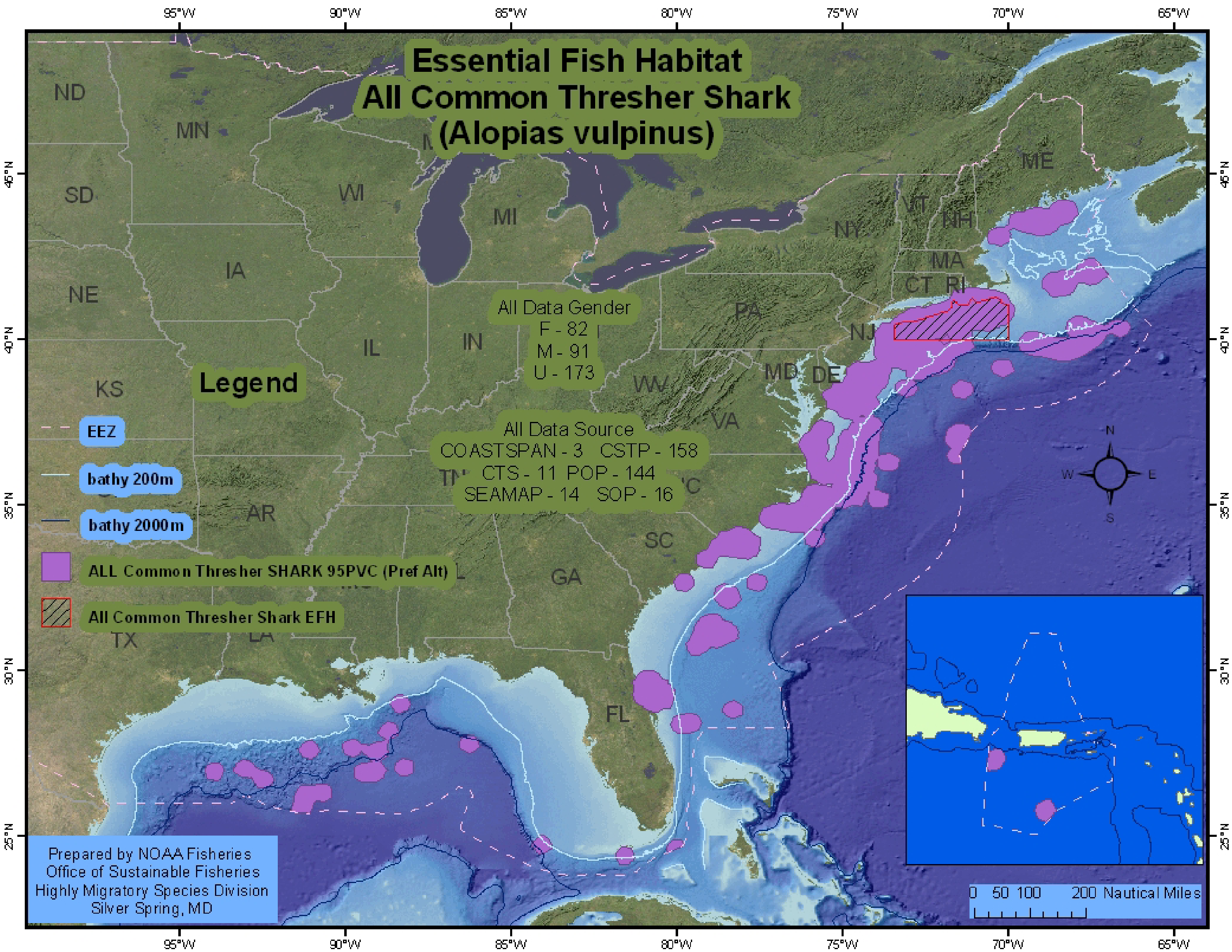

Figure 5.92 **Thresher Shark: All Life Stages Combined.**

CHAPTER 5 REFERENCES

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6.0 ANALYSIS OF FISHING AND NON-FISHING IMPACTS

6.1 Analysis of Fishing Impacts

The Magnuson-Stevens Act and the EFH regulations require NMFS to identify fishing activities that may adversely affect EFH and to minimize adverse effects on EFH from fishing activities to the extent practicable. Adverse effects from fishing may include physical, chemical, or biological alterations of the substrate, and loss of, or injury to, benthic organisms, prey species and their habitat, and other components of the ecosystem. Based on an assessment of the potential adverse effects of all fishing equipment types used within an area identified as EFH, NMFS must propose measures to minimize fishing impacts if there is evidence that a fishing practice is having more than a minimal and not temporary adverse effect on EFH.

In deciding whether fishing gears are having a negative effect, and if minimization of an adverse effect from fishing is practicable, NMFS must consider: (1) whether, and to what extent, the fishing activity is adversely impacting EFH and the fishery; (2) the nature and extent of the adverse effect on EFH; and, (3) whether the management measures are practicable, taking into consideration the long and short-term costs as well as the benefits to the fishery and its EFH, along with other appropriate factors consistent with National Standards of the Magnuson Stevens Act. The best scientific information available must be used as well as other appropriate information, as available.

NMFS completed the original analysis of fishing and non-fishing impacts in the 1999 FMP. Additional information gathered during a comprehensive five-year review was presented in the 2006 Consolidated HMS FMP, including a review of all fishing and non-fishing impacts. Each HMS gear, along with all other state and Federally managed fishing gears, the means by which they are fished, and their potential impacts on HMS and other species' EFH were described in the 2006 Consolidated HMS FMP, and are not repeated here.

The analysis in the 2006 Consolidated HMS FMP indicated that most HMS gears are fished in the water column and the impacts on EFH are generally considered negligible. HMS gears do not normally affect the physical characteristics that define HMS EFH such as salinity, temperature, dissolved oxygen, and depth. Similarly, most HMS gears are not expected to impact other fisheries' EFH, with the possible exception of shark BLL gear, depending on the area where it is fished. In the 2006 Consolidated HMS FMP, a preliminary determination was made that HMS gears, other than shark BLL, were not having a negative impact on EFH. Similarly, other state and Federally managed gears were also determined not to have an impact on HMS EFH, with the possible exception of some bottom-tending gears in shark nursery areas in coastal bays and estuaries. However, NMFS anticipates that any impacts resulting from these gears would be minimal and only temporary in nature.

In the following section, NMFS provides further analysis of the impacts of shark BLL gear on benthic habitats to determine whether or not adverse impacts to EFH are occurring by shark BLL gear. In addition, NMFS has evaluated the impact of bottom tending gears on shark nursery areas for species of sharks (blacktip, spinner (*Carcharhinus brevipinna*), blacknose (*Carcharhinus acronotus*), and finetooth) where certain substrates, such as mud bottom and seagrasses in the specific areas of Apalachicola and Apalachee Bays, have been identified as EFH. These analyses are given below.

Shark Bottom Longline Gear Impacts

The shark BLL fishery is active in the U.S. Atlantic Ocean and Gulf of Mexico from Virginia through Texas. Vessels in the fishery are typically fiberglass and average 50 feet in length (Hale *et al*., 2007). Longline characteristics vary regionally with gear normally consisting of about 8-24 km of longline and 500-1500 hooks (Hale *et al*., 2007). Gear is set at sunset and allowed to soak overnight before hauling back in the morning (Hale *et al*., 2007). As of 2007, there were approximately 143 active directed permit holders out of the 231 commercial shark directed permits holders (NMFS, 2008). These vessels historically made 4000 to 9000 sets a year (Hale *et al*., 2007). The shark BLL fishery targets large coastal sharks (LCS) but small coastal sharks (SCS), pelagic sharks, and dogfish species are also caught. The number of active permit holders is likely to decline as a result of Amendment 2 to the Consolidated HMS FMP which was implemented in July 2008 to reduce fishing effort. Specifically, landings of sandbar sharks were prohibited beginning in 2008, other than under the auspices of the shark research fishery, which will include approximately 11 vessels. Reduced quotas for non-sandbar LCS were also implemented. Many of the shark permit holders also hold Gulf of Mexico reef fish permits, dolphin-wahoo permits, king and Spanish mackerel permits, and snapper-grouper permits.

The impacts of shark BLL gear on the benthic habitat have not been specifically researched. In addition, habitat types where commercial shark fishermen set BLL gear have not been extensively studied, however, shark BLL sets are generally placed in sandy and/or muddy habitats where gear will not be entangled and lost. Bottom longline gear has less of an impact on mud and sandy sediments as opposed to complex coral reef bottom. The 1999 NMFS EFH Workshop categorized the impact of BLL gear on mud, sand, and hard-bottom as low (Barnette, 2001). Since there have not been extensive studies on the impacts of shark BLL gear on the benthic environment, NMFS is relying on information regarding impacts from BLL gear in other fisheries and other regions. However, given the differences in habitats among regions and how gear is fished in different fisheries, the associated impacts in these studies may not be applicable to impacts from shark BLL gear in the Southeast region of the United States. The following information has been excerpted from the GOMFMC's 2004 FEIS on EFH (GOMFMC, 2004) and Barnette (2001).

> "Anchors or weights, hooks, and the mainline are the principal components of BLL gear that can produce seabed effects (ICES, 2000). When a vessel is retrieving BLL gear it may be dragged across the bottom for some distance. The substrate penetration, if there were any, would not be expected to exceed the breadth of the fishhook, which is rarely more than 50/mm (Drew and Larsen, 1994). Based on these observations, it is assumed that longline gear would have a minor impact to sandy or muddy habitat areas. More important is the

potential effect of the BLL itself, especially when the gear is employed in the vicinity of complex vertical habitat such as sponges, gorgonians, and corals. Observations of halibut longline gear off Alaska included in a North Pacific Fishery Management Council Environmental Impact Statement (NPFMC, 1992) provide some insight into the potential interactions longline gear may have with the benthos. During the retrieval process of longline gear, the line was noted to sweep the bottom for considerable distances before lifting off the bottom. It snagged on whatever objects were in its path, including rocks and corals. Smaller rocks were upended and hard corals were broken, though soft corals appeared unaffected by the passing line. Invertebrates and other lightweight objects were dislodged and passed over or under the line. Fish were observed to move the groundline numerous feet along the bottom and up into the water column during escape runs, disturbing objects in their path. This line motion has been noted for distances of 15.2 m (50 ft) or more on either side of the hooked fish. Longline gear in the southeast is substantially lighter (often with monofilament groundlines) than the halibut longline gear in Alaska (generally 5/16th inch nylon or polyester rope as groundline), so southeast longlines should cause less damage than Alaskan longlines. However, the Alaskan marine ecosystem is much different from that in the southeast in that there are no tropical coral reefs, so specific damage assessment in Alaska may not apply to the Southeast Region. But the Alaskan marine ecosystem does have sponges and other vertical relief, which makes it somewhat analogous to the southeast conditions, and therefore, may give some insight to the type of damage BLL gear can cause. For instance, the shearing action of the longlines under tension would have similar results on sensitive vertical structure (Barnette, 2001). Due to the vertical relief that hard bottom and coral reef habitats provide, it would be expected that longline gear may become entangled, resulting in potential impacts to habitat. Based on this evaluation, Barnette (2001) suggested excluding the use of BLL gear in sensitive habitats, such as coral reefs."

It should also be noted that due to differences in ocean currents and environmental conditions in different regions, the Alaskan study may not be applicable to how BLL gear is fished and the impacts associated with the BLL gear in the Southeast region. However, since there have been no other published studies investigating the impact of BLL gear on benthic habitats, it is the only study to draw upon at this time.

Lost or abandoned longline gear can also cause potential problems with ghost fishing and grappling to retrieve gear. Fishermen generally maintain as much control as practicable over the gear to prevent losses. However, gear sometimes becomes lost because of weather or accidents, and may be abandoned by fishermen in closed areas trying to avoid detection by enforcement. Longline gear continues to catch fish and possibly catches sea turtles if bait or fish parts remain on the hooks, and self-baits if captured fish subsequently attract and catch other fish. The gear stops fishing when all hooks are bare. Cumulative effects of lost longline gear could be significant. Retrieval of lost or abandoned gear typically occurs by dragging a grappling hook across the bottom to snag the line. Grappling would cause minimal habitat damage to soft or unstructured bottom, but could cause severe local damage to fragile habitat such as coral. The magnitude of the potential problems from lost gear has not been evaluated in the southeast.

Gulf of Mexico

A detailed description of the benthic habitat in the Gulf of Mexico region can be found in Chapter 3 of the Final Environmental Impact Statement (FEIS) for the Gulf of Mexico Fishery Management Council's (GOMFMC) 2004 Generic Essential Fish Habitat Amendment (GOMFMC, 2004) (Figure 6.1). The description is not repeated in this Amendment. Shark BLL gear used for directed shark fishing in the Gulf of Mexico region is configured differently than what is found in other regions and other fisheries. Shark BLL vessels in the Gulf of Mexico had a mainline length that ranged from 12.9 to 31.4 km with an average of 18.1 km (Hale *et al*., 2007). The average bottom depth fished was 25.4 m and the number of hooks ranged from 228 to 1067 hooks with an average 602.5 hooks fished (Hale *et al*., 2007). The most commonly used hook was 18/0 circle hooks with 14/0 J hooks used in about 20 percent of the sets (Hale *et al*., 2007). The average soak duration was 10.9 hours (Hale *et al*., 2007).

To evaluate the impacts of BLL gear to sensitive habitats, such as coral reefs, NMFS analyzed the extent to which shark BLL gear is fished on coral reef habitats in the Gulf of Mexico. Most shark fishermen report their catch in the logbook for Gulf of Mexico Reef Fish, South Atlantic Snapper–Grouper, King and Spanish Mackerel, Shark, Atlantic Dolphin, and Wahoo (*i.e*., the Coastal Fisheries logbook). However, the Coastal Fisheries logbook does not include specific latitude and longitude information on the location of individual sets. Rather, fishermen report on a trip basis and indicate the statistical area where they were fishing on a given trip. Conversely, NMFS' scientific observers on shark fishing vessels record the latitude and longitude coordinates of each observed set. Therefore, NMFS used individual set data taken from the Commercial Shark Fishery Observer Program (CSFOP) from 1994 to through the 1st trimester of 2005 and set data taken from the shark BLL fishery observer program operating out of the NMFS Southeast Fisheries Science Center (SEFSC) in Panama City from the 2nd trimester of 2005 through 2006. From 2005 to the present, the shark BLL fishery observer program has randomly selected vessels possessing a current valid directed shark fishing permit for observer coverage with target coverage of 4-6 percent of the fishing fleet. However, from 1994 to 2003, observer coverage was 1.9 percent based on landings. NMFS used coral reef habitat maps provided by the Gulf of Mexico Fishery

Management Council to evaluate the number of observed sets that overlapped coral reef habitat within the Gulf of Mexico.

NMFS plotted individual observed set locations using the coordinates from the beginning and end points of the set connected with a straight line. NMFS then overlaid the set locations on coral reef habitat layers in the Gulf of Mexico, focusing primarily in the Florida Keys where the majority of coral reef structure is located (Figure 6.2). Only 17 observed sets intersected coral reef areas in the Gulf of Mexico and Florida Keys from 1994-2006 (Figure 6.3). Of the 17 sets, most intersected only a small portion of the reef, and many of those sets were actually made in areas between the reefs (Figure 6.4). Based on the observer coverage of 5 percent in the shark BLL fleet in 2007 (higher observer coverage rates are in effect for the shark gillnet fishery), it is estimated that approximately 340 sets (17 sets / 5 percent observer coverage) intersected coral reef habitat. Based on observer coverage of 1.9 percent from 1994 to 2003, this would equate to 894 sets (17 sets / 1.9 percent observer coverage). This gives a range of approximately 26 sets per year (340 sets / 13 years) to 68 sets per year (894 sets / 13 years) on coral reef habitat, depending on the level of observer coverage. Given the potentially low number of sets that intersected coral reef habitat, NMFS anticipates the impact of shark BLL gear on coral reefs would be minimal and temporary in nature. This is similar to the finding by the Gulf of Mexico Fishery Management Council which determined that the fishing impact index for shark BLL was low for shark BLL gear around the Florida Keys (Figure 6.5 taken from GOMFMC, 2004). In addition, with the implementation of Amendment 2 to the Consolidated HMS FMP on July 24, 2008 (73 FR 35778 and corrected on July 15, 2008, 73 FR 40658), NMFS anticipates that the level of directed shark fishing effort will decrease in light of quota reductions, reduced trip limits, and the prohibition of sandbar sharks outside of a shark research fishery.

NMFS also overlaid the number of shark BLL observed sets in relation to closed areas in the Gulf of Mexico region (Figure 6.6). These areas have been closed for various reasons, including closures for sensitive habitats. In the Gulf of Mexico, there are two closed areas to shark BLL gear: Madison-Swanson and Steamboat Lumps closed areas. The Madison-Swanson and Steamboat Lumps closed areas were implemented in 2006 and are closed to all HMS gears, except for trolling gear from May through October. These areas are closed to protect spawning gag grouper (*Mycteroperca microlepis*) as well as to protect the male gag grouper population year round.

Table 6.1 shows the number of observed BLL sets that intersected the different Gulf of Mexico closed areas. Tortugas South and Pulley Ridge have had the most observed sets with 7 and 9 observed sets intersecting these closed areas from 1994-2006, respectively. Based on an average 5 percent observer coverage, it is estimated that 140 shark BLL sets have intersected the Tortugas South closed area (7 observed sets / 5 percent observer coverage) and 180 shark BLL sets have intersected the Pulley Ridge closed area (9 observed sets / 5 percent observer coverage). Based on observer coverage of 1.9 percent, this would equate to 368 sets intersecting the in Tortugas South closed area (7 sets / 1.9 percent observer coverage), and 473 sets intersecting the Pulley Ridge closed area (9 sets / 1.9 percent observer coverage). This gives a range of approximately 11 sets (140 sets / 13 years) to 28 sets (368 sets / 13 years) per year in the Tortugas South closed area, and 14 sets (180 sets / 13 years) to 36 sets (473 sets / 13 years) per year in the Pulley Ridge closed area. Again, given the small number of sets each year in these areas, NMFS anticipates the impact of shark BLL gear in these areas would be minimal and only temporary in nature. In addition, with the implementation of Amendment 2 to the Consolidated HMS FMP, NMFS does not anticipate shark BLL fishing effort to increase in these areas; rather, it would most likely decrease due to quota reductions, reduction in trip limits, and the prohibition of sandbar sharks outside of a shark research fishery. As such, NMFS is not proposing any additional management measures for BLL gear in the Gulf of Mexico region to minimize adverse impacts on EFH at this time.

Table 6.1 The number of observed sets within the different Gulf of Mexico closed areas. Source: Shark BLL fishery observer program (1994-2006).

Area	Observed BLL Sets Intersecting Area
Alabama SMZ	0
East Flower Garden Bank	0
Florida Middle Grounds HAPC	2
Madison Swanson*	3
McGrail Bank HAPC	0
Pulley Ridge HAPC	9
Steamboat Lumps*	2
Stetson Bank	0
Tortugas North	0
Tortugas South	7
West Flower Garden Bank	0

*note: shark BLL sets in these areas occurred before closure in 2006.

U.S. Caribbean

While coral reefs are prevalent in the Caribbean region (see Figures 2.6-2.15 in the Caribbean Fishery Management Council's (CFMC) Generic Essential Fish Habitat Amendment (CFMC, 2004)), due to the absence of directed shark permit holders in the U.S. Virgin Islands and Puerto Rico, NMFS does not have logbook information on fishing effort or observer data from these areas. Typically, fishing effort data for fisheries in the U.S. Caribbean are not sufficiently accurate to map spatial distribution (CFMC, 2002). Some information is available on the number of fishing trips, but this is incomplete, has no spatial resolution, and there is great uncertainty about the validity of the data due to missing gear codes and use of multiple gears on a single trip (CFMC, 2004). Therefore, NMFS is unable to evaluate where shark BLL gear is used in the U.S. Caribbean region and assess its potential impact and no additional management measures for BLL gear in the U.S. Caribbean are being proposed at this time. NMFS is currently working on an Amendment to the 2006 Consolidated HMS FMP to help increase reporting and permitting compliance in this area that will allow for more accurate and spatially explicit descriptions of fishing effort in the future. In the meantime, NMFS has backstopped management measures implemented by the Caribbean Fishery Management Council, which closed six areas to protect EFH of mutton snapper, red hind, and other reef-dwelling species. NMFS has closed these six areas in the U.S. Virgin Islands and Puerto Rico to HMS BLL gear (Figure 6.7) (February 7, 2007, 72 FR 5633).

South Atlantic

A detailed description of the different marine habitats in the South Atlantic region can be found in Chapter 3 of 1998 Final Habitat Plan for the South Atlantic Region (SAFMC, 1998). The description is not repeated in this Amendment. Shark BLL gear used for directed shark fishing in the South Atlantic region is configured differently than what is found in other regions and other fisheries. Shark BLL vessels in the Atlantic had a mainline length that ranged from 5.6 to 50.0 km with an average of 21.1 km (Hale *et al*., 2007). The average bottom depth was 40.2 m and the number of hooks ranged from 96 to 1075 hooks with an average of 587 hooks fished (Hale *et al*., 2007). The most commonly used hook was 12/0 J hooks with 18/0 circle hook used about 20 percent of the time (Hale *et al*., 2007). The average soak duration was 11.0 hr (Hale *et al*., 2007).

In the South Atlantic, there are several closed areas to shark BLL gear. These include the Mid-Atlantic shark area closure for sandbar and dusky sharks that is closed to BLL gear from January 1 through July 31 of each year, and the eight marine protected areas (MPAs) that NMFS implemented at the request of the South Atlantic Fishery Management Council. These MPAs are closures throughout the year to most gear types with the exception of trolling gear for HMS and other coastal pelagic species, is allowed. The primary purpose of the closures is to protect the population and habitat of slow- growing, long-lived deepwater snapper grouper species (speckled hind (*Epinephelus drummondhayi*), snowy grouper (*Epinephelus niveatus*), Warsaw grouper (*Epinephelus nigritus*), yellowedge grouper (*Epinephelus flavolimbatus*), misty grouper (*Epinephelus mystacinus*), golden tilefish (*Lopholatilus chamaeleonticeps*), and blueline tilefish (*Caulolatilus microps*)).

