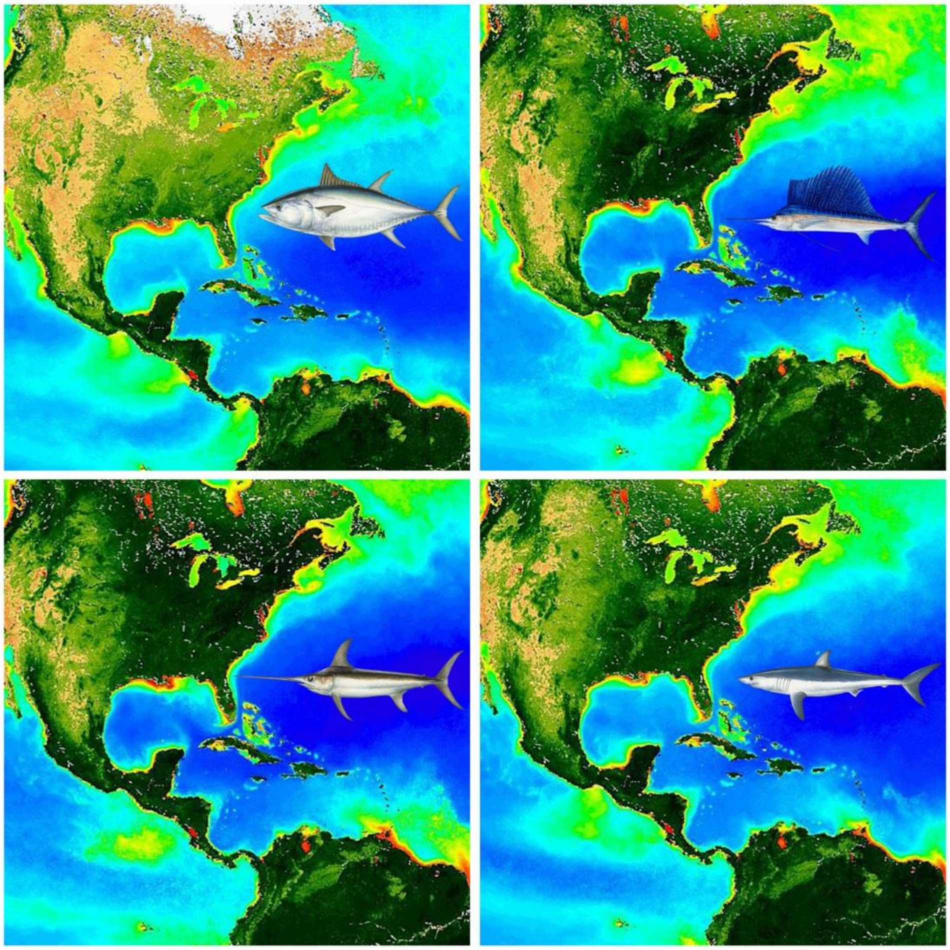
FINAL
Amendment 10 to the 2006 Consolidated Atlantic Highly Migratory Species Fishery Management Plan: Essential Fish Habitat

and Environmental Assessment



Office of Sustainable Fisheries
Atlantic Highly Migratory Species Management Division

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Abstract

Proposed Action: Amendment 10 to the 2006 Consolidated Atlantic Highly Migratory Species Fishery Management Plan to Update Essential Fish Habitat Delineations and Life History Descriptions for Atlantic Highly Migratory Species

Type of statement: Environmental Assessment (EA)

Lead Agency: National Marine Fisheries Service: Office of Sustainable Fisheries

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Abstract:

The National Marine Fisheries Service is amending the 2006 Consolidated Atlantic Highly Migratory Species (HMS) Fishery Management Plan (FMP) based on a review of data and literature relevant to Atlantic HMS Essential Fish Habitat (EFH). The purpose of the amendment is to update existing HMS EFH, designate new and update existing Habitat Areas of Particular Concern for some HMS, and analyze the adverse effects of fishing on EFH consistent with the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) and other relevant Federal laws, including the National Environmental Policy Act. The Magnuson-Stevens Act requires a review and updating of EFH FMP components based on new scientific or other relevant information at least once every five years and an update of the EFH designations accordingly. This final amendment presents the the results and underlying environmental impacts analysis of the statutorily required review and update of EFH for all federally managed Atlantic HMS. New information, including information on the biology, distribution, habitat requirements, life history characteristics, migratory patterns, spawning, pupping, and nursery areas of Atlantic HMS were considered when updating EFH in this final amendment.