As in the Gulf of Mexico, shark BLL gear in the South Atlantic is also typically placed in sandy or muddy habitats where expected impacts would be minimal or low (Barnette, 2001). However, BLL use in vertical or complex habitats could result in adverse effects to the benthic substrate. Unfortunately, there are no habitat maps for the South Atlantic region analogous to the coral reef maps available for the Gulf of Mexico region. As such, NMFS cannot assess the amount of shark BLL effort occurring on coral reef habitat in the South Atlantic. Anecdotal information from the shark fishery observer program, however, noted that of the 61 observed sets in 2007, only five sets had snagged pieces of coral and/or sponges on the line upon haulback. While this does not give an indication of the impact that the gear is having on the benthic environment (*i.e.*, the gear can be impacting the benthic habitat and not have coral or sponges on the line upon haulback), it indicates that at least some of the shark BLL sets are placed on coral or sponge habitat. Based on the average observer coverage of 5 percent in 2007. Thus, approximately 100 sets (5 sets / 5 percent observer coverage) out of the 1220 total sets (61 sets / 5 percent observer coverage) made in 2007 were placed on coral and sponge habitat in that particular year. NMFS will continue to work with the Regional Fishery Management Councils and Atlantic States Marine Fisheries Commission to assess the impacts of BLL gear on the benthic environment and will evaluate the need for potential closures to BLL gear in the South Atlantic as more explicit habitat information becomes available. In the meantime, as in the Gulf of Mexico, NMFS anticipates that the directed shark BLL effort will decrease in the future with the implementation of Amendment 2 to the Consolidated HMS FMP. Thus, potential impacts to the benthic environment by shark BLL gear experienced in 2007 and prior years may not be realized after the implementation of Amendment 2. Therefore, NMFS is not proposing any additional management measures for BLL gear in the South Atlantic region at this time.

<u>North Atlantic</u>

There is essentially no BLL fishing for sharks in the North Atlantic. Most BLL shark fishing efforts occurs from Virginia to Florida in the Atlantic Ocean. In the North Atlantic, most sharks are caught on PLL gear; PLL gear has been determined to not have an impact on EFH in the 2006 Consolidated HMS FMP (NMFS, 2006) because it floats in the water column and does not impact benthic habitat. In addition, the Northeast Region Essential Fish Habitat Steering Committee (NREFHSC) found that there was little scientific information that evaluates the effects of BLL gear on benthic marine habitats, and no information which evaluates these effects in the Northeast Region (NREFHSC, 2002). The panel concluded that BLL gears cause a low degree of impacts in mud, sand, and gravel habitats (NREFHSC, 2002). As such, given the lack of fishing effort using shark BLL in the North Atlantic, and the low degree of impact this gear would have in the habitats where shark BLL gear is usually set, NMFS anticipates any impact of shark BLL gear in these areas would be minimal and only temporary in nature. As such, NMFS is not proposing any additional management measures for BLL gear in the North Atlantic region at this time.

Non-HMS Gear Impacts

Nearly all HMS EFH is defined according to the geographic boundaries of a given area and water column characteristics, as opposed to specific benthic habitat types that might be affected by fishing gears, particularly bottom-tending gears such as shrimp trawls or fish traps. However, for some species of sharks (blacktip, spinner, blacknose, and finetooth), certain substrates, such as mud bottom and seagrasses in specific areas of Apalachicola and Apalachee Bays, have been identified as EFH (see Chapter 5). For these specific coastal and estuarine habitats, there may be an impact on benthic habitats from bottom-tending gears in state waters.

Trawl fisheries that scrape the substrate, disturb boulders and their associated epiphytes or epifauna, re-suspend sediments, flatten burrows and disrupt seagrass beds have the potential to alter the habitat characteristics that are important for survival of early life stages of many targeted and non-targeted species. According to the GOMFMC (2004), bottom tending gears in the Apalachicola and Apalachee Bay areas consist of shrimp trawls (Figure 6.8), stone crab pots (Figure 6.9), and fish traps (Figure 6.10). These three gears are the most likely gears to have an adverse effect on HMS EFH in the Apalachicola and Apalachee Bay areas. The GOMFMC calculated a fishing sensitivity index for all gears managed by the FMC using fishing effort and habitat sensitivity. For a full description of the methods, please see Section 2.1.5.2.2 (GOMFMC, 2004).

The overall fishing sensitivity for Apalachicola Bay was listed as low in the GOMFMC's (2004) analysis but moderate for Apalachee Bay area due to the presence of seagrasses (Figure 6.11). However, the overall fishing impact of shrimp trawls in these areas was indicated as low and almost non-existent for stone crab pots and fish traps (GOMFMC, 2004). Therefore, any adverse effects of these gears on these shark species' EFH are expected to be minimal and temporary in nature. As such, NMFS is not proposing management measures to minimize adverse impacts to EFH from fishing gears in the Apalachicola and Apalachee Bay areas; however, NMFS would continue to work with the Regional Fishery Management Councils and Interstate Marine Fisheries Commissions to evaluate measures to minimize adverse impacts in these areas if the impacts of bottom-tending gear should become more than minimal and not temporary in nature. As data becomes available to NMFS, NMFS will make the determination of whether or not these or additional gears have adverse effects on HMS EFH and if those effects are more than minimal and not temporary in nature.

No other benthic habitat types have been identified as EFH for neonate, young-of-the-year, or juvenile sharks (*i.e.*, neonate and juvenile shark EFH has been designated based on depth, and/or isobath; Chapter 5). Should additional benthic habitat types be identified as EFH in the future, then NMFS would need to conduct additional analyses to determine whether any fishing impacts are occurring in that particular habitat. Until such habitat types are identified and the degree of overlap and the extent to which habitat is altered by various bottom tending gears is known, NMFS cannot assess the impact of such gears on neonate and juvenile shark EFH.

Conservation measures

The following NMFS conservation recommendations are meant as precautionary measures, and should be used whenever possible in the event that impacts to coral reef or other hard bottom EFH habitat may be occurring but unverified.

- Vessels fishing with bottom longline gear should avoid or reduce BLL effort on corals, gorgonians, or sponge habitat in order minimize risk of habitat damage to these areas.
- Vessels fishing with BLL gear should take appropriate measures to identify bottom obstructions and avoid setting gear in areas where it may become entangle.
- If gear is lost, diligent efforts should be undertaken to recover the lost gear.

6.2 Analysis of Non-Fishing Impacts

The EFH regulations (50 CFR 600.815(a)(3)) require FMPs to identify non-fishing related activities that may adversely affect EFH. According to the regulations, FMPs must identify activities other than fishing that may adversely affect EFH. Broad categories of such activities include, but are not limited to: dredging, filling, excavation, mining, impoundment, discharge, water diversions, thermal additions, actions that contribute to non-point source pollution and sedimentation, introduction of potentially hazardous materials, introduction of exotic species, and the conversion of aquatic habitat that may eliminate, diminish, or disrupt the functions of EFH. For each activity, the FMP should describe known and potential adverse effects to EFH.

NMFS conducted a thorough review of non-fishing impacts in the 2006 Consolidated HMS FMP which is not repeated here. The intent of the current non-fishing impacts analysis is to consider those impacts that are most likely to have an adverse effect on HMS EFH and for which new information may be available. While difficult to quantify, there are a number of non-fishing activities with the potential to adversely affect EFH, and those activities are considered in more detail in the following section. For any development project that has the potential to adversely affect EFH, the regulations at 50 C.F.R. § 600.920 set forth the consultation process, which allows NMFS to make a determination of a project’s effects on EFH and provide conservation recommendations on actions that would adversely affect such habitat pursuant to section 305(b)(4)(A) of the Magnuson-Stevens Act. When the Federal action agency determines that an action may adversely affect EFH, the Federal action agency must initiate consultation with NOAA (16 U.S.C. §1855(b)(2)). In order to carry out this EFH consultation, the EFH regulations at 50 C.F.R. § 600.920(e)(3) call for the Federal action agency to submit to NMFS an EFH assessment containing "a description of the action; an analysis of the potential adverse effects of the action on EFH and the managed species; the federal agency's conclusions regarding the effects of the action on EFH; and proposed mitigation, if applicable." NMFS may request the Federal action agency include additional information in the EFH assessment such as results of on-site inspections, views of recognized experts, a review of pertinent literature, an analysis of alternatives and any other relevant information per 50 C.F.R. § 600.920(e)(4). Depending on the degree and type of habitat impact, compensatory mitigation may be necessary to offset permanent and temporary effects of the project. Should the project result in substantial adverse impacts to EFH, an expanded EFH consultation may be necessary (50 C.F.R. §600.920(i)). Adverse effects to EFH are defined in 50 C.F.R. 600.810 (a) as "any impact that reduces the quality and/or quantity of EFH." Adverse effects may include "site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions."

Section 305(b)(4)(B) of the MSA calls for the Federal action agency to provide NMFS with a detailed written response to any EFH conservation recommendations, including a description of measures adopted by the Federal action agency for avoiding, mitigating, or offsetting the impact of the project on EFH. In the case of a response that is inconsistent with NMFS recommendations, Section 305(b)(4)(B) of the MSA also indicates that the Federal action agency must explain its reasons for not following the recommendations. Included in such reasoning would be the scientific justification for any disagreements with NMFS over the anticipated effects of the proposed action and the measures needed to avoid, minimize, mitigate, or offset such effects pursuant to 50 CFR 600.920(k).

Following is a discussion of non-fishing impacts based largely on the 1999 HMS FMP and the 2006 Consolidated HMS FMP, and augmented with selected conservation measures found in the NMFS document "Impacts to Marine Fisheries Habitat from Non-Fishing Activities in the Northeast U.S." (NMFS, 2007).

Land-based Activities That May Impact HMS EFH

Coastal Development

Coastal development activities include urban, suburban, commercial, and industrial construction, along with development of corresponding infrastructure. These activities may result in erosion and sedimentation, dredging and filling (see following sub-section), point and non-point source discharges of nutrients, chemicals, and cooling water into streams, rivers, estuaries and ocean waters.

Industrial point source discharges include discharges from commercial and industrial development, including sewage discharges. These result in the contamination of water and degradation of water quality by introducing organics and heavy metals or altering other characteristics such as pH and dissolved oxygen. Dissolved oxygen, pH, nutrients, temperature changes and suspended materials, particularly when acting synergistically, are considered to have the greatest effect on coastal habitats. Improperly treated sewage treatment effluent has been shown to produce changes in water quality as a result of chlorination and increased contaminant loading, including solids, phosphorus, nitrogen and other organics, and human pathogens and parasites. This can result in alterations in the diversity and productivity of ecosystems and their respective communities. Thermal effluents from power plant cooling water discharges also can have a pronounced effect on coastal habitats, causing changes in the community structure

Non-point source pollution - that which results from land runoff, atmospheric deposition, drainage, groundwater seepage, or hydrologic modification - results in the deposition of pathogens, nutrients, sediments, heavy metals, pesticides, oxygen demanding substances road salts, hydrocarbons and other toxics. These materials can have a greater impact on coastal habitats than point source pollutants. Oxygen demanding substances can result in instances of hypoxia, or dead zones, which commonly occur in the Gulf of Mexico continental shelf bottom waters due to nutrient loading from the Mississippi River outflow.

Hydrological modifications associated with coastal development alter freshwater inflow to coastal waters, resulting in changes in salinity, temperature, and nutrient regimes, thereby contributing to further degradation of estuarine and nearshore marine habitats. The variety of pollutants and the severity of their effects from coastal development activities depend upon a number of factors, such as the nature of the construction, physical characteristics of the site involved, and proximity of the pollutant source to the coastline. However, all of these factors ultimately serve to degrade estuarine and coastal water quality to some degree in terms of dissolved oxygen levels, salinity concentrations, and contaminants. The result can be losses of important flora and fauna.

Conservation measures

- Adverse impacts resulting from construction should be avoided whenever practicable alternatives are identified. For those impacts that cannot be avoided, minimization through implementation of Best Management Practices (BMPs) should be employed. For those impacts that can neither be avoided nor minimized, compensation through replacement of equivalent functions and values should be required.

- Flood control projects in waterways draining into EFH should be designed to include mitigation measures and constructed using BMPs. For example, stream relocation and channelization should be avoided whenever practicable. However, should no practicable alternatives exist, relocated channels should be of comparable length and sinuosity as the natural channels they replace to maintain the quality of water entering receiving waters (*i.e.*, HMS EFH).

- Watershed protection/site development should be encouraged. Comprehensive planning for development on a watershed scale (and for small-scale site development as well) should be undertaken, including planning and designing to protect sensitive ecological areas, minimizing land disturbances and retaining natural drainage and vegetation whenever possible. To be truly effective, watershed planning efforts should include existing facilities even though they are not subject to EFH consultation.

- Pollution prevention activities, including techniques and activities to prevent non-point source pollutants from entering surface waters, should be implemented. Primary emphasis should be placed on public education to promote methods for proper disposal and/or recycling of hazardous chemicals, management practices for lawns and gardens, onsite disposal systems (OSDSs), and commercial enterprises such as service stations and parking lots.

- Construction erosion/sediment control measures should be used to reduce erosion and transport of sediment from construction sites to surface waters. A sediment and erosion control plan should be developed and approved prior to land disturbance.

- Runoff from new development should be managed so as to meet two conditions: 1) the average annual total suspended solids loadings after construction is completed are no greater than pre-development loadings; and, 2) to the extent practicable, post-development peak runoff rate and average volume are maintained at levels that are similar to pre-development levels.

- Construction site chemical control measures should address the transport of toxic chemicals to surface water by limiting the application, generation, and migration of chemical contaminants (*i.e.*, petrochemicals, pesticides) and providing proper storage and disposal.

- New OSDSs should be built to reduce nutrient/pathogen loadings to surface waters. OSDSs should be designed, installed and operated properly and to be situated away from open waterbodies and sensitive resources such as wetlands, and floodplains. Protective separation between the OSDS and the groundwater table should be established. The OSDS unit should be designed to reduce nitrogen loadings in areas where surface waters may be adversely affected. Operating OSDSs should prevent surface water discharges and reduce pollutant loadings to ground water. Inspection at regular intervals and repair or replacement of faulty systems should occur.

- Roads, highways, bridges and airports should be situated away from areas that are sensitive ecosystems and susceptible to erosion and sediment loss. The siting of such structures should not adversely impact water quality, should minimize land disturbances, and should retain natural vegetation and drainage features.

- Construction projects of roads, highways, bridges and airports should implement approved erosion and sediment control plans prior to construction to reduce erosion and improve retention of sediments onsite during and after construction.

- Construction site chemical control measures for roads, highways, and bridges should limit toxic and nutrient loadings at construction sites by ensuring the proper use, storage, and disposal of toxic materials to prevent significant chemical and nutrient runoff to surface waters.

- Operation and maintenance activities for roads, highways, bridges, and airports should be developed so as to reduce pollutant loadings to receiving waters during operation and maintenance.

- Runoff systems should be developed for roads, highways, bridges, and airports to reduce pollutant concentrations in runoff from existing roads, highways, and bridges. Runoff management systems should identify priority pollutant reduction opportunities and schedule implementation of retrofit projects to protect impacted areas and threatened surface waters.

- The planning process for new and maintenance channel dredging projects should include an evaluation of the potential effects on the physical and chemical characteristics of surface waters that may occur as a result of the proposed work, and should reduce undesirable impacts. When the operation and maintenance programs for existing modified channels are reviewed, they should identify and implement any available opportunities to improve the physical and chemical characteristics of surface waters in those channels.

- Bridges should be designed to include collection systems which convey surface water runoff to land-based sedimentation basins.

- Sewage treatment discharges should be treated to meet state water quality standards. Implementation of up-to-date methodologies for reducing discharges of biocides (*e.g.*, chlorine) and other toxic substances is encouraged.

- Use of land treatment and upland disposal/storage techniques of solid waste from sewage treatment should be implemented where possible. Use of vegetated wetlands as natural filters and pollutant assimilators for large scale wastewater discharges should be limited to those instances where wetlands have been specifically created for this purpose. The use of such constructed wetlands for water treatment should be encouraged wherever the overall environmental and ecological suitability of such an action can been demonstrated.

- Sewage discharge points in coastal waters should be located well away from critical habitats. Proposals to locate outfalls in coastal waters must be accompanied by hydrographic studies that demonstrate year round dispersal characteristics and provide proof that effluents will not reach or affect fragile and productive habitats.

- Dechlorination facilities or lagoon effluent holding facilities should be used to destroy chlorine at sewage treatment plants.

- No toxic substances in concentrations harmful (synergistically or otherwise) to humans, fish, wildlife, and aquatic life should be discharged. The EPA's Water Quality Criteria Series should be used as a guideline for determining harmful concentration levels. Use of the best available technology to control industrial waste water discharges should be required in areas adjacent to habitats essential to HMS. Any new potential discharge that will influence HMS EFH must be shown not to have a harmful effect on HMS or their habitat.

- The siting of industries requiring water diversions and large-volume water withdrawals should be avoided in areas influencing HMS EFH. Project proponents should demonstrate that project implementation will not negatively affect HMS, their EFH, or their food supply. Where such facilities currently exist, best management practices should be employed to minimize adverse effects on the aquatic environment.

- All NPDES permits should be reviewed and strictly enforced in areas affecting HMS EFH.

- Hazardous waste sites should be cleaned up (*i.e.*, remediated) to prevent contaminants from entering aquatic food chains. Remedial actions affecting aquatic and wetland habitats should be designed to facilitate restoration of ecological functions and values.

Agriculture (and Silviculture)

Cropland, livestock rangeland, and commercial nursery grounds can be connected to coastal waters and inland tributaries. Agricultural and silvicultural practices can affect estuarine, coastal and marine water quality through nutrient enrichment and chemical contamination from animal wastes, fertilizers, pesticides and other chemicals via non-point source runoff or via drainage systems that serve as conduits for contaminant discharge into natural waterways. Pesticides can adversely affect EFH through direct toxicological impact on the health or performance of exposed fish, an indirect impairment of the productivity of aquatic ecosystems, and a loss of aquatic vegetation that provides physical shelter for fish. In addition, uncontrolled or improper irrigation practices can contribute to non-point source pollution, and may exacerbate contaminant flushing into coastal waters. Major impacts also include nutrient over-enrichment with subsequent deoxygenation of surface waters, and algal blooms, which can also produce hypoxic or anoxic conditions and stimulation of toxic dinoflagellate growth. Excessively enriched waters often will not support fish, and may also not support food web assemblages and other ecological assemblages needed to sustain desirable species and populations. Agricultural activities also increase soil erosion and associated sediment transport in adjacent water bodies, resulting in high turbidity. Many of these same concerns may apply to silviculture as well.

Conservation measures

- Federal agencies, in conjunction with state agencies, should establish and approve criteria for vegetated buffer strips in agricultural areas adjacent to estuarine and coastal HMS EFH in order to minimize pesticide, fertilizer, and sediment loads to these areas critical for HMS survival. The effective width of these vegetated buffer strips should vary with the slope of the terrain and soil permeability.

- Concerned Federal agencies (*e.g.*, Natural Resources Conservation Service) should conduct or contribute to programs and demonstration projects to educate farmers on improved agricultural practices that would minimize the use and wastage of pesticides, fertilizers, and top soil, and reduce the adverse effects of these materials on HMS EFH.

- Delivery of sediment from agricultural lands to receiving waters should be minimized. Land owners have a choice of one of two approaches: 1) apply the erosion component of the U.S. Department of Agriculture's Conservation Management System through such practices as conservation tillage, strip cropping, contour farming, and terracing; or 2) design and install a combination of practices to remove settleable solids and associated pollutants in runoff for all but the largest storms.

- New and existing confined animal facilities should be designed to limit discharges to waters of the United States by storing wastewater and runoff caused by all storms up to and including the 25-year frequency storms. For smaller existing facilities, the management systems that collect solids, reduce contaminant concentrations, and reduce runoff should be designed and implemented to minimize the discharge of contaminants in both facility wastewater and runoff caused by all storms up to and including 25-year frequency storms.

- Stored runoff and solids should be managed through proper waste utilization and the use of disposal methods which minimize impacts to surface and ground water.

- Development and implementation of comprehensive nutrient management plans should be undertaken, including development of a nutrient budget for the crop, identification of the types and amounts of nutrients necessary to produce a crop based on realistic crop yield expectations, and an identification of the environmental hazards of the site.

- Pesticide and herbicide management should minimize water quality problems by reducing pesticide use, improving the timing and efficiency of application (not within 24 hours of expected rain or irrigation), preventing backflow of pesticides into water supplies, and improving calibration of pesticide spray equipment. Improved methods should be used such as integrated pest management (IPM) strategies. IPM strategies include evaluating current pest problems in relation to the cropping history, previous pest control measures, and applying pesticides only when an economic benefit to the producer will be achieved (*i.e.*, application based on economic thresholds). If pesticide applications are necessary, pesticides should be selected to minimize environmental impacts such as persistence, toxicity, and leaching potential.

- Livestock grazing should protect sensitive areas, including streambanks, wetlands, estuaries, ponds, lake shores, and riparian zones. Protection is to be achieved with improved grazing management that reduces the physical damage and direct loading of animal waste and sediment to sensitive areas, *i.e.*, by restricting livestock access or providing stream crossings.

- Upland erosion should be reduced by either applying the range and pasture components of a Conservation Management System, or maintaining the land in accordance with the activity plans established by either the Bureau of Land Management or the Forest Service. Such techniques include the restriction of livestock from sensitive areas through locating salt, shade, and alternative drinking sources away from sensitive areas, and providing livestock stream crossings.

- Irrigation systems that deliver necessary quantities of water yet reduce non-point pollution to surface waters and groundwater should be developed and implemented.

- BMPs should be implemented to minimize habitat impacts when agricultural ditches are excavated through wetlands that drain to HMS EFH.

- NPDES/SPDES permits, in consultation with state fishery agencies, should be required for agricultural ditch systems that discharge into areas adjacent to HMS EFH.

Coastal and Offshore Activities That May Impact HMS EFH

Dredging and Disposal of Dredge Material

Coastal development can involve dredging operations for shoreline, commercial and residential development. Dredging operations also occur in order to maintain certain areas for activities such as shipping, boating, construction of infrastructure (*e.g.*, offshore oil and gas pipelines), and marine mining. Coastal development involving dredging and filling can also result in the destruction of coastal wetlands. This results not only in the loss and alteration of wetland vegetation, and altered hydrologic and temperature regimes, but also in the elimination of protective buffer zones that serve to filter sediments, nutrients, and contaminants - such as heavy metals and pesticides - that are transported to the coastal zone in ground and surface waters. All of these factors result in significant effects on coastal ecosystems, particularly the loss of important habitat for early life stages of many fishery species, including sharks.

Disposal of the dredged material takes place in designated open water disposal areas, often near the dredge site. These operations often result in negative impacts on the marine environment. Of particular concern regarding HMS EFH is the temporary degradation of water quality due to the resuspension of bottom materials, resulting in water column turbidity, potential contamination due to the release of toxic substances (metals and organics), and reduced oxygen levels due to the release of oxygen-consuming substances (*e.g.*, nutrients, sulfides). Even with the use of approved practices and disposal sites, ocean disposal of dredged materials is expected to cause environmental harm since contaminants will continue to be released, and localized turbidity plumes and reduced oxygen zones may persist.

Conservation measures

- Coastal development traditionally has involved dredging and filling of shallows and wetlands, hardening of shorelines, clearing of riparian vegetation, and other activities that adversely affect the habitats of living marine resources. Mitigation measures should be required for all development activities with the potential to influence HMS EFH.

- Destruction of wetlands and shallow coastal water habitats should not be permitted in areas adjacent to HMS EFH. Mitigating or compensating measures should be employed where destruction is unavoidable. Project proponents should demonstrate that project implementation will not negatively affect HMS, their habitat, or their food sources.

- Seasonal restrictions should be imposed and enforced so as to avoid operations during critical life history stages (*e.g.*, shark pupping), depending the habitats affected, environmental conditions, and species requirements.

- Best engineering and management practices (*e.g.*, seasonal restrictions, modified dredging methods, and/or disposal options) should be employed for all dredging and in-water construction projects. Such projects should be permitted only for water dependent purposes when no feasible alternatives are available. Mitigating or compensating measures should be employed where significant adverse impacts are unavoidable. Project proponents should demonstrate that project implementation will not negatively affect HMS, their EFH, or their food sources.

- Project guidelines should make allowances to cease operations or take additional precautions to avoid adversely affecting HMS EFH during seasons when sensitive

HMS life stages might be most susceptible to disruption (*e.g*., seasons when spawning is occurring).

- When projects are considered and in review for open water disposal permits for dredged material, Federal permitting agencies should identify the direct and indirect impacts such projects may have on HMS EFH.

- Uncontaminated dredged material may be viewed as a potentially reusable resource if properly placed and beneficial uses of these materials should be investigated. Materials that are suitable for beach nourishment, marsh construction or other beneficial purposes should be utilized for these purposes as long as the design of the project minimizes impacts on HMS EFH.

- "Beneficial Use" proposals in areas of HMS EFH should be compatible with existing uses by HMS. If no beneficial uses are identified, dredged material should be placed in contained upland sites. The capacity of these disposal areas should be used to the fullest extent possible. This may necessitate dewatering of the material or increasing the elevation of embankments to augment the holding capacity of the site. Techniques could be applied that render dredged material suitable for export or for use in re-establishing wetland vegetation.

- No unconfined disposal of contaminated dredge material should be allowed in HMS EFH.

- Disposal sites should be located in uplands when possible.

Aquaculture and Mariculture

Aquaculture is an expanding industry in the United States, with most facilities located in farmland, tidal, intertidal and coastal areas. Aquaculture related impacts that adversely affect the chemical and biological nature of coastal ecosystems include the discharge of excessive waste products and the release of exotic organisms and toxic substances. Problems resulting from the introduction of food and fecal wastes may be similar to those resulting from certain agricultural activities. However, greater nutrient input and localized eutrophic conditions are currently the most probable environmental effects of aquaculture activities. Extremely low oxygen levels and fish kills, of both natural stocks and cultured fish, have been known to occur in impounded wetlands where tidal and wind circulation are severely limited and the enclosed waters are subject to solar heating. In addition, there are impacts related to the dredging and filling of wetlands and other coastal habitats, as well as other modifications of wetlands and waters through the introduction of pens, nets, and other containment and production devices.

Conservation measures

- Aquaculture operations should be located, designed and operated to avoid or minimize adverse impacts on estuarine and marine habitats and native fishery stocks. Those impacts that cannot be eliminated should be fully mitigated.

- Aquaculture facilities should be operated in a manner that minimizes impacts on the local environment by utilizing water conservation practices and effluent discharge standards that protect existing designated uses of receiving waters.

- Federal and state agencies should cooperatively promulgate and enforce measures to ensure that diseases from aquaculture operations do not adversely affect wild stocks. Animals that are to be moved from one biogeographic area to another or to natural waters should be quarantined to prevent disease transmission.

- To prevent disruption of natural aquatic communities, cultured organisms should not be allowed to escape; the use of organisms native to each facility's region is strongly encouraged.

- Commercial aquaculture facilities and enhancement programs should consider the genetic make-up of the cultured organisms in order to protect the genetic integrity of native fishes.

- Aquaculture facilities should meet prevailing environmental standards for wastewater treatment and sludge control.

Navigation

Navigation-related threats to estuarine, coastal, and offshore environments that have the potential to affect HMS EFH include navigation support activities such as excavation and maintenance of channels (including disposal of excavated sediments) which result in the elevation of turbidity and resuspension of contaminants; construction and operation of ports, mooring and cargo facilities; construction of ship repair facilities; and construction of channel stabilization structures such as jetties and revetments. In offshore locations the disposal of dredged material is the most significant navigation related threat, resulting in localized burial of benthic communities and degradation of water quality. In addition, threats to both nearshore and offshore waters are posed by vessel operation activities such as the discharge and spillage of oil, other hazardous materials, trash and cargo, all of which may result in localized water quality degradation and direct effects on HMS, especially eggs, larvae, and neonates that may be present. Wakes from vessel operation may also exacerbate shoreline erosion, effecting habitat modification and potential degradation.

Conservation measures

- Permanent dredged material disposal sites should be located in upland areas. Where long-term maintenance is anticipated, upland disposal sites should be acquired and maintained for the entire project life.

- Construction techniques (*e.g.*, silt curtains) should minimize turbidity and dispersal of dredged materials into HMS EFH.

- Prop washing should not be used as a dredging method.

- Channels and access canals should not be constructed in areas known to have high sediment contamination levels. If construction must occur in these areas, specific techniques, including the use of silt curtains, are needed to contain suspended contaminants.

- Alignments of channels and access canals should utilize existing channels, canals and other deep water areas to minimize initial and maintenance dredging requirements. All canals and channels should be clearly marked to avoid damage to adjacent bottoms from prop washing.

- Access channels and canals should be designed to ensure adequate flushing to avoid creating low dissolved oxygen conditions or sumps for heavy metals and other contaminants. Widths of access channels in open water should be minimized to avoid impacts to aquatic substrates. In canal subdivisions channels and canals within the development should be no deeper than the parent body of water and should be a uniform depth or become gradually shallower inland.

- To ensure adequate circulation confined and dead-end canals should be avoided by utilizing bridges or culverts that ensure exchange of the entire water column. In general, depths of canals should be minimized, widths maximized, and canals oriented towards the prevailing summer winds in order to enhance water exchange.

- Consideration should be given to the use of locks in navigation channels and access canals which connect more saline areas to fresher areas.

- To the maximum extent practicable, all navigation channels and access canals should be backfilled upon abandonment and restored to as near pre-project condition as possible. Plugs, weirs or other water control structures may also be necessary as determined on a case-by-case basis.

- All vessels transporting fuels and other hazardous materials should be required to carry equipment to contain and retrieve the spill.

- Dispersants should not be used to clean up fuels and hazardous materials unless approved by the EPA/Coast Guard after consultation with fisheries agencies.

Marinas and Recreational Boating

Marinas and recreational boating are increasingly popular uses of coastal areas. As marinas are located at the water's edge, there is often no buffering of associated pollutants released into the water column. Impacts caused by marinas include lowered dissolved oxygen, increased temperatures, bioaccumulation of pollutants by organisms, toxic contamination of water and sediments, resuspension of sediments and toxics during construction, eutrophication, change in circulation patterns, shoaling, and shoreline erosion. Pollutants that result from marina activities include nutrients, metals including copper released from antifouling paints, petroleum hydrocarbons, pathogens, and polychlorinated biphenyls. Also, chemicals commonly used to treat timber used for piers and bulkheads (*e.g.*, creosote, copper, chromium, and arsenic salts) are introduced into the water. Other potential impacts associated with recreational boating are the result of improper sewage disposal, fuel and oil spillage, cleaning operations, and disposal of fish waste. Propellers from boats can also cause direct damage to multiple life stages of organisms, including eggs, larvae/neonates, juveniles and adults; destratification; elevated temperatures, and increased turbidity and contaminants by resuspending bottom materials.

Conservation measures

- Water quality must be considered in the siting and design of both new and expanding marinas.

- Marinas are best created from excavated uplands that are designed so that water quality degradation does not occur. Applicants should consider basin flushing characteristics and other design features such as surface and waste water collection and treatment facilities. Marina siting and design should allow for maximum flushing of the site. Adequate flushing reduces the potential for the stagnation of water in a marina and helps to maintain the biological productivity as well as reduce the potential for toxic accumulation in bottom sediments. Catchment basins for collecting and storing runoff should be included as components of the site development plan.

- Marinas should be designed and located so as to protect against adverse impacts on important habitat areas as designated by local, state, or Federal governments.

- Where shoreline erosion is a non-point source pollution problem, shorelines should be stabilized. Vegetative methods are strongly preferred.

- Runoff control strategies, which include the use of pollution prevention activities and the proper design of hull maintenance areas, should be implemented at marina sites.

- Marinas with fueling facilities should be designed to include measures for reducing oil and gas spillage into the aquatic environment. Fueling stations should be located and designed so that in the case of an accident spill contaminants can be contained in a limited area. Fueling stations should have fuel containment equipment as well as a spill contingency plan.

- To prevent the discharge of sewage directly to coastal waters new and expanding marinas should install pumpout, pump station, and restroom facilities where needed. Pumpout facilities should be maintained in operational condition and their use should be encouraged to reduce untreated sewage discharges to surface waters.

- Solid wastes produced by the operation, cleaning, maintenance, and repair of boats should be properly disposed of in order to limit their entry to surface waters.

- Sound fish waste management should be part of the project design, including a combination of fish cleaning restrictions, public education, and proper disposal facilities.

- Appropriate storage, transfer, containment, and disposal facilities for liquid materials commonly used in boat maintenance, along with the encouragement of recycling of these materials, should be required.

- The amount of fuel and oil leakage from fuel tank air vents should be reduced.

- Potentially harmful hull cleaners and bottom paints (and their release into marinas and coastal waters) should be minimized.

- Public education/outreach/training programs should be instituted for boaters, as well as marina operators, to prevent improper disposal of polluting materials.

Marine Sand and Minerals Mining

Mining for sand (*e.g.*, for beach nourishment projects), gravel, and shell stock in estuarine and coastal waters can result in water column effects by changing circulation patterns, increasing turbidity, and decreasing oxygen concentrations at deeply excavated sites where flushing is minimal. Ocean extraction of mineral nodules is a possibility for some non-renewable minerals now facing depletion on land. Such operations are proposed for the continental shelf and the deep ocean proper. Deep borrow pits created by mining may become seasonally or permanently anaerobic. Marine mining also elevates suspended materials at mining sites, creating turbidity plumes that may move several kilometers from these sites. Resuspension of sediments can affect water clarity over wide areas, and could also potentially affect pelagic eggs and larvae. In addition, resuspended sediments may contain contaminants such as heavy metals, pesticides, herbicides, and other toxins.

There is also interest in non-energy OCS resources (*e.g.*, sand) for beach re-nourishment projects. The Minerals Management Service 's (MMS) Marine Minerals Program provides policy direction and guidance for the development of marine mineral resources on the OCS. The Marine Minerals Program works with coastal states to identify sand deposits in Federal waters suitable for beach nourishment. One such example is a lease agreement made that MMS provided the city of Jacksonville, Florida, with access to 1.24 million cubic yards of sand on the OCS. Other states have also entered into cooperative agreements with MMS (http://www.gomr.mms.gov/homepg/offshore/atlocs/atlocs.html). Depending on the scale, duration, and timing of the re-nourishment project, there is potential to impact coastal habitats that may include EFH for HMS. Dredging may cause water turbidity, siltation, and changes to water column characteristics that could affect habitat use for a number of HMS.

Conservation measures

- Sand mining and beach nourishment should not be allowed in HMS EFH during seasons when HMS are utilizing the area, particularly during spawning and pupping seasons.
- Gravel extraction operations should be managed to avoid or minimize impacts to the bathymetric structure in estuarine and nearshore areas.
- An integrated environmental assessment, management, and monitoring program should be a part of any gravel or sand extraction operation, and encouraged at Federal and state levels.
- Planning and design of mining activities should avoid significant resource areas important as HMS EFH.
- Mitigation and restoration should be an integral part of the management of gravel and sand extraction policies.
- Given the increase in sea level rise and potentially growing need to re-nourish beaches, this activity needs to be closely monitored in areas that are adjacent to or located in HMS EFH.

Ocean Dumping

The disposal of dredged sediments and hazardous and/or toxic materials (*e.g.*, industrial wastes) containing concentrations of heavy metals, pesticides, petroleum products, radioactive wastes, pathogens, etc., in the ocean degrades water quality and benthic habitats. These effects may be evident not only within the immediate vicinity of the dumping activity, but also at farther locations, as well, due to current transport and the potential influence of other hydrographic features. Disposal of hazardous and toxic materials by U.S. flag vessels and vessels operating in the U.S. territorial sea and contiguous zone is currently prohibited under the Marine Protection Research and Sanctuaries Act (MPRSA), although under certain circumstances the Environmental Protection Agency may issue emergency permits for dumping industrial wastes into the ocean. Major dumping threats to the marine environment are therefore limited mostly to illegal dumping and accidental disposal of material in unauthorized locations. However, given the amount of debris that is deposited along the Nation's beaches every year, including hazardous materials such as medical wastes, it is evident that effects from such dumping may be substantial.

Conservation measures

- Federal and state agencies mandated with ocean dumping enforcement responsibilities should continue to implement and enforce all legislation, rules and regulations, and consider increasing monitoring efforts where warranted.

- Disposal of hazardous materials within areas designated as EFH for HMS should not be allowed under any circumstances, including emergency permit situations.

Petroleum Exploration and Development

One of the major activities with the potential to impact HMS EFH is oil and gas development. Currently there are approximately 4,000 oil and gas platforms in the Gulf of Mexico (Figure 6.12) and fewer than 100 in the Atlantic (Figure 6.13). Most of the structures are in waters shallower than 1,000 feet (~300 m), however, there are efforts to expand oil drilling to deeper areas of the Gulf. Approximately 72 percent of the Gulf of Mexico's oil production comes from wells drilled in 1,000 feet (305 meters) of water or greater (Figure 6.14) (MMS, 2008(b)). In 2007, 54 percent of all Gulf of Mexico leases were located in water depths greater than 1,000 feet. In the two 2007 lease sales, Western Gulf Lease Sale 204 and Central Gulf Lease Sale 205, almost 70 percent of the tracts receiving bids were in water depths of 1,312 feet or greater (400 meters) (Figure 6.15). Additionally, 94 exploratory wells and 48 development wells were drilled in 2007. Of the 48 development wells drilled, 60 percent were in ultra-deepwater, water depths greater than 5,000 feet. Eight new deepwater discoveries were announced by oil and gas operators in 2007 with the deepest in 7,400 feet of water (MMS, 2008). Many of the shallower sites and most of the deepwater sites fall within HMS EFH, particularly for bluefin tuna. Many of the deeper sites are also located within the proposed HAPC for bluefin tuna.

The continued expansion of deep water oil exploration is detailed in the MMS report, Deepwater Gulf of Mexico 2008: America's Offshore Energy Frontier, which chronicles the activities of the oil and gas industry in the deepwater (1,000 feet of water or more) Gulf over the past sixteen years (MMS, 2008(b)).

In the Atlantic, ten oil and gas lease sales were held between 1976 and 1983. Fifty-one wells were drilled in the Atlantic OCS; five Continental Offshore Stratigraphic Test (COST) wells between 1975 and 1979, and 46 industry wells between 1977 and 1984 (Figure 6.16). Five wells offshore New Jersey had successful drillstem tests of natural gas and/or condensate. These five wells were abandoned as non-commercial. Reports on each of the eight exploratory and two COST wells drilled in the North Atlantic Planning Area are available and reports on 10 of the 34 wells drilled in the Mid-Atlantic Planning Area are available on the MMS webpage at http://www.gomr.mms.gov/homepg/atlantic/georges_bank.html.

For oil platforms, there are direct and indirect impacts to the environment such as disturbance created by the activity of drilling, associated pollution from drilling activities, discharge of wastes associated with offshore exploration and development, operational wastes from drilling muds and cuttings, potential for oil spills, and potential for catastrophic spills caused by accidents or hurricanes, and alteration of food webs created by the submerged portions of the oil platform, which attract various invertebrate and fish communities. Anecdotal information suggests that some recreational fishermen may target various fish species, including HMS, in the vicinity of oil platforms due to increased abundance and availability near platforms. The apparent increase in abundance of a number of species may be due to increased prey availability resulting from various fish and invertebrate communities that are attracted to or attach directly to the structures and submerged pilings. While the apparent increase in abundance of fish near oil platforms may appear to be beneficial, little is known about the long term environmental impacts of changes caused by these structures to fish communities, including potential changes to migratory patterns, spawning behavior, and development of early life stages. Currently there is debate about whether the positive effects of the structures in attracting fish communities would be harmed by removal of the platforms when they are decommissioned.

Conservation measures

- A plan should be in place to avoid the release of hydrocarbons, hydrocarbon-containing substances, drilling muds, or any other potentially toxic substance into the aquatic environment. Storage of these materials should be in enclosed tanks whenever feasible or, if not, in lined mud pits or other approved sites. Equipment should be maintained to prevent leakage. Catchment basins for collecting and storing surface runoff should be included in the project design.

- Exploration/production activities and facilities should be designed and maintained in a manner that will maintain natural water flow regimes, avoid blocking surface drainage, and avoid erosion in adjacent coastal areas.

- Activities should avoid wetlands. Drilling should be conducted from uplands, existing drill sites, canals, bayous or deep bay waters (greater than six feet), wherever possible, rather than dredging canals or constructing board roads. When wetland use is unavoidable, work in previously disturbed wetlands is preferable to work in high quality or undisturbed wetlands. If this is not possible, temporary roads (preferably board roads) to provide access are more desirable than dredging canals because roads generally impact less acreage and are easier to restore than canals. If the well is a producer, the drill pad should be reduced to the minimum size necessary to conduct production activities and the disturbed area should be restored to pre-project conditions.

- Upon completion or abandonment of wells in wetlands, all unnecessary equipment should be removed and the area restored to pre-project elevations. The well site, various pits, levees, roads and other work areas should be graded to pre-project marsh elevations and then restored with indigenous wetland vegetation. Abandoned canals frequently need plugging and capping with erosion-resistant material at their origin to minimize bank erosion and to prevent saltwater intrusion. In addition, abandoned canals will frequently need to be backfilled to maximize fish and wildlife production in the area and to restore natural sheet flows. Spoil banks containing uncontaminated materials should be backfilled into borrow areas or breached at regular intervals to re-establish hydrological connections.

- In open bays maximum use should be made of existing navigable waters already having sufficient width and depth for access to the drill sites.

- An oil spill response plan should be developed and coordinated with Federal and state resource agencies.

- Activities on the OCS should be conducted so that petroleum-based substances such as drilling muds, oil residues, produced waters, or other toxic substances are not released into the water or onto the sea floor: drill cuttings should be shunted through a conduit and discharged near the sea floor, or transported ashore or to less sensitive, NMFS-approved offshore locations; drilling and production structures, including pipelines, generally should not be located within one mile of the base of a live reef.

- Prior to pipeline construction, less damaging, alternative modes of oil and gas transportation should be explored.

- State natural resource agencies should be involved in the preliminary pipeline planning process to prevent violations of water quality and habitat protection laws and to minimize impact of pipeline construction and operation on aquatic resources.

- Pipeline alignments should be located along routes that minimize damage to marine and estuarine habitats. Buried pipelines should be examined periodically for maintenance of adequate earthen cover.

- All vessels transporting fuels and other hazardous materials should be required to carry equipment to contain and retrieve the spill. Dispersants shall not be used to clean up fuels and hazardous materials unless approved by the EPA/Coast Guard and fishery agencies.

- NPDES permit conditions such as those relating to dissolved oxygen, temperature, impingement and entrainment, under the Clean Water Act should be monitored and strictly enforced in areas that could affect HMS EFH.

- NPDES permits should be reviewed every five years for all energy production facilities.

Liquefied Natural Gas

Several liquefied natural gas (LNG) facilities have been proposed in the Gulf of Mexico (Figure 6.17). For LNG facilities, a major concern is the saltwater intake system used to heat LNG and regasify it before piping to shore. LNG facilities sometimes have open loop, once-through heating systems known as open rack vaporizers, which require large amounts of sea water to heat LNG. One such project, Main Pass LNG, which was proposed to be located in the Gulf of Mexico 37 miles east of Venice, LA, included a water intake system that would require an average of 180 million gallons of sea water per day (MGD) to heat and regasify LNG. Short-term, maximum sea water use for this facility would have been over 200 MGD. As described in the Main Pass LNG DEIS, the use of the sea water intake system would subject early life stages of marine species to entrainment, impingement, thermal shock, and water chemistry changes, potentially causing the annual mortality of hundreds of billions of zooplankton, including fish and shellfish eggs and larvae. Depending on the location of the facility, this could have an adverse effect on EFH for HMS or other species. The proposal was amended to include a closed loop system after receiving comments from a number of agencies, including NOAA, that mitigating measures such as a closed loop system should be considered.

Closed loop systems are currently being used in the United States to regasify LNG and are proposed for multiple onshore and offshore LNG terminals throughout the nation, with the notable exception of the offshore waters of the Gulf of Mexico. These systems, which do not rely on an external saltwater intake source and thus do not require large amounts of seawater, have considerably lower impacts on fish eggs, larvae, and zooplankton than open loop systems.