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1 INTRODUCTION

1.1 Background

The Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) includes provisions concerning the identification and conservation of essential fish habitat (EFH) (16 U.S.C. 1801 et seq.). EFH is defined in National Marine Fisheries Service (NMFS) implementing regulations as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity” (50 CFR 600.10). NMFS must identify and describe EFH, minimize to the extent practicable the adverse effects of fishing on EFH, and identify other actions to encourage the conservation and enhancement of EFH (600.815). Under NMFS’EFH regulations, an adverse effect is defined as “any impact that reduces quality and/or quantity of EFH.” (Id.).

Federal agencies that authorize, fund, or undertake actions, or propose to authorize, fund or undertake actions that may adversely affect EFH must consult with NMFS as required by § 305(b)(2) of the Magnuson-Stevens Act. Where a state or interstate fishing activity adversely affects EFH, NMFS will consider that action to be an adverse effect and will provide EFH Conservation Recommendations to the appropriate state or interstate fishery management agency on that activity (600.815(c)).

1.2 Management History

NMFS issued a Fishery Management Plan (FMP) in April 1999 for Atlantic Tunas, Swordfish, and Sharks (1999 FMP), combining, amending, and replacing previous FMPs for swordfish and sharks, and creating the first FMP for tunas. It identified and described EFH for Atlantic tunas, swordfish, and sharks. Habitat Areas of Particular Concern (HAPCs) were also identified and described for sandbar sharks. The FMP for billfishes was issued in 1988, and in 1999, Amendment 1 to the 1988 Billfish FMP identified and described EFH for billfishes. In both the 1988 Billfish FMP and Amendment 1 to the 1988 Billfish FMP, there were some billfishes for which insufficient information prevented identification and description of EFH; therefore, no EFH was delineated for those species.

In November 2003, NMFS issued Amendment 1 to the 1999 FMP, which, among other things, updated EFH for five shark species due to changes in stock status (blacktip shark, which was no longer overfished; sandbar shark, for which overfishing was occurring; and finetooth shark, for which overfishing was occurring) and due to new information that had become available at that time (dusky shark and nurse shark). 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 or swordfish. No new HAPCs were implemented at that time, and NMFS did not update EFH for any of the other species in the management unit.

Table 1 Species Managed under the 2006 Consolidated Atlantic HMS FMP and its Amendments

Common Name	*Scientific Name*	Common Name	*Scientific Name*
Skipjack tuna	*Katsuwonus pelamis*	Sandbar shark	*Carcharhinus plumbeus*
Albacore tuna	*Thunnus alalunga*	Smalltail shark	*Carcharhinus porosus*
Yellowfin tuna	*Thunnus albacares*	Night shark	*Carcharhinus signatus*
Bigeye tuna	*Thunnus obesus*	Sand tiger	*Carcharias taurus*
Bluefin tuna	*Thunnus thynnus*	White shark	*Carcharodon carcharias*
		Basking shark	*Cetorhinus maximus*
Swordfish	*Xiphias gladius*	Tiger shark	*Galeocerdo cuvier*
		Nurse shark	*Ginglymostoma cirratum*
Sailfish	*Istiophorus platypterus*	Sevengill shark	*Heptranchias perlo*
White marlin	*Kajikia albida*	Sixgill shark	*Hexanchus griseus*
Blue marlin	*Makaira nigricans*	Bigeye sixgill shark	*Hexanchus nakamurai*
Roundscale spearfish	*Tetrapturus georgii*	Shortfin mako	*Isurus oxyrinchus*
Longbill spearfish	*Tetrapturus pfluegeri*	Longfin mako	*Isurus paucus*
		Porbeagle	*Lamna nasus*
Bigeye thresher shark	*Alopias superciliosus*	Smooth dogfish	*Mustelus canis*
Thresher shark	*Alopias vulpinus*	Florida smoothhound	*Mustelus norrisi*
Blacknose shark	*Carcharhinus acronotus*	Gulf smoothhound	*Mustelus sinusmexicanus*
Bignose shark	*Carcharhinus altimus*	Lemon shark	*Negaprion brevirostris*
Narrowtooth shark	*Carcharhinus brachyurus*	Bigeye sand tiger	*Odontaspis noronhai*
Spinner shark	*Carcharhinus brevipinna*	Blue shark	*Prionace glauca*
Silky shark	*Carcharhinus falciformis*	Whale shark	*Rhincodon typus*
Galapagos shark	*Carcharhinus galapagensis*	Caribbean sharpnose shark	*Rhizoprionodon porosus*
Finetooth shark	*Carcharhinus isodon*	Atlantic sharpnose shark	*Rhizoprionodon terraenovae*
Bull shark	*Carcharhinus leucas*	Scalloped hammerhead	*Sphyrna lewini*
Blacktip shark	*Carcharhinus limbatus*	Great hammerhead	*Sphyrna mokarran*
Oceanic whitetip shark	*Carcharhinus longimanus*	Bonnethead	*Sphyrna tiburo*
Dusky shark	*Carcharhinus obscurus*	Smooth hammerhead	*Sphyrna zygaena*
Caribbean reef shark	*Carcharhinus perezii*	Atlantic angel shark	*Squatina dumerili*