Conservation measures

- Use of closed loop systems should be recommended over open loop systems to minimize the level of impingement and entrainment of marine organisms; design intake structures to minimize entrainment of impingement.
- Locate facilities that use surface waters away from estuaries, embayments and other coastal areas that are use for spawning, pupping and nurseries.
- Avoid the use of biocides to prevent fouling if possible; if necessary, use the least damaging antifoulants.
- Schedule dredging activities to avoid times of spawning and pupping and when vulnerable life stages are otherwise present
- Ensure that facilities have appropriate gas spill response plans and protocols in place.

Renewable Energy Projects

Other activities that may affect HMS EFH include renewable offshore energy projects. The Energy Policy Act of 2005 authorized MMS to establish the Outer Continental Shelf (OCS) Alternative Energy and Alternate Use (AEAU) Program. Under this authority, MMS will regulate alternative energy projects and projects that involve the alternate use of existing oil and gas platforms on the OCS. Alternative energy includes, but is not limited to wind, wave, solar, underwater current and generation of hydrogen. Alternate uses of existing facilities may include aquaculture, research, education, recreation, or support for offshore operations and facilities.

MMS has proposed five locations offshore of New Jersey, Delaware, Georgia, Florida, and California for alternative energy development (Figure 6.18-6.21). Since these projects fall within current EFH for HMS and a number of other Federally managed fish stocks, MMS has initiated the consultation process with NOAA. MMS is proposing limited, temporary leases in these areas for data collection and technology testing related to wind, wave and ocean current energy development. According to MMS, at this time, there is no commercial energy production associated with the proposed leases. Prior to any leases actually being issued or consideration of specific project proposals, MMS will need to determine if competitive interest exists for research in the five areas. MMS must also evaluate other information related to those areas such as environmental factors and current commercial activities such as fishing and shipping. The MMS issued a Federal Register (72 FR 62673, November 6, 2007) that provides details about the five areas along with instructions for the public to provide comments. NMFS has provided comments to MMS on the potential impacts of the projects and will continue to consult with MMS as the projects proceed. Conservation recommendations include:

Conservation measures

- Employ bubble curtains or cofferdams where possible.

- Utilize appropriate work windows to avoid impacts during sensitive times of year (*e.g.*, anadromous fish runs and spawning, larval, and juvenile development periods).

- Use any other new technologies and methods that may minimize impacts to fish and fish habitat.

- Contingency plans should be in place to respond to spills associated with service platforms.

- Barrage-type tidal facilities should not be permitted due to the potential impacts to migratory species (*e.g.*, HMS).

6.2.1 Cumulative Impacts

According to the regulations (50 CFR 600.815(a)(5)) FMPs should analyze the cumulative impacts of both natural and man-made causes on EFH. In addition, in accordance with NEPA, cumulative impacts are defined as the impacts on the environment that result from the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions, regardless of who undertakes such actions. Cumulative impacts can result from individually minor, but collectively significant actions taking place over a period of time. To the extent feasible and practicable, FMPs should analyze how the cumulative impacts of fishing and non-fishing activities influence the function of EFH on an ecosystem or watershed scale. An assessment of the cumulative and synergistic effects of multiple threats, including the effects of natural stresses (such as storm damage or climate-based environmental shifts), and an assessment of the ecological risks resulting from the impact of those threats on EFH, should also be included. This cumulative impact analysis addresses cumulative impacts as required for EFH identification and designation and as required under NEPA.

The designation of EFH can result in cumulatively beneficial ecological impacts, as the designation would result in a need for federal agencies to consult with NMFS if their actions adversely affect EFH. However, the positive ecological impacts are realized only if the recommended conservation measures are implemented as a part of the action proposed by the consulting agency, therefore, a detailed cumulative impact analysis of these future outcomes is speculative and cannot be considered "reasonably foreseeable" for detailed analysis in this EIS.

Prior to the passage of the Magnuson-Stevens Act there was little or no emphasis or attention paid to anthropogenic influences on ocean habitats, and the important function of habitat in maintaining healthy fish stocks. Since the passage of the Magnuson-Stevens Act and the EFH provisions that require agencies to consult with NMFS when considering projects that may have an adverse effect on EFH, much greater attention has been focused on activities that are likely to affect fish habitat.

There are a variety of past, present, and reasonably foreseeable future actions that have the potential to affect HMS EFH. They range, among other things, from coastal development and associated coastal runoff and non-point source pollution in coastal areas to OCS oil and gas development, and global warming. Since most HMS EFH is comprised of open ocean environments occurring over broad geographic ranges, large-scale impacts such as global warming that affect ocean temperatures, currents, and potentially food chain dynamics, are most likely to have an impact and pose the greatest threat to HMS EFH. Anecdotal information suggests that such changes may be occurring and influencing the distribution and habitat usage patterns of HMS and non-HMS fish stocks.

Temperatures changes of a few degrees can disrupt upwelling currents that reduce or eliminate the nutrients necessary for phytoplankton which could have potential repercussions throughout the food chain. As a result, changes in migratory patterns may be the first indication that large scale shifts in oceanic habitats that may be occurring. Some have pointed to the shift in availability of bluefin tuna from fishing grounds off North Carolina to waters off Canada during the winter months as evidence of changes in oceanographic conditions that may be affecting historical distribution patterns. Although the evidence is still lacking, causative factors in the shift include preferences for cooler water temperatures and prey availability. A recent report by the Conservation Law Foundation indicated that low food availability had reduced growth rates in larval cod and haddock and that rising sea surface temperatures had the potential to further reduce productivity for these and other fish stocks off the New England coast (Bandura and Vucson, 2006).

Wetland loss is a cumulative impact that results from activities related to coastal development: residential and industrial construction, dredging and dredge spoil placement, port development, marinas and recreational boating, sewage treatment and disposal, industrial wastewater and solid waste disposal, ocean disposal, marine mining, and aquaculture. In the late 1970s and early 1980s the country was losing wetlands at an estimated rate of 300,000 acres per year. The Clean Water Act and state wetland protection programs helped decrease wetland losses to 117,000 acres per year, between 1985 and 1995. Estimates of wetlands loss vary according to the different agencies. The USDA estimates attributes 57 percent wetland loss to development, 20 percent to agriculture, 13 percent to deepwater habitat, and 10 percent to forest land, rangeland, and other uses. Of the wetlands lost to uplands between 1985 and 1995, the U.S. Fish and Wildlife Service estimates that 79 percent of wetlands were lost to upland agriculture. Urban development, and other types of land use activities were responsible for six percent and 15 percent, respectively.

Nutrient enrichment has become a major cumulative problem for many coastal waters. Nutrient loading results from the individual activities of coastal development, non-point source pollution, marinas and recreational boating, sewage treatment and disposal, industrial wastewater and solid waste disposal, ocean disposal, agriculture, and aquaculture. Excess nutrients from land based activities accumulate in the soil, pollute the atmosphere, pollute ground water, or move into streams and coastal waters. Nutrient inputs are known to have a direct effect on water quality. For example, in extreme conditions excess nutrients can stimulate excessive algal blooms or dinoflagellate growth that can lead to increased turbidity, decreased dissolved oxygen, and changes in community structure, a condition known as eutrophication. Examples of such dinoflagellates or algae that are known to cause harmful algal blooms (HAB) include *Gymnodinium breve,* the dinoflagellate that causes neurotoxic shellfish poisoning, dinoflagellates of the genus *Alexandrium,* which causes paralytic shellfish poisoning, *Aureococcus anophagefferens,* the algae which causes “brown tides”, and diatoms of the genus *Pseudo-nitzschia* which cause amnesic shellfish poisoning. *Pfiesteria piscicida* is a recently-described toxic dinoflagellate that has been documented in the water column in coastal areas of Delaware, Maryland, and North Carolina.

In addition to the direct cumulative effects incurred by development activities, inshore and coastal habitats are also jeopardized by persistent increases in certain chemical discharges. The combination of incremental losses of wetland habitat, changes in hydrology, and nutrient and chemical inputs produced over time, can be extremely harmful to marine and estuarine biota, resulting in diseases and declines in the abundance and quality of the affected resources.

Future investigations will seek to analyze cumulative impacts of chemicals and other discharges, as well as habitat alterations, within specific geographic locations (certain estuarine, coastal and offshore habitats) in order to evaluate the cumulative impacts on HMS EFH. Information and techniques that are developed for this process will be used to supplement future revisions of these EFH provisions as the information becomes available.

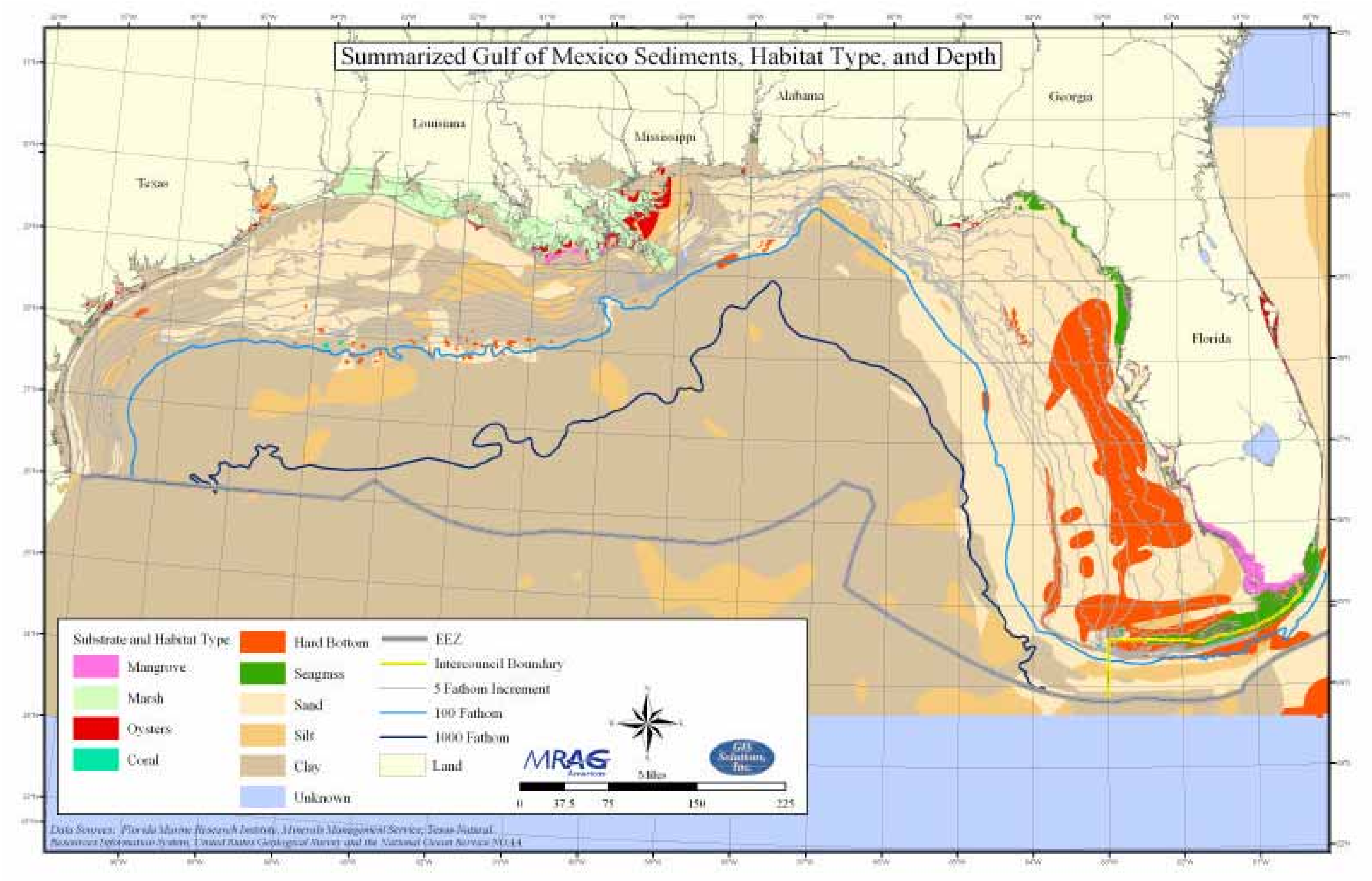


Figure 6.1 Distribution of substrate and habitat type in the Gulf of Mexico. Source: Figure 3.1.3 in GOMFMC, 2004.

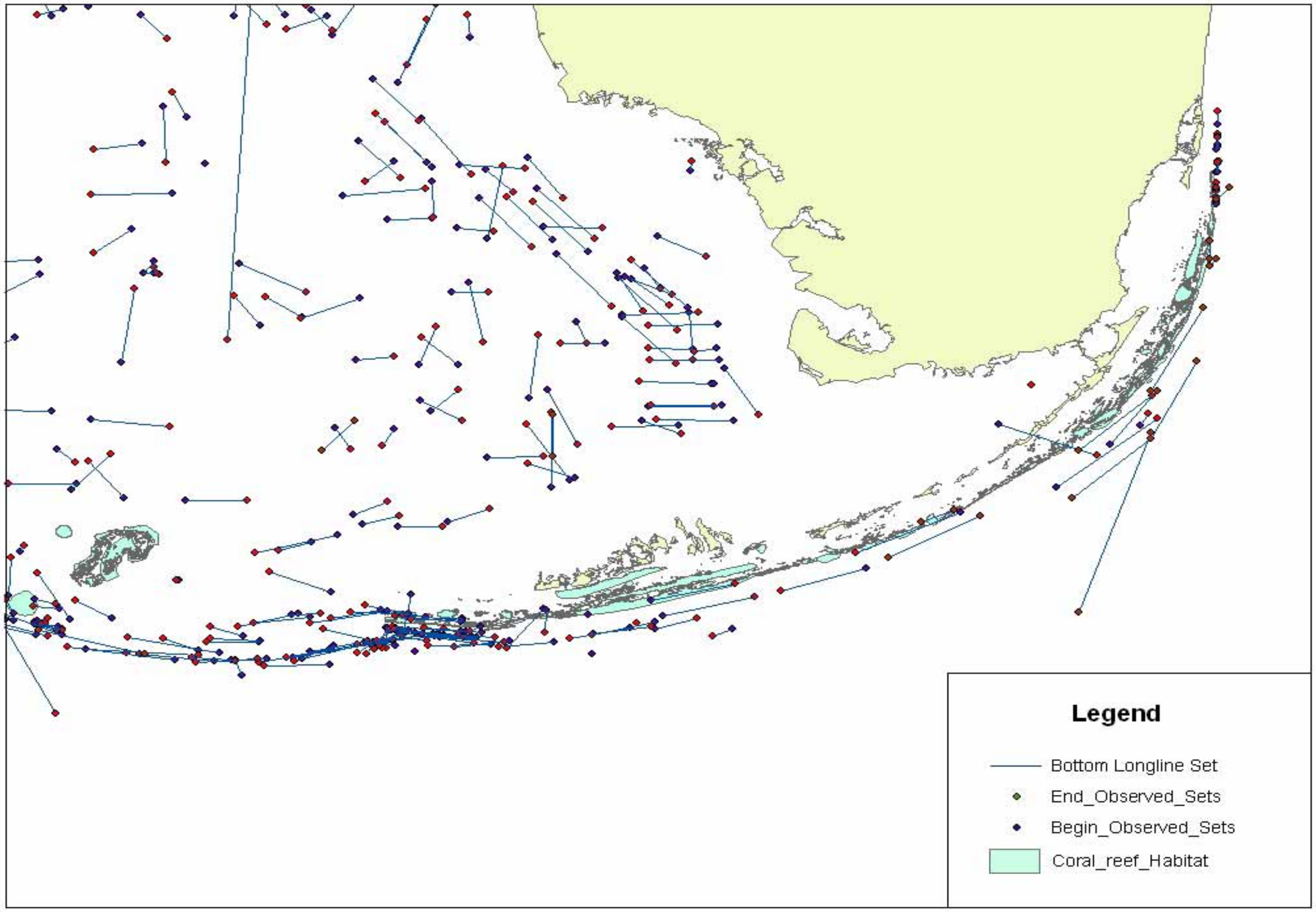


Figure 6.2 Location of sets from the CFSOP and shark BLL fishery observer program (1994-2006) in relation to coral reef habitat (in blue) around the Florida Keys. Source: CFSOP and shark BLL fishery observer program (1994-2006).

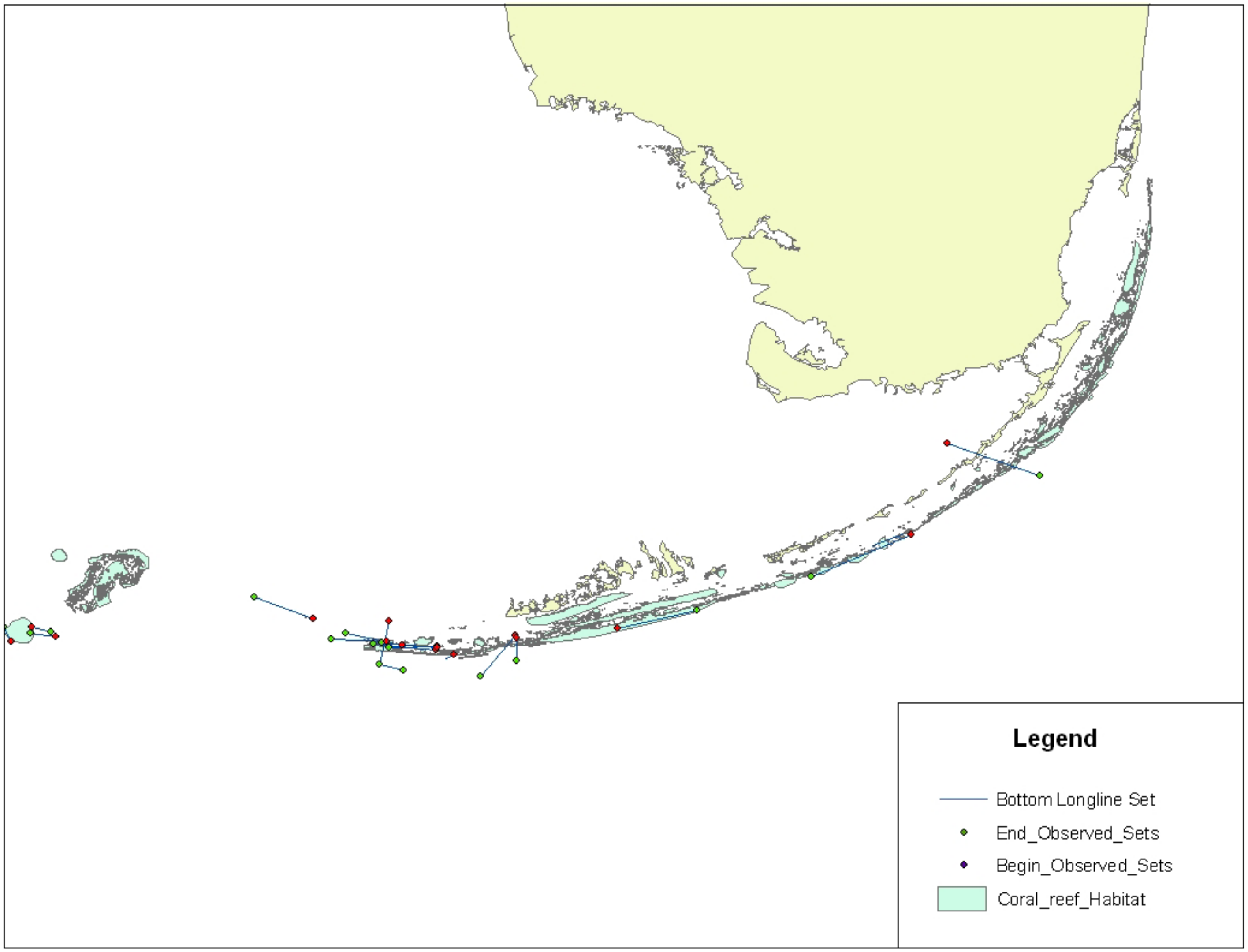


Figure 6.3 Location of only those sets that intersected coral reef habitat (in blue) around the Florida Keys. Source: CFSOP and shark BLL fishery observer program (1994-2006).

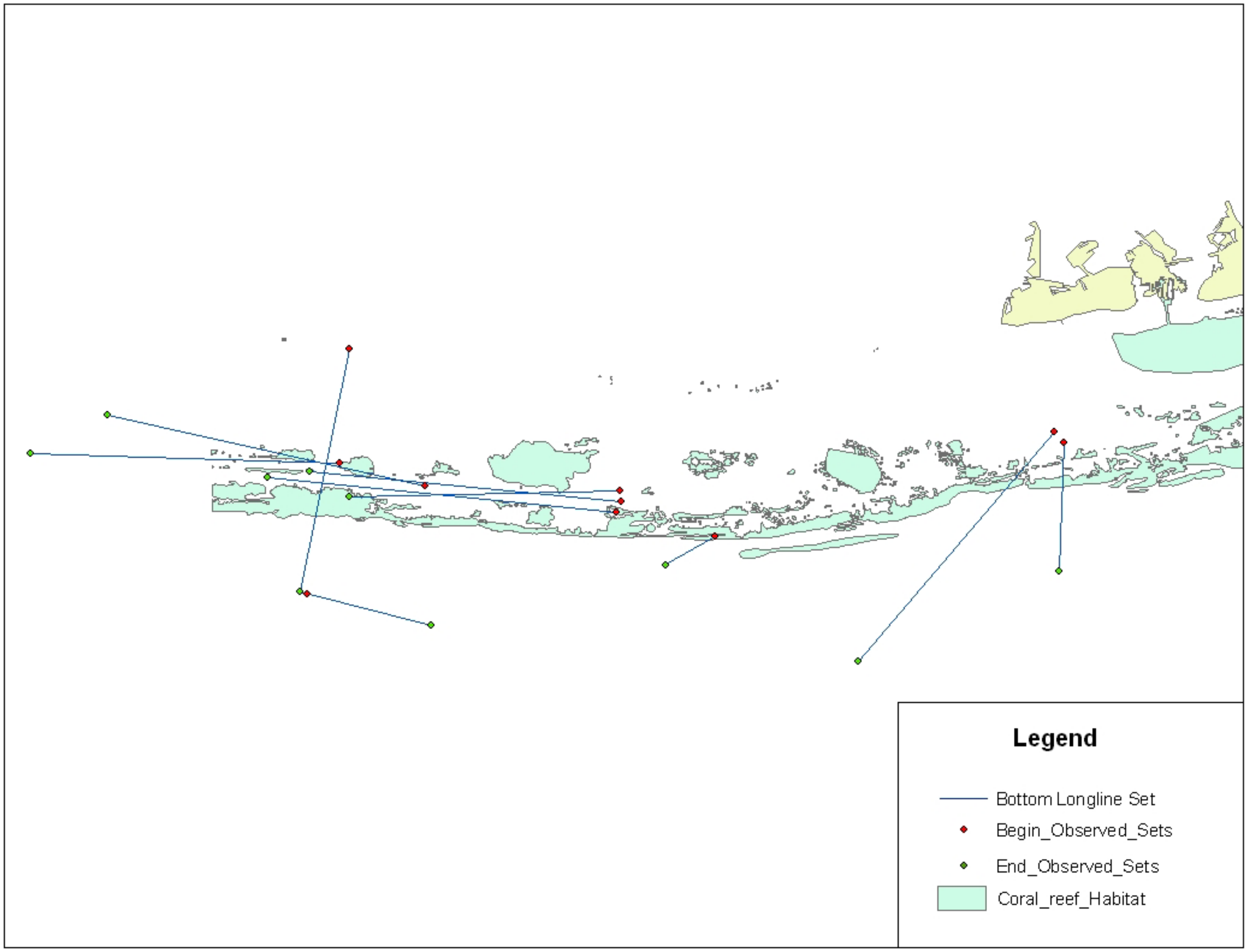


Figure 6.4 Zoomed in view of the location of only those sets that intersected coral reef habitat (in blue) around the Florida Keys. Source: CFSOP and shark BLL fishery observer program (1994-2006).

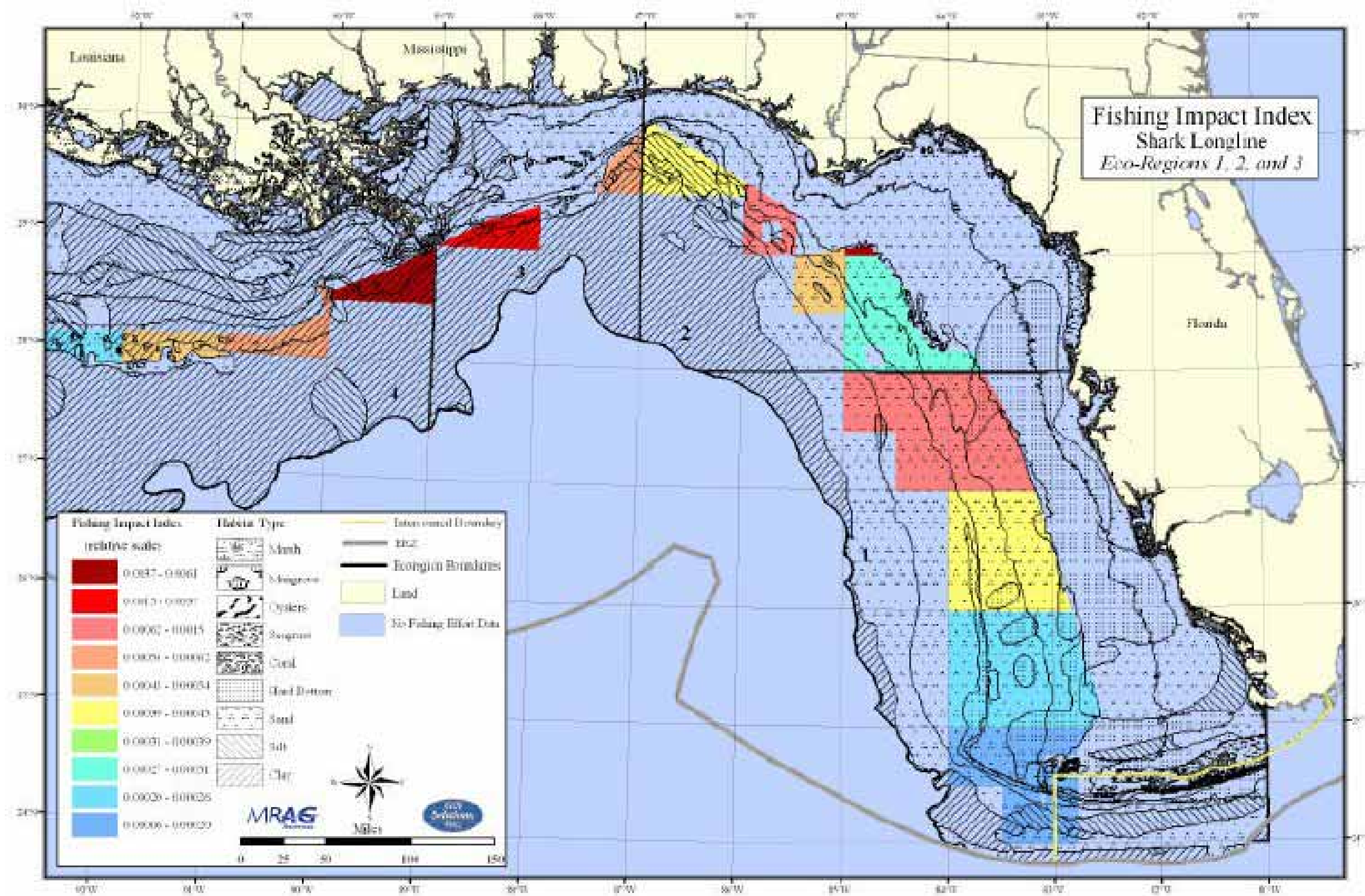


Figure 6.5 Fishing impact index for shark bottom longline gear in the Gulf of Mexico. Different colors indicate sensitivity to all fishing gears in the Gulf of Mexico. Higher sensitivity numbers (red color) indicate greater vulnerability to overall fishing impacts. Figure 3.5.26b in GOMFMC, 2004.

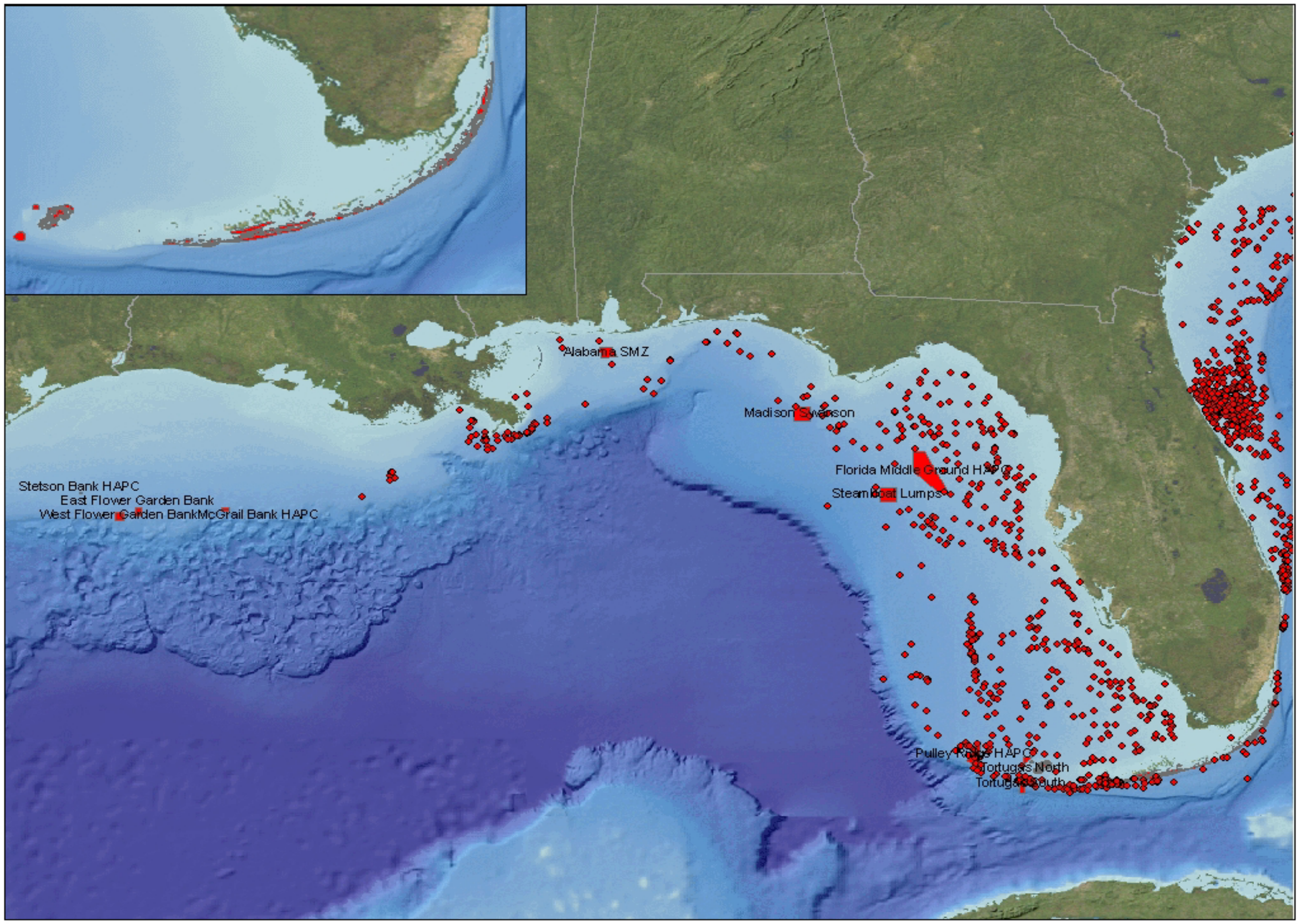


Figure 6.6 Location of sets from the CFSOP and shark BLL fishery observer program (1994-2006) in relation to closed areas in the Gulf of Mexico region. Source: CFSOP and shark BLL fishery observer program (1994-2006). Note: the insert shows the location of coral reef habitat around the Florida Keys.

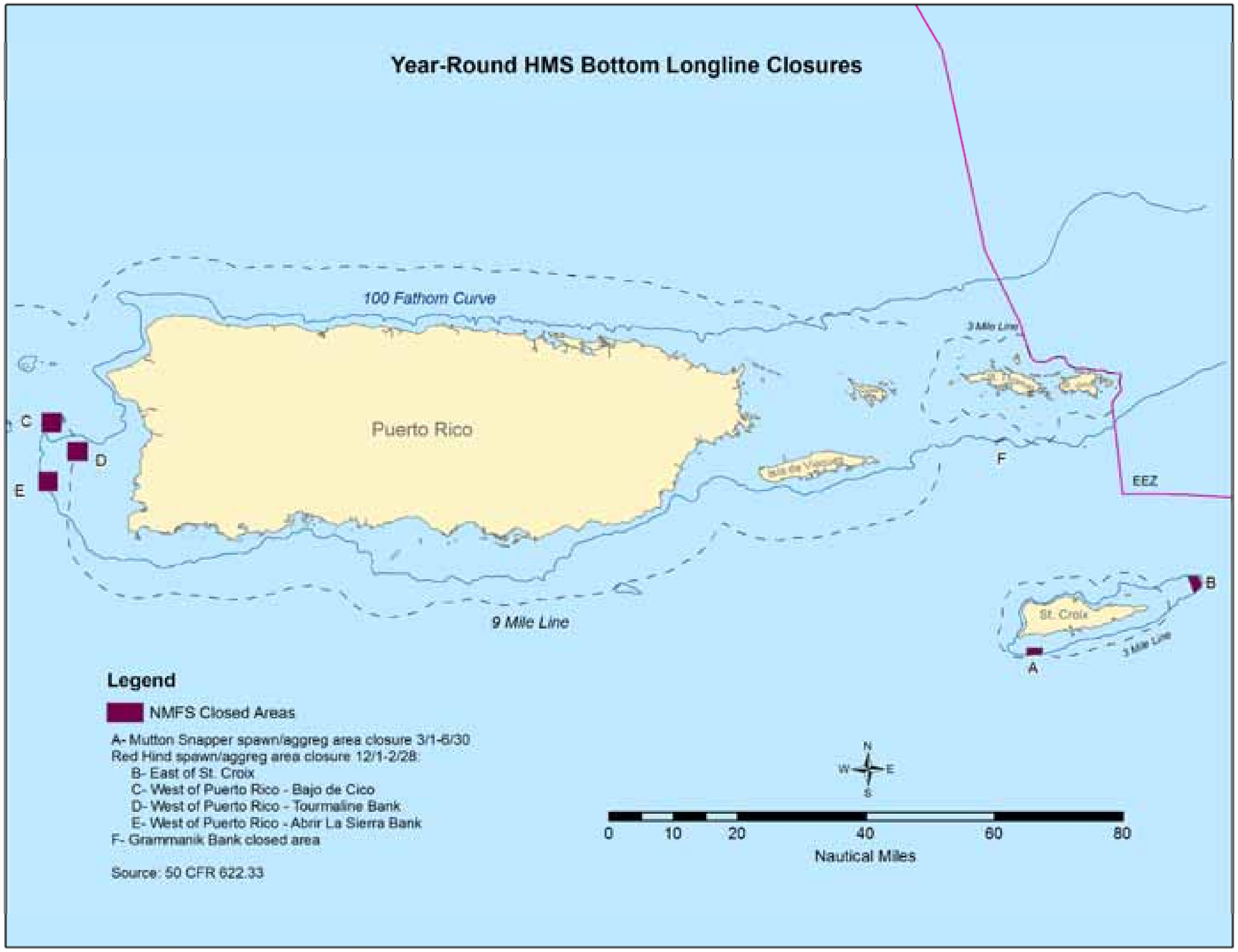


Figure 6.7 Six year round closures to bottom tending gear, including shark bottom longline gear, off Puerto Rico and the U.S. Virgin Islands.

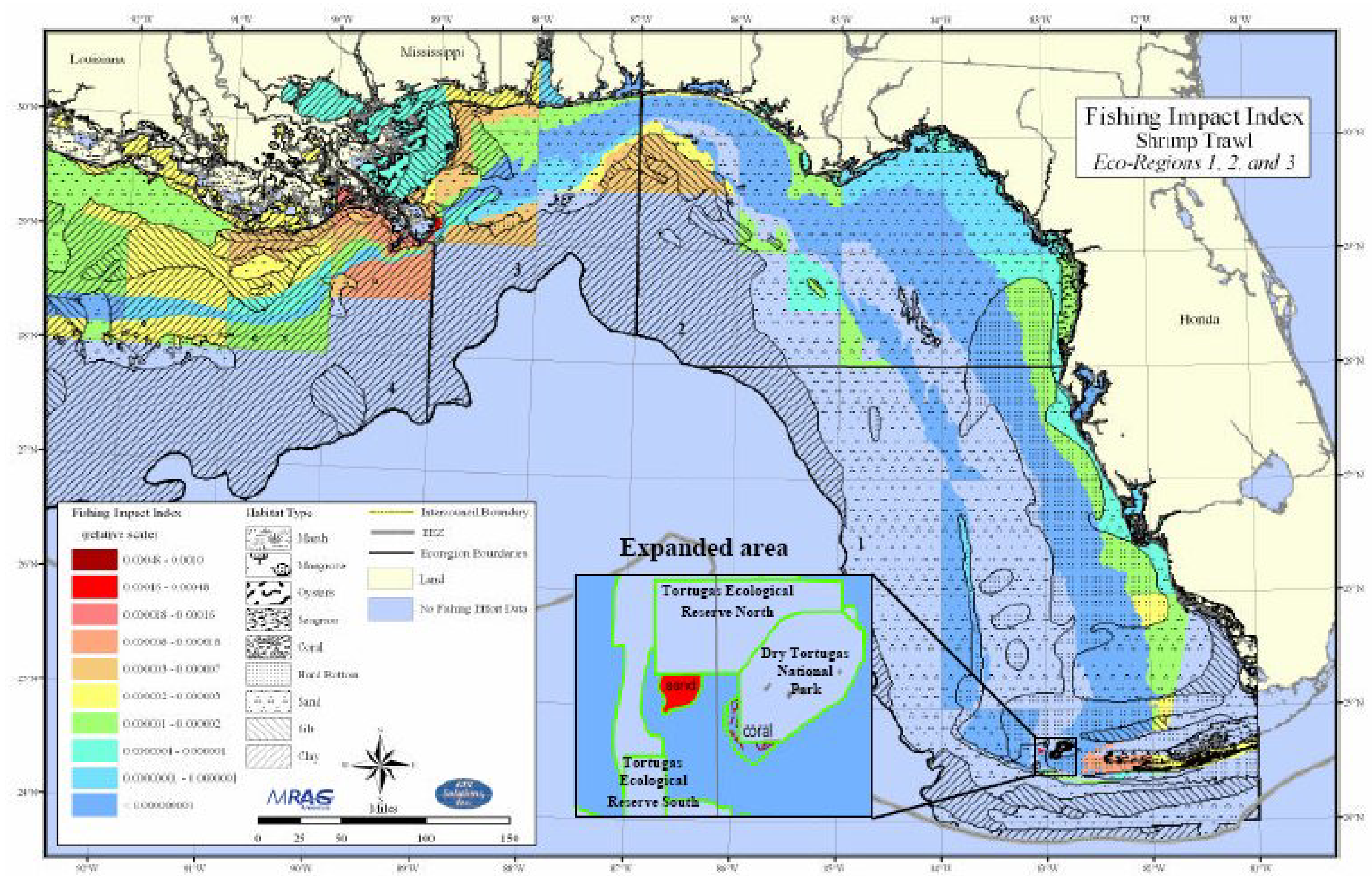


Figure 6.8 Fishing impact index for shrimp trawls in the Gulf of Mexico. Higher sensitivity numbers (red color) indicate greater vulnerability to overall fishing impacts. Source: Figure 3.5.23b in GOMFMC, 2004.

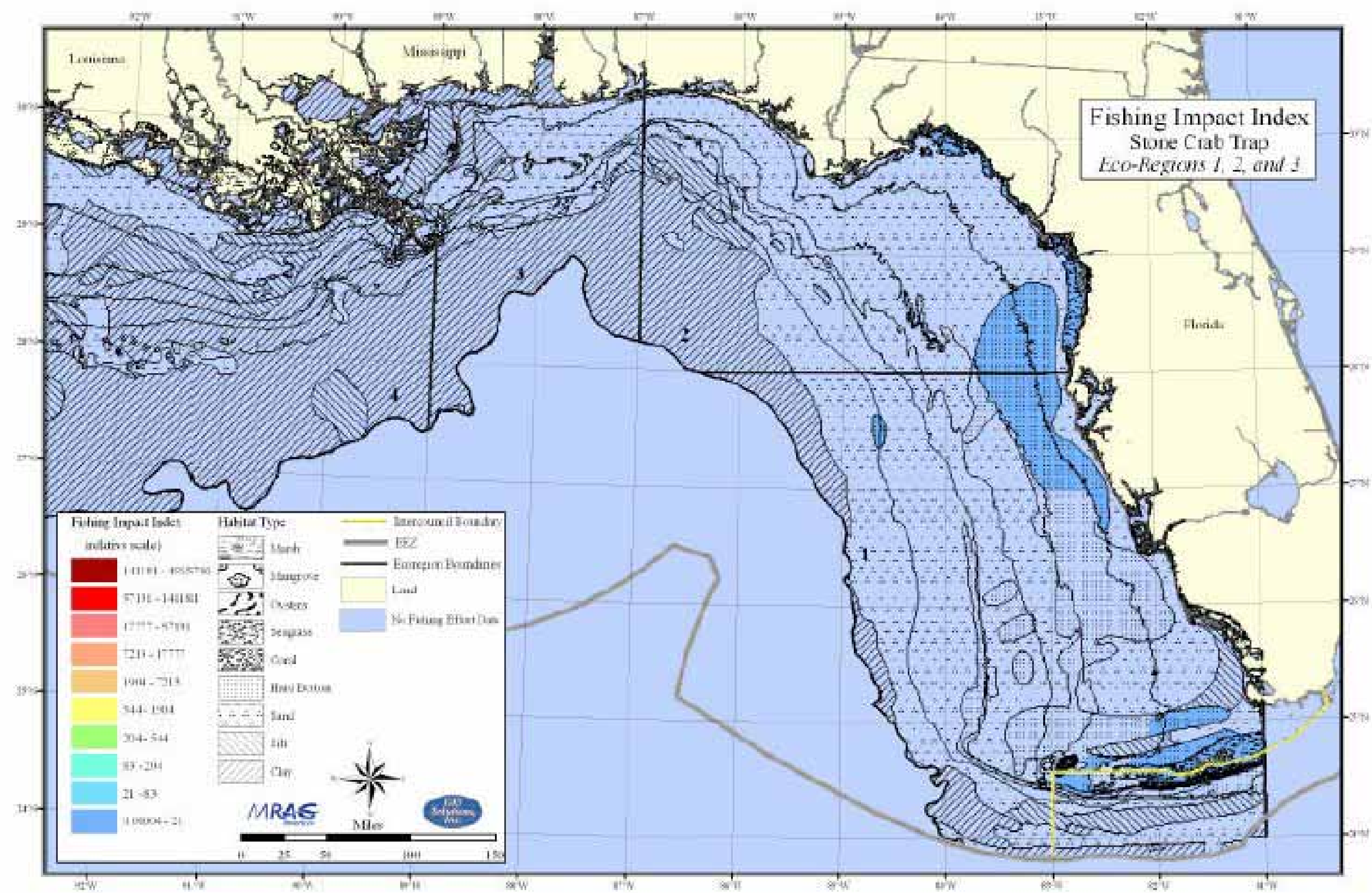


Figure 6.9 Fishing impact index from stone crab pots in the Gulf of Mexico. Higher sensitivity numbers (red color) indicate greater vulnerability to overall fishing impacts. Source: Figure 3.5.24 in GOMFMC, 2004.