NMFS began the comprehensive review (referred to as Phase 1) of all Atlantic HMS EFH as part of the 2006 Consolidated Atlantic HMS FMP, which was released on July 14, 2006 (71 FR 40096). In that document, 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. The 2006 Consolidated Atlantic 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 under Phase 1, NMFS searched for all new literature and information 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 and are described in Chapter 10 of the 2006 Consolidated Atlantic HMS FMP. Based on this evaluation, NMFS determined that modification to existing EFH for some species and/or life stages was warranted, and that any changes to EFH, including new HAPCs and potential measures to minimize fishing effects, should be considered in a separate amendment (referred to as Phase 2). NMFS also conducted a comprehensive review of all federally- and non-federally managed fishing gears that formed the basis for further analysis on gear impacts.

All EFH text descriptions and maps previously provided in separate documents (e.g., the 1999 FMP, Amendment 1 to the Billfish FMP (1999), and Amendment 1 to the 1999 FMP for Sharks, Tuna and Swordfish (2003)) were combined in the 2006 Consolidated Atlantic HMS FMP.

Several subsequent HMS actions have directly identified and described EFH, including Amendments 1 and 3 and an interpretive rule and final action on roundscale spearfish. In 2009, NMFS completed Phase 2 of the 5-Year Review and update of EFH for Atlantic HMS in Amendment 1 to the 2006 Consolidated Atlantic HMS FMP (Amendment 1; June 12, 2009; 74 FR 28018). In Amendment 1, NMFS updated and revised existing identifications and descriptions of EFH for Atlantic HMS, designated a HAPC for bluefin tuna in the Gulf of Mexico, and analyzed fishing and non-fishing effects on EFH pursuant to §305(b) of the Magnuson-Stevens Act.

Amendment 3 to the 2006 Consolidated HMS FMP (75 FR 30484; June 1, 2010) added the smoothhound shark management group to the Atlantic HMS management unit and designated EFH for the group. Details, including a map of the final EFH, are available in Chapter 11 of Amendment 3.

An interpretive rule and final action (75 FR 57698; September 22, 2010) added roundscale spearfish to the Atlantic HMS management unit and defined its EFH. Roundscale spearfish and white marlin (whose genus was also updated to *Kajikia*) were previously managed as one species and historic data on habitat distribution likely included both species; therefore, the designation of roundscale spearfish EFH was the same as the designation of EFH for white marlin in Amendment 1.

Since then, as detailed in the following section, NMFS completed its latest 5-Year Review for Atlantic HMS EFH on June 30, 2015 to meet the requirement that a review of information available on EFH must be completed at least once every five years, and EFH provisions must be revised or amended, as warranted (§ 600.815(a)(10)).