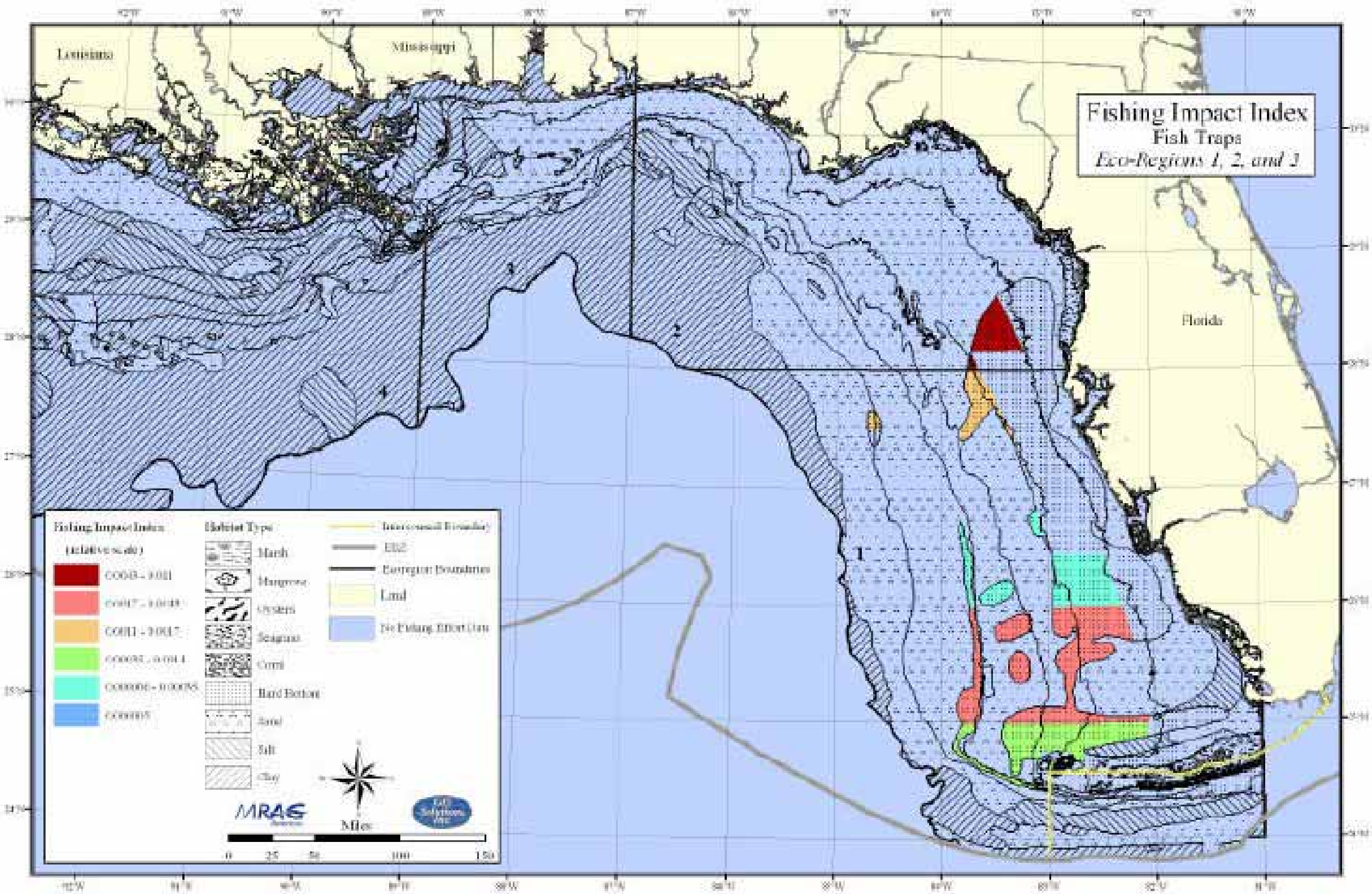


Figure 6.10 Fishing impact index from fish traps in the Gulf of Mexico. Higher sensitivity numbers (red color) indicate greater vulnerability to overall fishing impacts. Source: Figure 3.5.19 in GOMFMC, 2004.

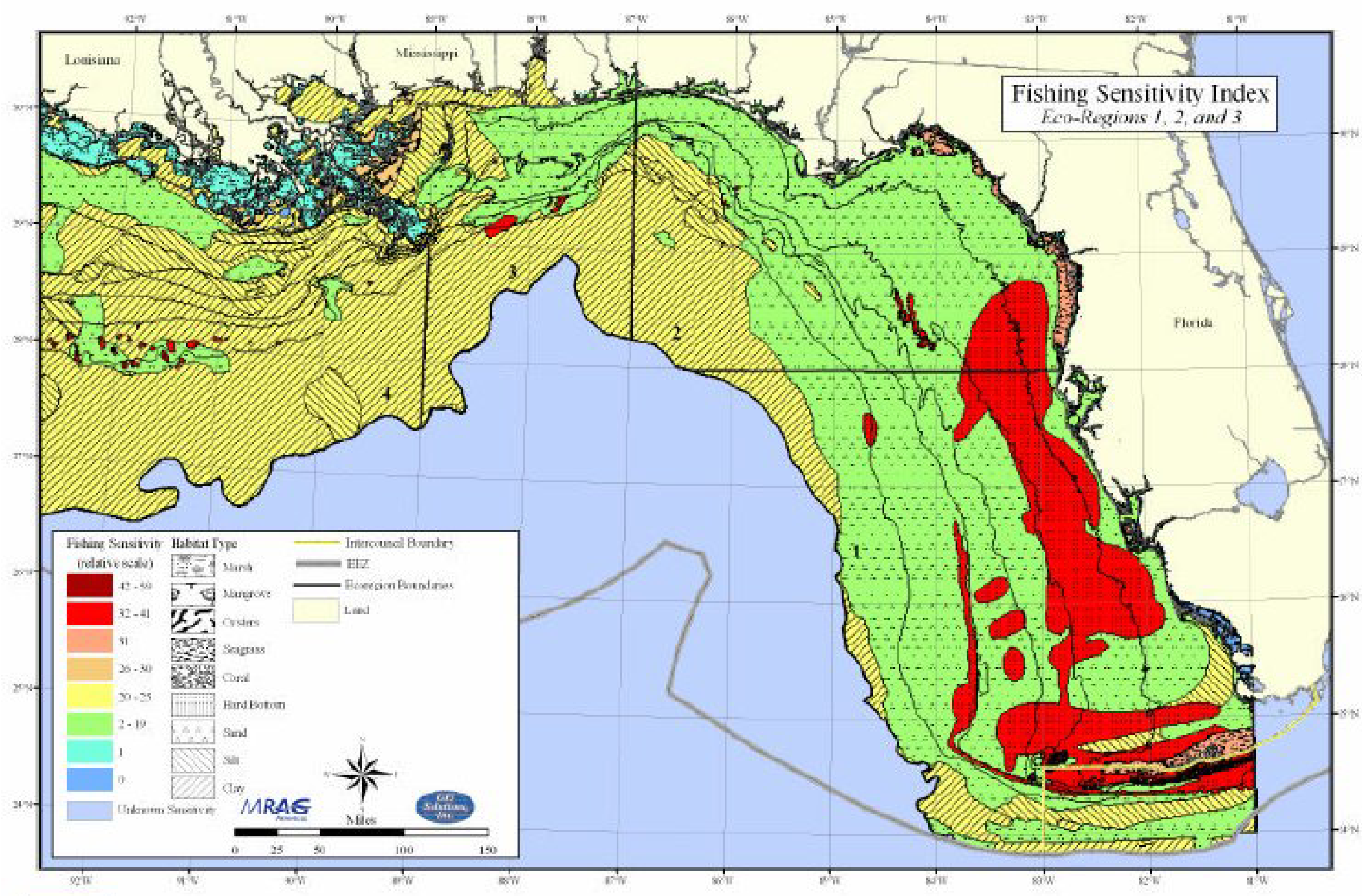


Figure 6.11 Habitat sensitivity to all fishing gears in the Gulf of Mexico. Higher sensitivity numbers indicate greater vulnerability to overall fishing impacts. Source: Figure 3.5.16b in GOMFMC, 2004.

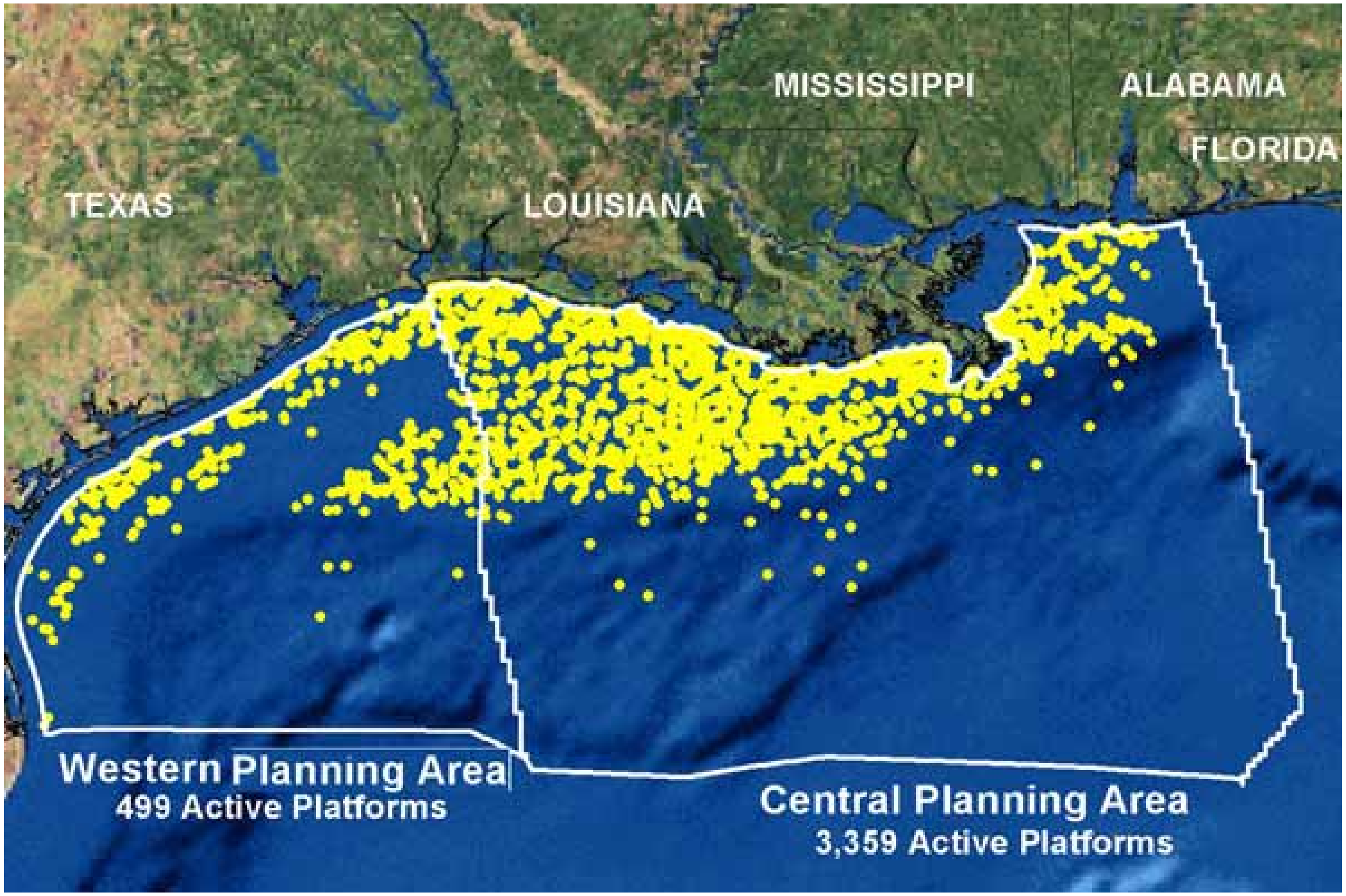


Figure 6.12 Oil and gas platforms in the Gulf of Mexico. Source: MMS and NOAA's Ocean Explorer webpage http://oceanexplorer.noaa.gov.

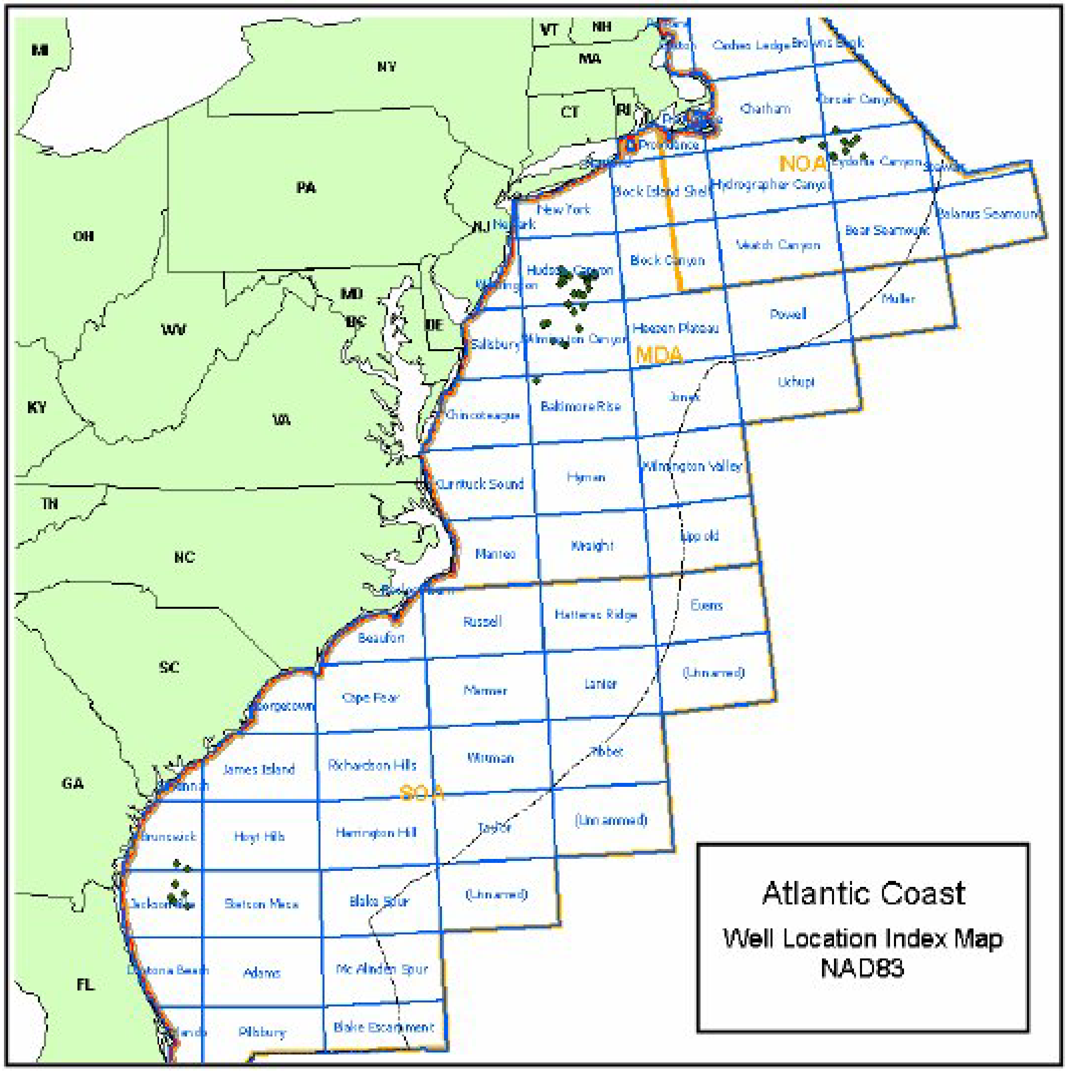


Figure 6.13 Oil platform locations (represented by points on the map) as well as lease grids in the Atlantic. Source: MMS

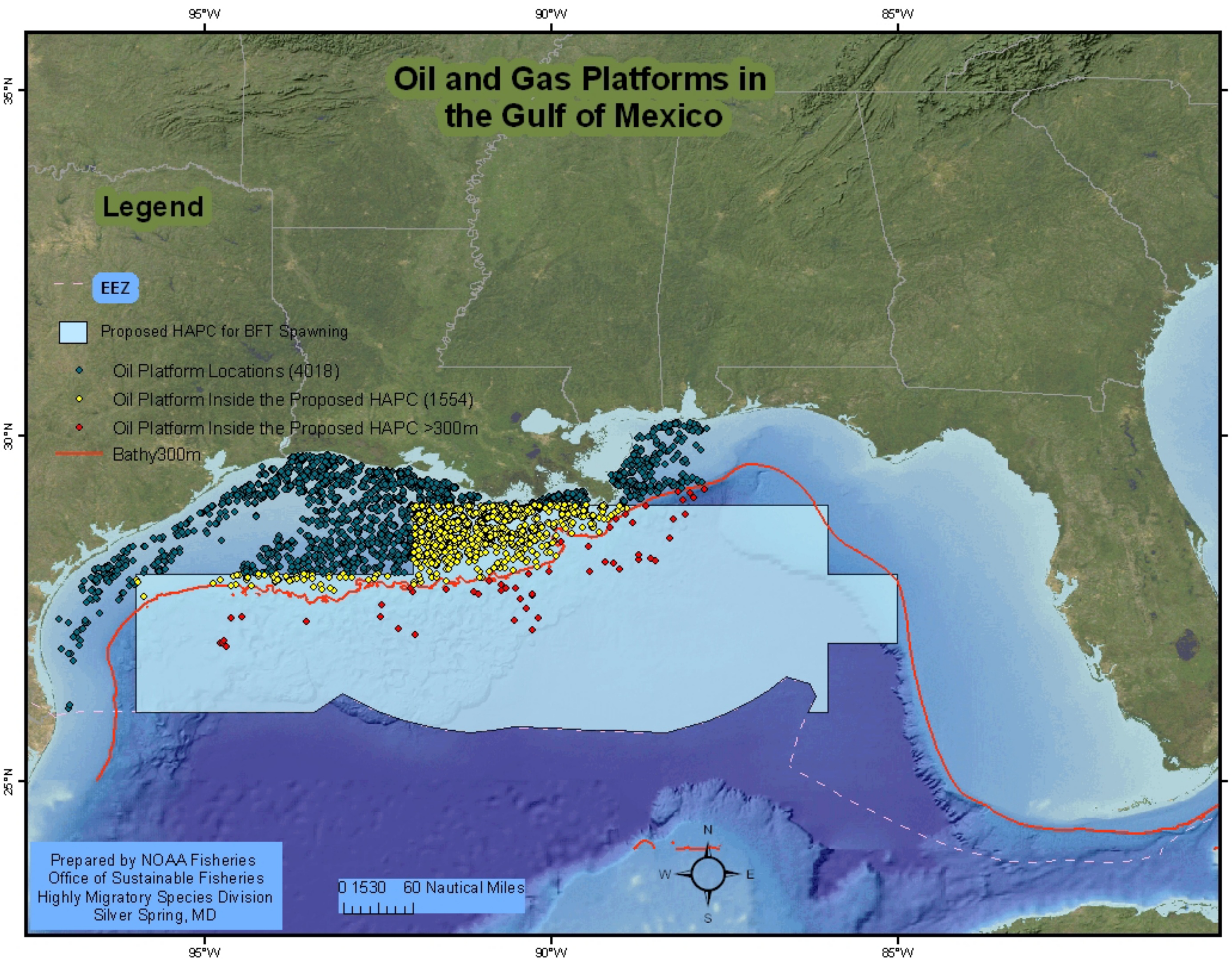
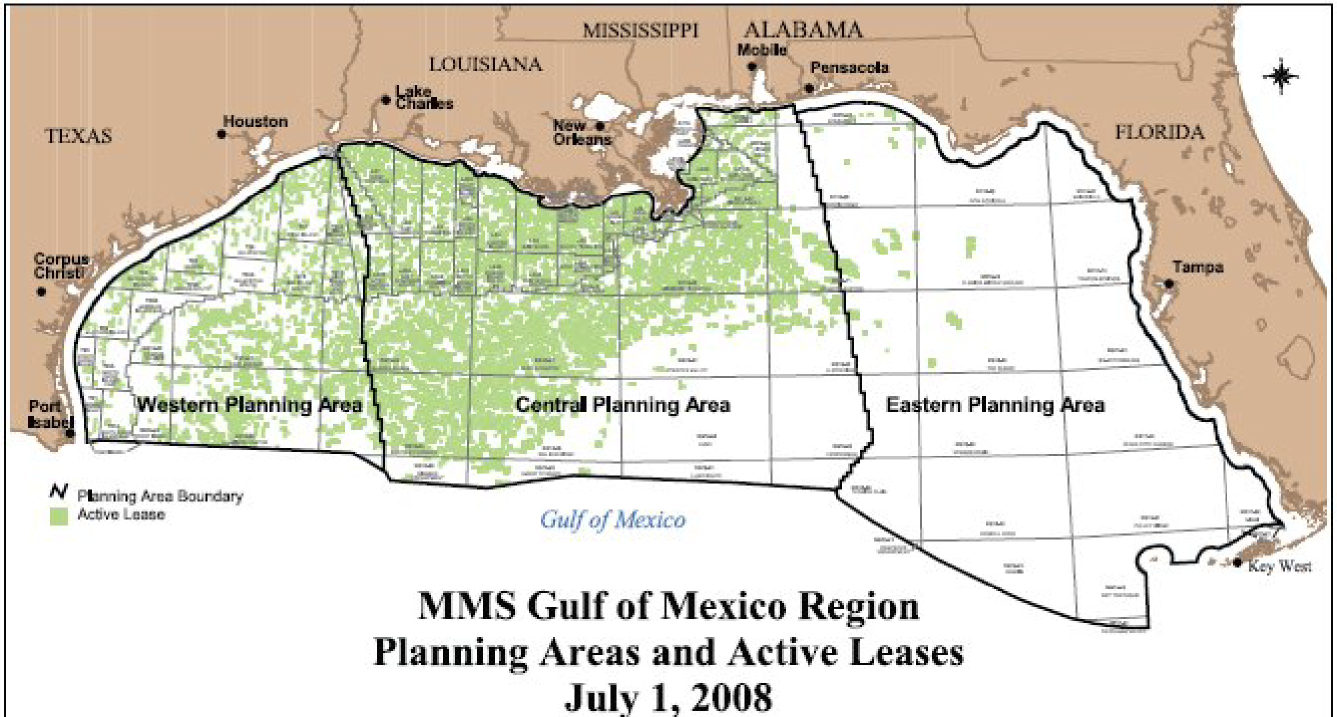


Figure 6.14 Oil and gas platforms in the Gulf of Mexico in relation to the proposed bluefin tuna HAPC and the 300m bathymetric line. Oil and gas platforms in the proposed HAPC are shown in yellow and red, the red locations are deeper than 300m. Source: MMS.