1.3 Approach

The 2015 EFH 5-Year Review evaluated published scientific literature, unpublished scientific reports, information solicited from interested parties, and previously unavailable or inaccessible data. NMFS announced the initiation of this review and solicited information for this review from the public in a Federal Register notice on March 24, 2014 (79 FR 15959). The initial public review/submission period ended on May 23, 2014. The draft EFH 5-Year Review was made available in March 2015, and public comments on the draft were solicited in a Federal Register notice on March 5, 2015 (80 FR 11981). The public comment period for the draft EFH 5-Year Review ended on April 6, 2015.

The final EFH 5-Year Review for Atlantic HMS included tunas (bluefin, bigeye, albacore, yellowfin, and skipjack), oceanic sharks, swordfish, and billfishes (blue marlin, white marlin, sailfish, roundscale spearfish, and longbill spearfish). The Atlantic HMS EFH 5-Year Review considered data regarding Atlantic HMS and their habitats from 2009 to date, as relevant information available during this period was not considered in Final Amendment 1 to the 2006 Consolidated Atlantic HMS FMP (75 FR 30484; June 1, 2010); Final Environmental Impact Statement (EIS) for Amendment 3 to the 2006 Consolidated HMS FMP (75 FR 30484; June 1, 2010); and the interpretive rule that described EFH for roundscale spearfish (75 FR 57698; September 22, 2010).

NMFS analyzed the information gathered through the EFH review process, and the final EFH 5-Year Review notice of availability was published on July 1, 2015 (80 FR 37598). Based on this review NMFS determined that a revision of HMS EFH was warranted, and an amendment to the 2006 Consolidated Atlantic HMS FMP would be undertaken. EFH should be periodically reviewed and amended as warranted based on new scientific evidence or other relevant information at least once every five years. A review of literature published in 2009 and the following years provided new information for certain Atlantic HMS that warranted revision to EFH geographic boundaries for those species. For other Atlantic HMS, NMFS did not identify new data that warranted revisions to EFH geographic boundaries. In addition, databases supporting long-standing sampling programs that were previously utilized in Amendment 1 (e.g., NMFS observer data, NMFS bottom longline (BLL) shark survey) were updated annually with new data that should be incorporated into the analyses.

In the 5-Year Review, NMFS also re-evaluated the methodologies used to designate EFH geographic boundaries for Atlantic HMS, considering new information as appropriate. The EFH methodology used in this final amendment was first developed and applied in Amendment 1. In Amendment 1, NMFS selected this EFH methodology after evaluating four alternatives to delineate EFH, which ranged between a no action alternative, consideration of the full range of a species as EFH, and two analysis methods that would reduce EFH to the areas with the highest concentration of data points. NMFS provided comparative EFH maps in Amendment 1 showing how EFH would change based on the analysis methodology. The preferred methodology was selected in Amendment 1 because it was less subjective and more reproducible, and was derived from actual data points instead of data merged and interpolated from a grid. Subsequent review of analysis methodology in the most recent EFH 5-Year Review confirmed that this methodologyis the best approach to designate EFH. More sophisticated models and statistical techniques are available; however, these models require high-resolution catch per unit effort (CPUE) or density data, or concurrent ecological data, which may not be available for Atlantic HMS. Consultation with the Atlantic HMS Advisory Panel and comments received during the public comment period did not yield additional suggestions on EFH delineation methods or suggest that continued use of the Amendment 1 methodology was inappropriate. NMFS provided updates and opportunity for comment at two HMS Advisory Panel meetings held since the finalization of the 2015 Atlantic HMS EFH 5-Year Review, and participants provided no alternate methodology.

During the public comment period for Draft Amendment 10, NMFS received numerous comments in support of the preferred alternative. Although, some commenters expressed concern about the modeling approach used to delineate EFH, they did not identify a better alternative to delineate Atlantic HMS EFH. NMFS, therefore, concluded that the methodology used in Amendment 1 continues to be appropriate and applied that methodology to develop this final amendment. This methodology is described in Appendix F. NMFS may explore alternative models and approaches in the future if identified and appropriate to better account for habitat associations and the spatial distribution of available data (see Appendix H, Response to Comments).

NMFS also determined in the EFH 5-Year Review that modification to current HAPCs and the creation of new HAPCs might be warranted.