	Total Blocks	Total Acres	Blocks Leased	Acres Leased
Westen Planning Area	5,240	28,576,583	1,824	10,213,248
Central Planning Area	12,370	66,452,086	5,416	28,875,454
Eastern Planning Area	11,486	64,556,650	128	720,217
Totals	29,096*	159,585,319	7,368	39,808,919

* 7 blocks are split between the CPA and EPA

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Figure 6.15 Total number of blocks, total acres, blocks leased and acres leased by planning area in the Gulf of Mexico. Source: MMS.

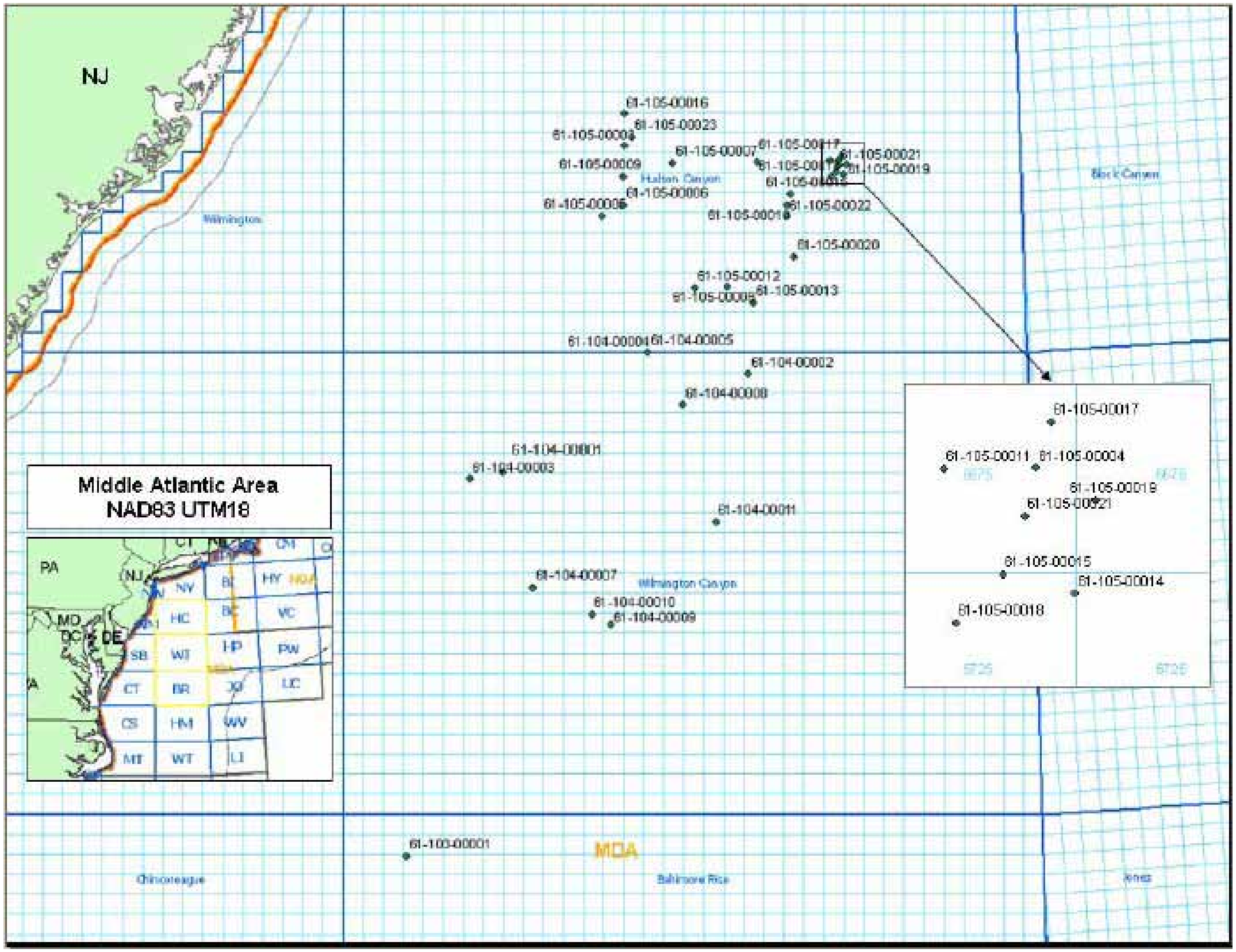

Figure 6.16 Oil platform locations in the mid-Atlantic. Source: MMS

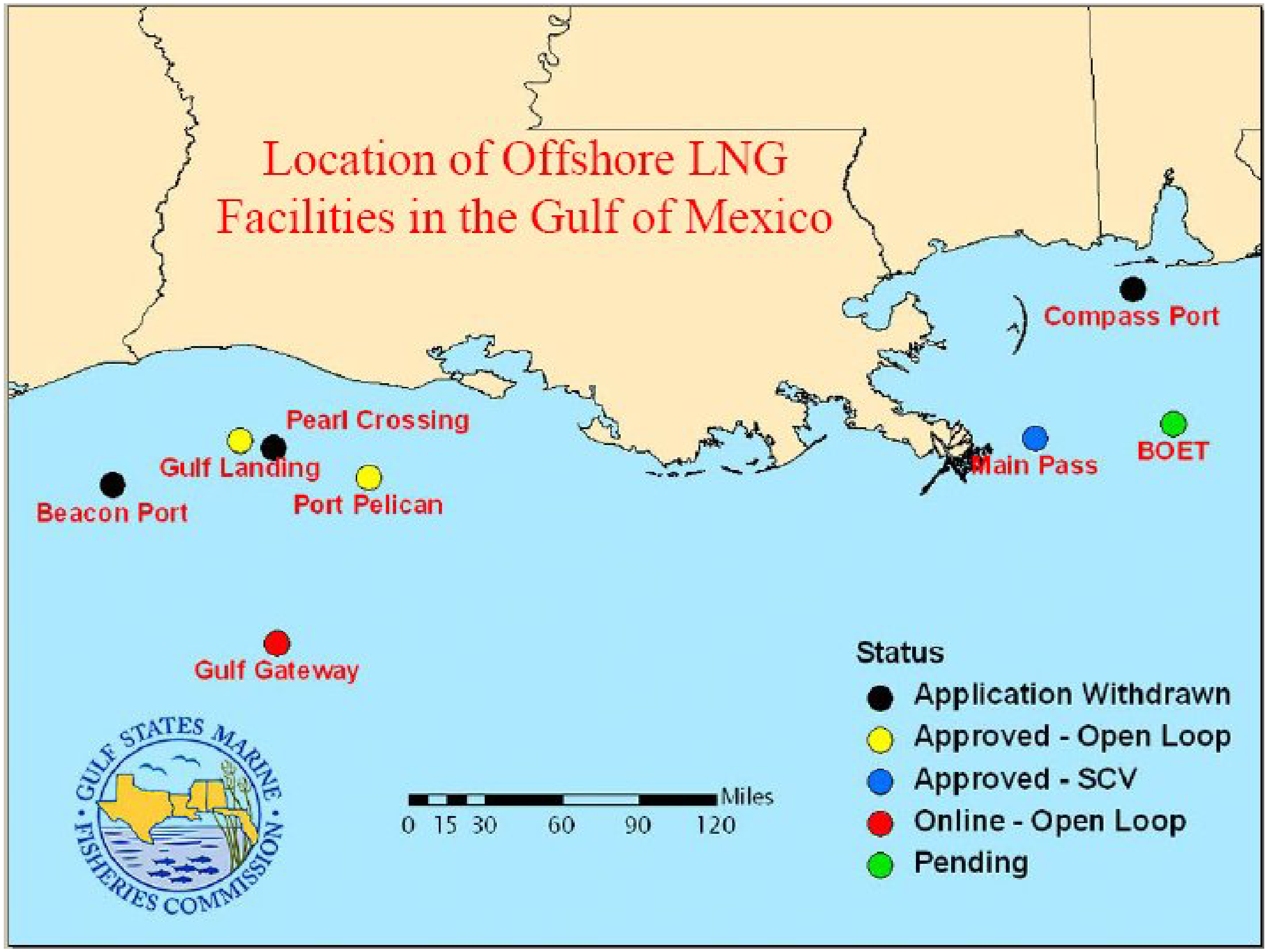

Figure 6.17 Proposed offshore liquefied natural gas (LNG) facilities in the Gulf of Mexico. Source: GSMFC.

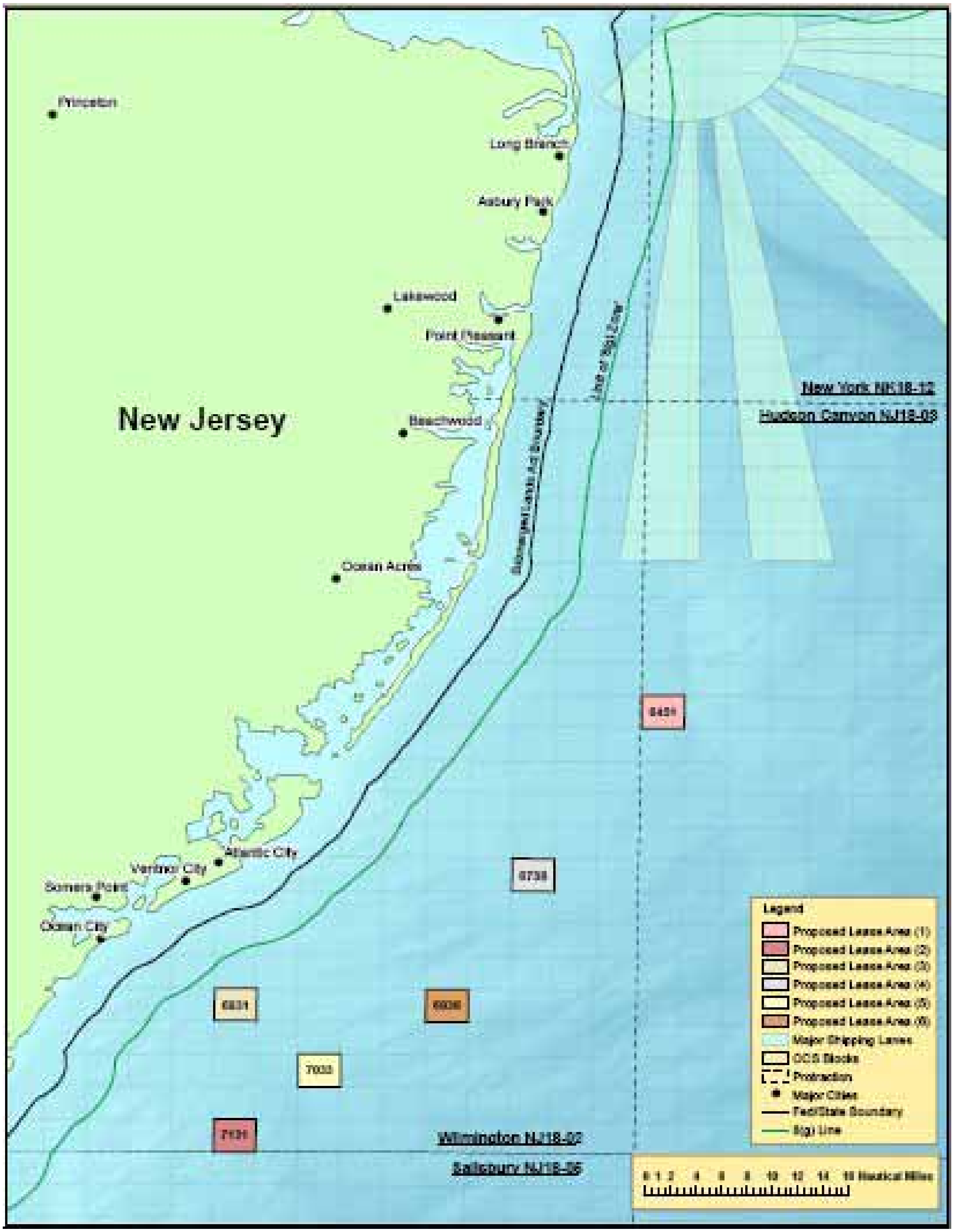

Figure 6.18 Locations for proposed renewable energy projects off New Jersey. Source: MMS

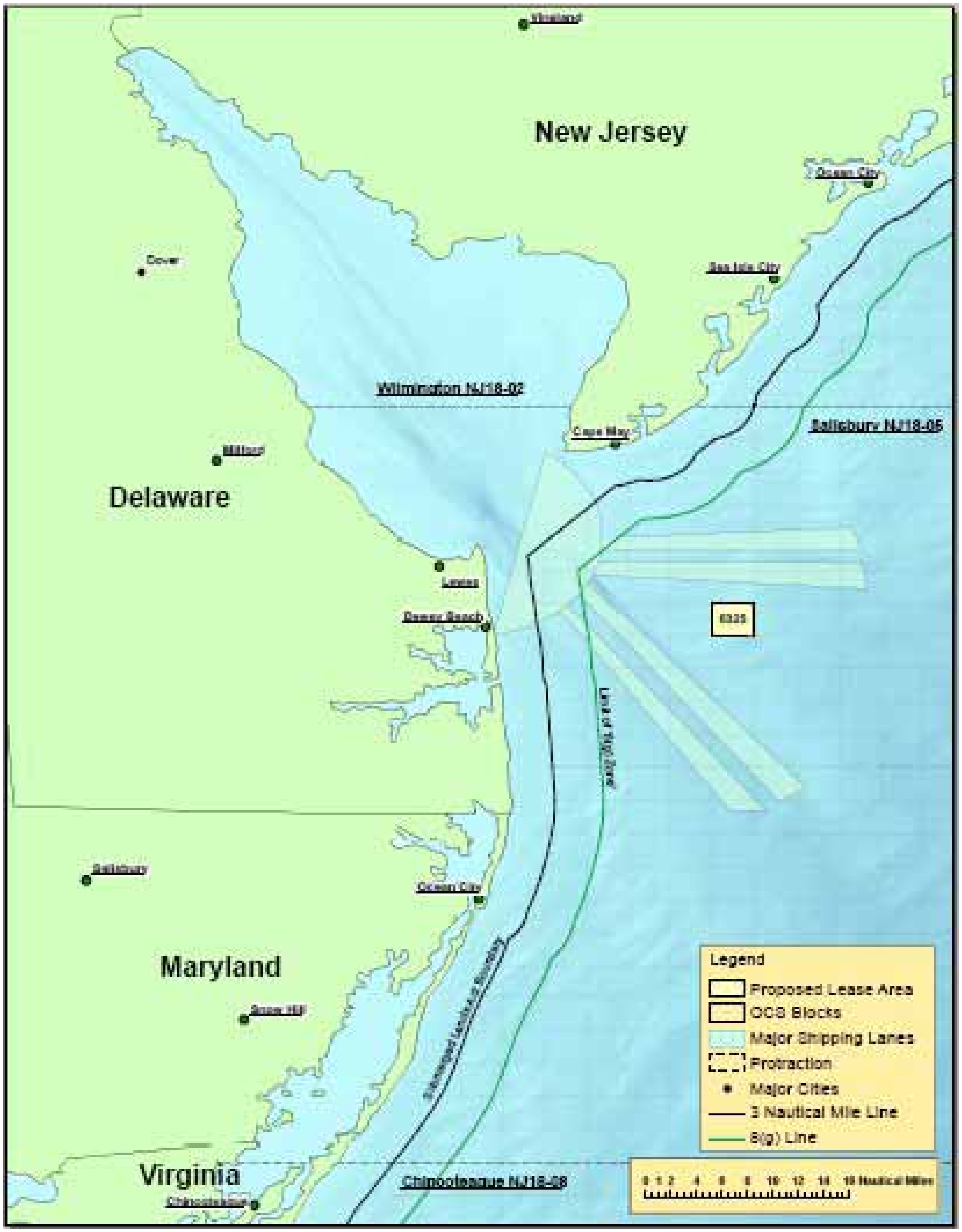

Figure 6.19 Locations for proposed renewable energy projects off Delaware. Source: MMS

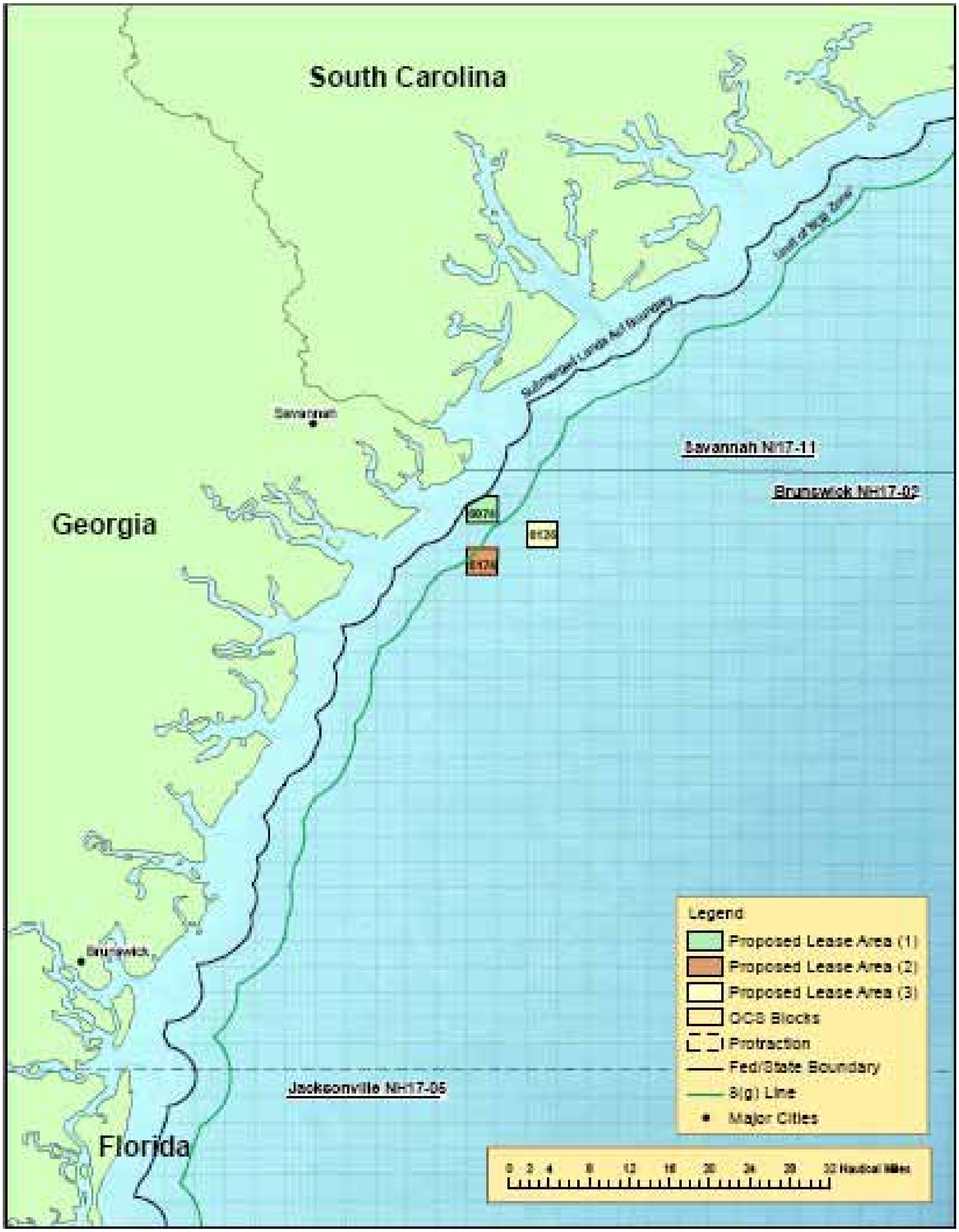

Figure 6.20 Locations for proposed renewable energy projects off Georgia. Source: MMS

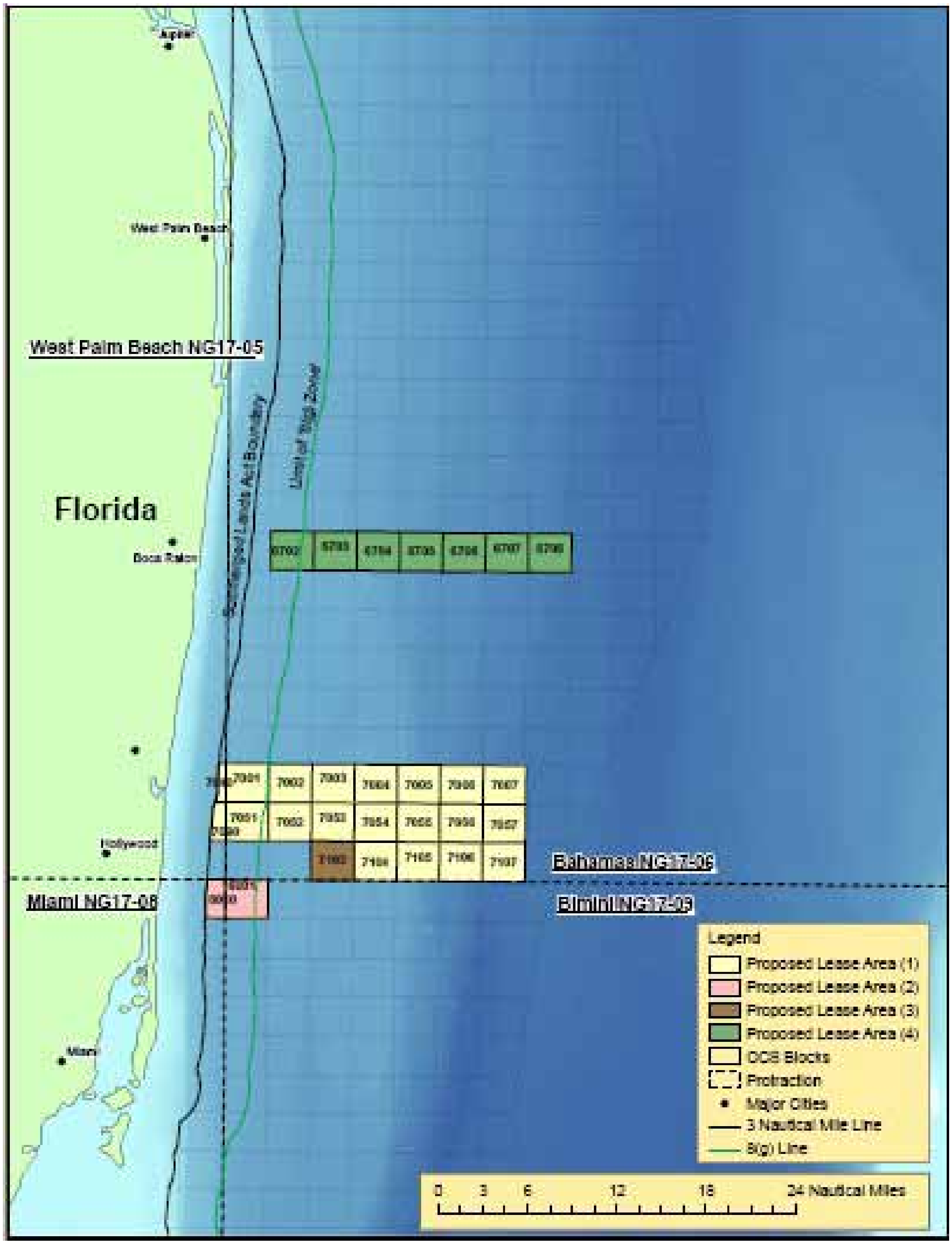

Figure 6.21 Locations for proposed renewable energy projects off Florida. Source: MMS

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7.0 RESEARCH AND INFORMATION NEEDS

Although a substantial amount of research regarding HMS and habitat associations has been conducted since publication of the 1999 FMP, there are still considerable information gaps. In many cases the movements of these animals are still not well understood or have only been defined in broad terms. Furthermore, although the habitats through which these animals transit may be intensely studied, and the physical and biological processes fairly well understood in broad terms, there is little understanding of the particular characteristics that influence the distribution of tuna, swordfish, sharks, and billfish within those systems. Unlike many estuarine or coral reef species that can be easily observed, collected or cultured, the extensive mobility and elusiveness of the species, combined with their rarity, has delayed the generation of much of the basic biological and ecological information needed to analyze their habitat affinities. Based on the present state of information concerning the habitat associations of HMS, the following research and information needs have been identified.

Tuna and swordfish

Ecosystem Structure and Function

- Investigate the influence of habitat characteristics such as temperature (*e.g.*, the relation to thermal fronts) and salinity on tuna and swordfish distributions, spatially as well as seasonally.

- Monitor animal movements using advanced archival and satellite telemetry technology in order to better define tuna and swordfish distributions, seasonality, environmental tolerances and preferred habitats.

- Identify spawning areas and investigate the role of environmental factors which affect distribution and survival of larval and juvenile tuna and swordfish, leading to variations in year class abundance.

- Characterize submarine canyon processes, eddies, gyres, and fronts as they interact with tuna and swordfish and characterize their importance as zones of aggregation.

- Further identify major prey species for tuna and swordfish, including preferred feeding areas and influences of environmental factors.

- Gain a better understanding of the life histories of tuna and swordfish, including the development of culture methods to keep tuna and swordfish alive in captivity for life history studies.

- Improve the capability to identify tuna and swordfish eggs and early life stages of these species.

- Expand investigations of BFT movement and stock structure, and determine the levels of each stock on mixing grounds of the western Atlantic and the central North Atlantic.

- Improve our understanding of BFT movements during the first year(s) of life to help elucidate migration paths of juveniles.

- Characterize BFT natal homing behavior to spawning grounds in the Gulf of Mexico and Mediterranean to provide more information on spawning migrations and behavior.

- Develop a detailed model for the breeding habitat of BFT in the Gulf of Mexico and determine their essential breeding habitat.

Effects of Habitat Alteration

- Identify fisheries that operate in tuna and swordfish EFH and characterize threats to tuna and swordfish EFH, particularly spawning and nursery areas.

- Investigate the effects of contaminants on tuna and swordfish life stages, especially eggs and larvae; this would require the development of better laboratory culture techniques for these species.

- Determine the effects of contaminants (*e.g*., oil spills) in offshore epipelagic habitats where tuna and swordfish are known to spawn or otherwise aggregate.

- Identify habitat linkages between inshore and offshore habitats to better define the zone of influence for inshore activities that may adversely affect tuna and swordfish habitats.

Synthesis and Information Transfer

- Incorporate/develop spatially consistent databases of environmental conditions throughout the tuna and swordfish ranges (*e.g.*, temperature, salinity, currents).

- Further analyze fishery dependent data to construct a clearer view of relative abundances.

- Contour abundance information to better visualize areas where tuna and swordfish are most commonly encountered.

- Construct spatial databases for early life history stages (*i.e.*, eggs and larvae).

- Derive objective criteria to model areas of likelihood for relative abundances of tuna and swordfish based on environmental parameters.

- Define and model habitat suitability based on seasonal analyses of tolerances of environmental conditions.

Sharks

Ecosystem Structure and Function

- Continue the delineation of shark nurseries using a more quantitative approach beyond simple presence-absence information; establish the geographic boundaries of the summer nurseries of commercially important species.

- Determine the location of the winter residency areas using a more quantitative approach beyond simple presence-absence information

- Expand the use of acoustic telemetry and satellite archival tags in shark species, particularly of juvenile shark in seasonal migrations, to better define locations, distributions, and environmental tolerances.

- Determine if sharks return to their natal nurseries; determine if females exhibit philopatry.

- Determine growth and survival rates of each life stage

- Determine biotic and abiotic relationships such as temperature (*e.g.*, the relation to thermal fronts) and salinity spatially as well as seasonally; determine the significance of areas of aggregation; determine the role of coastal/inshore habitats in supporting neonates and juveniles.

- Expand current models for delineating EFH for shark nursery grounds to include water quality and other anthropogenic variables that potentially influence distribution.

- Study the physiological responses of juvenile sharks to organochlorine contaminant exposure in order to understand how these pollutants may impact reproduction and subsequently population growth.

- Information on shark populations and their dynamics within nursery areas, including short- and long-term movement patterns.

- Evaluate tidal marshes and other coastal habitats for their importance in sustaining shark populations.

- Examine the role of sharks in regulating ecosystem structure.

- Expand the knowledge of barrier island/shark interactions in the Gulf of Mexico, including diel movements and prey species.

- Studies on shark community dynamics, including how inter- and intra-specific interactions between shark species and size classes influence their distributions.

- Research as to the cues that trigger movement to and from EFH, including nurseries.

- Further understand how shark species utilize coastal habitats on a diel basis.

- Determine factors that determine the carrying capacity of nursery areas; determine factors that regulate shark population dynamics in a location, nursery area selection, habitat use within nurseries, effects of human disturbance.

Effects of Habitat Alteration

- Document the effects of anthropogenic disturbance on the distribution, abundance and survival of neonates and juveniles in inshore and estuarine areas.

- Identify fisheries that operate in shark EFH and characterize threats from fishery practices to shark EFH, particularly nursery areas.

- Identify the types of habitats shark bottom longline gear is set on and its potential impact to the benthic environment.

Synthesis and Information Transfer

- Incorporate/develop spatially consistent databases of environmental conditions throughout the sharks' ranges (*e.g.*, temperature, salinity, currents).

- Further analyze historic and current fishery independent data to construct a clearer view of relative abundances.

- Contour abundance information to better visualize areas where sharks are most commonly encountered.

- Construct spatial databases for early life history stages (neonates and early juveniles), incorporating seasonal changes.

- Derive objective criteria to model areas of likelihood for relative abundances of sharks based on environmental parameters.

- Define and model habitat suitability based on seasonal analyses of species tolerances of environmental conditions.

Billfish

Ecosystem Structure and Function

- Investigate the influence of habitat characteristics such as temperature (*e.g.*, the relation to thermal fronts) and salinity on billfish distributions, spatially as well as seasonally.

- Monitor animal movements using advanced archival and satellite telemetry technology in order to better define billfish distributions, seasonality, environmental tolerances and preferred habitats; have longer monitoring times to capture seasonality in the tag deployments.

- Monitor long-term, large scale movements of billfish populations, critical for defining, assessing, and managing their stocks.

- Identify spawning, nursery and feeding habitats.

- Investigate the role of environmental factors which affect distribution and survival of larvae and juveniles, leading to variations in year class abundance.

- Characterize submarine canyon processes, eddies, gyres, and fronts as they interact with billfish and characterize their importance as zones of aggregation.

- Further identify major prey species for billfish, including preferred feeding areas and influences of environmental factors.

- Gain a better understanding of the life history of billfish, including age and growth; develop culture methods to keep billfish alive in captivity for life history studies.

- Develop new methods for identifying billfish eggs, larvae and juveniles, gender, and state of maturity; in particular, develop techniques to better distinguish roundscale spearfish from white marlin to more accurately determine abundances of each and conduct spatial and temporal comparisons.

- Develop alternative innovative stock assessment models to better estimate the level of bycatch of billfish in different fisheries.

- Develop fishery independent indices of abundance for billfish.

- Obtain more detailed spatio-temporal information on the distribution of marlin reproduction and the identification of nursery areas for management decisions.

- Expand reproductive studies on a regional scale to further define essential fish habitat for billfish – may require major research vessel time to accomplish this.

- Conduct post-release survival studies for recreational and commercial fisheries.

Effects of Habitat Alteration

- Investigate the effects of contaminants on billfish life stages, especially eggs and larvae; this would require the development of better laboratory culture techniques for these species.

- Determine the effects of contaminants (*e.g.*, oil spills) in offshore epipelagic habitats where billfish are known to spawn or otherwise aggregate.

- Identify habitat linkages between inshore and offshore habitats to better define the zone of influence for inshore activities that may adversely affect billfish habitats.

Synthesis and Information Transfer

- Incorporate/develop spatially consistent databases of environmental conditions throughout the billfish ranges (*e.g.*, temperature, salinity, currents).

- Further analyze fishery dependent data to construct a clearer view of relative abundances.

- Contour abundance information to better visualize areas where billfish are most commonly encountered.

- Construct spatial databases for early life history stages (*i.e.*, eggs and larvae).

- Derive objective criteria to model areas of likelihood for relative abundances of billfish based on environmental parameters.

- Define and model habitat suitability based on seasonal analyses of tolerances of environmental conditions.

- Define and model habitat suitability based on seasonal analyses of tolerances of environmental conditions.

8.0 LIST OF PREPARERS

The development of this Amendment involved input from many people within National Marine Fisheries Service (NMFS), NMFS contractors, and input from constituent groups including the Highly Migratory Species (HMS) Advisory Panel. Staff and contractors from the HMS Management Division, in alphabetical order, who worked on this document include:

Jess Beck, PhD, Knauss Fellow
Randy Blankinship, MS, Fishery Management Specialist
Mike Clark, MS, Fishery Management Specialist
Craig Cockrell, BS, Contractor
Peter Cooper, MS, Fishery Management Specialist
Doug Graham, Cartographer
Sari Kiraly, MS, Fishery Management Specialist
Eric Orbesen, MS, Fishery Management Specialist
Chris Rilling, MS, Fishery Management Specialist
Margo Schulze-Haugen, MS, Fishery Management Specialist
Jackie Wilson, PhD, Fishery Management Specialist

The development of this document also involved considerable input from other staff members and Offices throughout NOAA including, but not limited to:

- The Southeast Fisheries Science Center (John Carlson, Katie Siegfried, Lori Hale, Dana Bethea, Eric Prince, John Lamkin, Joe Serafy);
- The Northeast Fisheries Science Center (Nancy Kohler, Cami McCandless);
- NOAA General Counsel (Stacey Nathanson, Megan Walline); and
- NMFS NEPA staff (Aileen Smith, Steve Kokkinakas, Cristi Reid).

8.1 List of Agencies, Organizations, and Persons Consulted and to Whom Copies of the Draft EIS Will Be Sent

Under 304(g)(1)(A) of the Magnuson-Stevens Act, NMFS is required to consult with and consider comments and view of affected Counils, commissioners and advisory groups appointed under Acts implementing relevant international fishery agreements pertaining to highly migratory species. NMFS will consult with, and provide copies of the DEIS to the Atlantic and Gulf States Marine Fisheries Commissions, the Northeast, Mid-Atlantic, South Atlantic, Gulf of Mexico, and Caribbean Fishery Management Councils, and the HMS Advisory Panel.

On December 16, 2004, the Office of Management and Budget (OMB) issued a directive requiring Federal Agencies to have "influential scientific information" and "highly influential scientific assessments" peer reviewed. NMFS decided that the Draft Amendment 1 to the Consolidated Atlantic HMS FMP could contain "influential scientific information," which is defined as: scientific information (factual inputs, data, models, analyses, technical information, or scientific assessments) that the Agency reasonably can determine does have or will have a clear and substantial impact on important public policies or private sector decisions. As such, NMFS has requested three scientists who were not involved in the drafting of Amendment 1 to the Consolidated HMS FMP to review certain sections of the Draft Amendment.

Per the OMB peer review bulletin, NMFS requested that the peer review evaluate the clarity of hypotheses, the validity of the research design, the quality of data collection procedures, the robustness of the methods employed, the appropriateness of the methods for the hypotheses being tested, the extent to which the conclusions follow from the analysis, and the strengths and limitations of the overall product. The peer reviews will be used, as appropriate, to clarify assumptions, findings, and conclusions of the alternatives analyzed in the Final Amendment 1 to the Consolidated HMS FMP. The reviews and NMFS' responses will be provided in the Final Amendment 1 to the Consolidated HMS FMP.

Copies of the DEIS will be distributed to:

Highly Migratory Species Advisory Panel

New England Fishery Management Council
50 Water Street, Mill 2
Newburyport, MA 01950

Mid-Atlantic Fishery Management Council
Suite 2115 Federal Bldg.
300 S. New St
Dover, DE 19904-6726

South Atlantic Fishery Management Council
4055 Faber Place Drive, Suite 201
North Charleston, SC 29405

Gulf of Mexico Fishery Management Council
2203 N. Lois Avenue, Suite 1100
Tampa, FL 33607

Caribbean Fishery Management Council
268 Muñoz Rivera Ave.,
Suite 1108
San Juan, Puerto Rico 00918-1920

Atlantic States Marine Fisheries Commission
1444 Eye Street, NW
Sixth Floor
Washington, DC 20005

Gulf States Marine Fisheries Commission
P.O. Box 726
Ocean Springs, Mississippi 39566-0726

U.S. Environmental Protection Agency
Ariel Rios Building
1200 Pennsylvania Avenue, N.W.
Washington, DC 20460

9.0 APPENDIX 1 – SCOPING COMMENTS

Scoping is the first phase in preparing a Fishery Management Plan (FMP), FMP Amendment, Environmental Impact Statement, or Environmental Assessment associated with a proposed rulemaking. During the scoping process, the public is given the opportunity to consider and comment on the proposed action(s) and related issues. In Amendment 1 to the Consolidated HMS FMP, NMFS is re-examining areas identified as HMS EFH in light of new information that has become available since EFH was originally delineated in the 1999 FMP, and will modify the boundaries, if warranted. In doing so, NMFS will develop and examine a range of alternatives for action, but may also consider the option of maintaining the current EFH boundaries, if appropriate. Comments received during the scoping process are summarized below. Verbal comments received during the joint scoping and HMS Advisory Panel meeting held on March 15, 2007, are also included. In addition, two written comments were received and are summarized below.

The comments offered at the scoping meeting generally fall into four broad categories: data considerations, extent of EFH, impacts on EFH, and Habitat Areas of Particular Concern (HAPCs).

Data Considerations

Comment 1: NMFS is using fish encounter data to define EFH. Encounter data, however, is not weighted by the amount of fishing effort. Areas with less fishing effort may also be important EFH. Also, if a species is declining in abundance, then designating EFH by encounter rates would result in EFH decreasing over time when EFH identification would be even more critical. Pelagic EFH exists in space and time and NMFS needs to look at seasonal variations, as well.

Comment 2: NMFS needs to adjust data for differences in fishing effort. Presence-absence data is prone to clumping due to effort. There are data clumps off Daytona Beach, Florida because a lot of sharks are being caught there. For blacktip, NMFS shows EFH in the northern Gulf of Mexico. The entire area from Mobile Bay to central Louisiana is not just EFH but a fish ecosystem unique to North America that is highly productive for finfish and crustaceans. Is there another direction we should be heading that is away from EFH and maybe toward something like the ecosystem approach?

Extent of EFH

Comment 3: EFH is too broadly defined. The definition has not changed since 1998. Recreational and commercial fisheries see EFH as forage base and nursery areas, and the areas should thus be narrowed down. There is a concern that EFH may encompass overly large areas.

Comment 4: The 10 mile buffer zones for coastal and 20 for pelagics are wide areas, particularly if one considers coastal species on the shelf. Off the coast of Florida a 10-20 nautical mile buffer would put you in Bahamian waters. Therefore, the buffers may be too large.

Comment 5: Are warm water eddies EFH? Recreational fishermen fish warm water eddies because they are legitimate ecosystems. If one has to fish 10 miles away from these, it won't work. Buffer zones are being proposed to established boundaries.

Comment 6: EFH needs to be defined to a certain area. Does that include bottom habitat? Is EFH a specific area that has latitude/longitude coordinates? If so, eddies wouldn't be EFH, as they are moving columns of water.

Comment 7: I have experience with winter flounder EFH with Federally permitted projects. The supposed consultation involves the local field office saying "no." My experience is that the person implementing will not care about "notes." They will only consult the map. There is a cascade of effects that I don't think people who originally wrote the EFH guidelines intended. It does affect marina operations. I know you can't ignore Congress and we can't be rid of EFH, but it seems there are misnomers going around. The true EFH is a species' essential area, its HAPC; everything else is its range. NMFS should make the EFH as small as possible, because despite the best intentions, one has no idea how it will be extrapolated and implemented by an agency.

Comment 8: There is a proposal by several environmental groups to establish 15 Marine Protected Areas (MPAs), which are best fishing areas (e.g., Stellwagen Bank, Jeffries Ledge). We are constantly fighting Stellwagen Bank; it is worrisome that someone will take any excuse to close it out.

Impacts on EFH

Comment 19: NMFS should include predator-prey relationships in the FMP. Loss of prey species can have an adverse affect on EFH. It can degrade feeding habitat. This would be effective if NMFS issues guidance to the Councils on how they should manage, for example, squid and herring for bluefin tuna (BFT). For BFT and swordfish, identifying key prey species is important, but the management of prey species falls to the Councils. The Councils need guidance from NMFS, which should provide more information on predator–prey relationships.

Comment 10: Make it clear in the FMP Amendment that the greatest benefit to establishing EFH is requiring major projects to consult with NMFS. It is good to hear that NMFS is not focusing on fishing data that affect fishermen.

Comment 11: How does something get labeled EFH? The South Atlantic Fishery Management Council (SAFMC) has asked you to complement their closures and ban bottom longline (BLL) gear. One SAFMC closure is off North Carolina, and it shows where people have been fishing with BLL. Doesn't there have to be some type of data to be able to ban gear in those different areas? There should be a biological reason to ban gear. These areas that you have labeled as EFH are the whole range for fishing, and I am concerned they will be banned in the same way – without a biological reason. It appears the SAFMC was on a "fishing expedition." We need to revisit banning BLL.

Comment 12: The SAFMC minutes might imply that there are some people who were on a "fishing expedition." But it has been more about inquiry, looking for information, exploring alternatives, and there are different opinions. Complementary measures were asked because of impact of BLL in those areas.

Comment 13: You said there were no problems with access, even if the area was deemed EFH. If you find a certain area is a spawning area, then how will this affect harvest and rulemaking?

Comment 14: Sargassum is EFH, and I pass through it all the time. It is a little scary because that particular EFH is not the bottom.

Comment 15: Sargassum was identified as EFH by the SAFMC, and the result was to allow very limited harvesting. But no one is prevented from taking boats through it, or fishing around it, which is why it was designated and protected in the first place, so people could continue to use it as prime fishing grounds. We need to find out what needs to be protected and what impacts we can control and those we cannot.

Habitat Areas of Particular Concern

Comment 16: EFH can be meaningful for spawning grounds. There is new research available that indicates spawning in the western Gulf of Mexico. The western Gulf should be raised to a HAPC for BFT.

Comment 17: I support the recommendation that BFT spawning grounds in the Gulf of Mexico be considered HAPC. The northwestern Gulf is a discrete area in space and time for spawning. The status of stock is well known. More scrutiny on fishing impacts on that spawning stock would be well worth the effort.

Comment 18: EFH for adult BFT in the 1999 HMS FMP is incomplete. The Gulf of Mexico EFH should be expanded to include all waters within the U.S. Exclusive Economic Zone that are off the continental shelf and west of 86W longitude. We also recommend that this area be classified as a HAPC, as this region meets the requirements for the strongest designation as a HAPC under the EFH regulations. Establishing these spawning grounds as HAPC is necessary to identify this area as critically important to the long-term productivity of the western BFT population, which is in need of additional levels of protection from adverse impacts.

Comment 19: Are you considering EFH in terms of Mid- and South Atlantic Councils and Atlantic states? Are HAPCs being defined according to the New England Council? Will you incorporate this into the document? New England developed a HAPC package laying out elements that need to be incorporated for HAPC designations. NMFS is taking a top down approach to seeing what is in existence and what others have done in terms of protecting those areas; this is an area we should consider because this is where these animals reside.

Instead we should try to marry bottom up and top down information instead of deciding on whether 10 mile buffers are appropriate.

Shark EFH

Comment 20: There are only 19 of 22 large coastal sharks and 6 of 7 small coastal sharks profiled in the July 2006 HMS FMP text. At the very least, all managed sharks should be included in the EFH update, even if NMFS has little or no knowledge of certain species of sharks.