Consistent with the regulations at §600.805(a) and §600.815(a)(10), this FMP amendment constitutes the final step in addressing the required EFH provisions to review, revise and if neessary amend EFH information in the 2006 Consolidated Atlantic HMS FMP. This Final Amendment updates previous EFH information contained in the 2006 Consolidated Atlantic HMS FMP, and includes new descriptions and identifications of Atlantic HMS EFH, analysis of potential adverse effects on EFH (including minimizing, to the extent practicable, adverse effects from fishing), and actions to conserve and enhance EFH. NMFS did not make significant changes from the Draft to the Final. EFH has been refined in response to updated information or information provided in comments. For example, since the draft was issued, datasets have been updated with additional datapoints, which has refined our understanding of species location and habitat. These datasets are Level 1, which indicate that presence/absence of a species in a habitat. In response to updated datasets, appropriate, slight modifications were made to incorporate possible habitat locations based on the best information available

1.4 Purpose of and Need for Action

The Magnuson-Stevens Act includes provisions concerning the identification and conservation of EFH (16 U.S.C. 1801 et seq.). EFH is defined in NMFS implementing regulations as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity”

(50 CFR §600.10). NMFS must identify and describe EFH, minimize to the extent practicable the adverse effects of fishing on EFH, and identify other actions to encourage the conservation and enhancement of EFH (§600.815). As part of this final amendment, NMFS examines alternatives for updating existing HMS EFH, modifying and/or considering additional HAPCs, analyzing fishing gear impacts, and, where necessary, identifying ways to avoid or minimize, to the extent practicable, adverse fishing impacts effects on EFH, consistent with the Magnuson-Stevens Act and other relevant Federal laws. Proposed Action

NMFS proposes to update and revise existing HMS EFH following methodology established in Amendment 1 to the 2006 Consolidated HMS FMP; modify current HAPCs for bluefin tuna and sandbar shark; designate new HAPCs for lemon shark and sand tiger shark, as necessary; and analyze fishing and non-fishing effects on EFH by considering environmental and management changes and new information that has become available since 2009.

1.4.1 Purpose

The purpose of this Draft Amendment is to update EFH for Atlantic HMS with the most recent information available, minimize to the extent practicable the adverse effects of fishing activities on EFH, and identify other actions to encourage the conservation and enhancement of EFH.

1.4.2 Need

Through the 5-Year Review process and in consultation with the public and other consulting parties, NMFS identified new information on the biology, distribution, habitat requirements, life history characteristics, migratory patterns, and spawning, pupping, and nursery areas of Atlantic HMS that have become available since the designation of EFH for Atlantic HMS in 2009. Consistent with the requirements of the Magnuson-Stevens Act, and in order to meet the National Standard 2 requirement that conservation and management measures be based on the best scientific information available, NMFS now must further evaluate this new information, update HMS EFH where necessary, consider the modification or designation of HAPCs, and evaluate new information regarding fishing and non-fishing impacts on EFH.

1.5 Scope of the NEPA Analysis

This final Environmental Assessment (EA) analyzes the potential effects of updating HMS EFH, designating HAPCs, and minimizing adverse effects of fishing and non-fishing on EFH. Specifically, it analyzes the potential direct, indirect, and cumulative ecological, social, and economic impacts associated with eight alternatives. While the identification of EFH and HAPCs in itself does not result in any direct environmental, social, or economic impacts, there are indirect impacts that can occur as a result of identifying EFH and HAPCs. Designation of EFH requires Federal Agencies to consult with NMFS on all actions, or proposed actions, authorized, funded, or undertaken by that agency that may adversely affect EFH. NMFS must consider the potential impacts of these actions on EFH and, for actions that would adversely affect EFH, provide EFH conservation recommendations (avoid, minimize, mitigate, or otherwise offset adverse effects) to conserve EFH. Federal agencies must provide a detailed response to NMFS and any Council commenting under §305(b)(3) of the Magnuson-Stevens Act.

In considering this final amendment, NMFS is responsible for complying with a number of Federal regulations, including NEPA. Under NEPA, a draft EA is prepared to determine whether a proposed action is likely to have any significant adverse or beneficial impacts on the human environment. If this analysis identifies no significant environmentalimpacts, the decision maker – in this case NMFS – documents that conclusion and approves the proposed action in a Finding of No Significant Impacts (FONSI). If analysis of a proposed action in a draft EA does identify significant environmental impacts, the decision maker must prepare an EIS to more thoroughly evaluate the potential impacts and potential ways to reduce or mitigate those impacts. In analyizing the potential effects of the alternatives for the draft and final Amendment 10, NMFS did not identify significant impacts that would require the preparation of an EIS for this action.

The purpose of this final EA is to analyze the potential effects of alternatives for updatess and revisions to existing HMS EFH, designats of new or updates to existing HAPCs, and to analyze potential fishing and non-fishing effects on these alternatives. The alternatives are described in detail in Chapter 2, and analyses of any potential effects from the alternatives are presented in Chapter 4. Species-specific life history reviews and EFH text descriptions are presented in Chapter 6. Maps depicting EFH text descriptions are available in Appendix G. Other sections address the required components of EFH (i.e., Fishing and Non-Fishing Effects, Research and Information Needs) and NEPA analyses, supporting information for analyses, and methodology. The following definitions were generally used to characterize the nature of the various impacts and effects evaluated with this EA.

Short- or Long-Term Impacts

These characteristics are determined on a case-by-case basis and do not refer to any rigid time period. In general, short-term impacts are those that would occur only with respect to a particular activity or for a finite period. Long-term impacts are those that are more likely to be persistent and chronic.

Direct or Indirect Impacts

A direct impact is caused by a proposed action and occurs contemporaneously at or near the location of the action. An indirect impact is caused by a proposed action and might occur later in time or be farther removed in distance but still be a reasonably foreseeable outcome of the action. For example, a direct impact of erosion on a stream might include sediment-laden waters in the vicinity of the action, whereas an indirect impact of the same erosion might lead to lack of spawning and result in lowered reproduction rates of indigenous fish downstream.

Minor, Moderate, or Major Impacts

These relative terms are used to characterize the magnitude of an impact. Minor impacts are generally those that might be perceptible but, in their context, are not amenable to measurement because of their relatively minor character. Moderate impacts are those that are more perceptible and, typically, more amenable to quantification or measurement. Major impacts are those that, in their context and due to their intensity (severity), have the potential to meet the thresholds for significance set forth in CEQ regulations (40 CFR 1508.27) and, thus, warrant heightened attention and examination for potential means for mitigation to fulfill the requirements of NEPA.

Adverse or Beneficial Impacts

An adverse impact is one having adverse, unfavorable, or undesirable outcomes on the man-made or natural environment. A beneficial impact is one having positive outcomes on the man-made or natural environment. A single act might result in adverse impacts on one environmental resource and beneficial impacts on another resource.

Adverse Effects on EFH

NMFS has defined an adverse effect for purposes of the MSA EFH provisions to mean any impact that reduces the quality and/or quantity of EFH. Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components. Adverse effects to EFH may result from actions occurring within EFH or outside of EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions (§600.810).

Cumulative Impacts

CEQ regulations implementing NEPA define cumulative impacts as the "impacts on the environment which result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions" (§1508.7). Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time within a geographic area.

Other Applicable Statutory Requirements

In addition to NEPA, NMFS must comply with other Federal statutes and requirements such as Executive Order 12866 and the Regulatory Flexibility Act. This document comprehensively analyzes the alternatives considered for all of these requirements. While some of the sections were written in a way to comply with the specific criteria under these various statutes and requirements, it is the document as a whole that meets these criteria and not any individual sections.

2 SUMMARY OF THE ALTERNATIVES

NEPA requires that any federal agency proposing a major federal action consider all reasonable alternatives, in addition to the proposed and/or preferred actions. The evaluation of alternatives in an EA assists NMFS in ensuring that any unnecessary impacts are avoided through an assessment of alternative ways to achieve the underlying purpose of and need for the project that may result in less environmental harm.

To warrant detailed evaluation, an alternative must be reasonable and meet the purpose and need of the action (see Section 1.4). Screening criteria are used to determine whether an alternative is reasonable. The following discussion identifies the screening criteria used in this EA to evaluate whether an alternative is reasonable; evaluates various alternatives against the screening criteria (including the preferred measures) and identifies those alternatives found to be reasonable; identifies those alternatives found not to be reasonable; and for the latter, the basis for this finding. Alternatives considered but found not to be reasonable are not evaluated in detail in this EA.

Screening Criteria – To be considered "reasonable" for purposes of this EA, an alternative must meet the following criteria:

- *Consistent with the 10 National Standards set forth in the Magnuson-Stevens Act;*
- *Administratively feasible. The costs associated with implementing an alternative cannot be prohibitively exorbitant or require unattainable infrastructure;*
- *Cannot violate other laws (e.g., Shark Conservation Act, Endangered Species Act, and Marine Mammal Protection Act);*
- *Consistent with the 2006 Consolidated Atlantic HMS FMP and its amendments;*
- *Consistent with Essential Fish Habitat provisions of the Magnuson-Stevens Act at §600.805, §600.810, and §600.815;*
- *An alternative related to HAPC designation must be consistent with the HAPC guidelines at §600.815(a)(8); and*
- *An alternative related to HAPC designation must be consistent with the NMFS HAPC policy # 03-201-15 (2006) that indicates the purpose is to focus conservation efforts on localized areas within EFH that are vulnerable to degradation or are especially important ecologically for managed fish.*

This chapter includes a full range of reasonable alternatives designed to meet the purpose and need for the action described in Chapter 1. The environmental, economic, and social impacts of these alternatives are discussed in later chapters. See Chapter 4 for a review of anticipated ecological impacts of the proposed HAPC designations, and Chapter 6 for the review of life history and EFH text descriptions for each Atlantic HMS.

2.1 Essential Fish Habitat Designations

The following alternatives represent a range of options for updating EFH designations. Since the primary data type used to delineate EFH boundaries are species-specific distribution data, NMFS has identified geographic areas, rather than specific habitat types, to determine EFH. Where information was available, NMFS has included specific habitat requirements for each species in the life history and EFH text descriptions; however, the spatial boundaries depicted in the maps in Appendix G and the text descriptions of EFH presented in Chapter 6 for each species would collectively define the EFH boundaries. The method to delineating EFH boundaries under preferred Alternative 2 is the same methodology used in Amendment 1 to the 2006 Consolidated Atlantic HMS FMP and applied to all Atlantic HMS EFH. In Amendment 1, some species had insufficient information or data to identify EFH for individual life stages (adult, juvenile, and young-of-the-year (YOY)/neonate sharks; or adult, juvenile, and egg/larval/spawning tunas, swordfish, or billfishes). For those species, the data for all life stages may have been combined into one comprehensive data set to identify EFH. There were other species (primarily sharks) for which there was insufficient information to identify and describe EFH, either spatially or with descriptions for any lifestage. NMFS determined that the same limitations applied to the delineation of certain species' EFH in Final Amendment 10.

Alternative 1: No Action - Retain current EFH designations

EFH for Atlantic HMS were previously designated or updated in Amendment 1, Amendment 3, and the Roundscale Spearfish Interpretive Rule. These EFH designations were evaluated in the 2015 EFH 5-Year Review, which gathered relevant new information and recommended, based on that information, that NMFS update EFH descriptions and designations for Atlantic HMS. Under this alternative, NMFS would not update the existing EFH designations as a result of the more recent information analyzed in that 5-Year Review. Any EFH conservation recommendations given during a consultation would continue to be based upon the Atlantic HMS EFH information available in 2009.

Alternative 2: (*Preferred*) Update all Atlantic HMS EFH designations with new data collected since 2009, using the methodology established under Amendment 1

In Amendment 1, NMFS considered a number of analytical approaches to mapping and analyzing the data in an effort to develop a methodology that would be reproducible, transparent, and result in specific areas that could be mapped and identified with spatial boundaries. The preferred approach in Amendment 1 was to establish 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 data points for a particular species and life stage and creating a percent volume contour (also referred to as a probability boundary, or in cases where the tools are collectively referenced, the "Kernal Density Estimation / 95 Percent Volume Contour" model). The percent volume contours, with minor adjustments made as necessary based on scientific literature or recommendations from NOAA Fisheries staff in the Southeast Fisheries Science Center (SEFSC) and Northeast Fisheries Science Center (NEFSC), were deemed the EFH boundaries. A detailed description of the tool and the analytical approach used to create the boundary is provided in Chapter 4 of Amendment 1 to the 2006 Consolidated HMS FMP and Appendix F of this final amendment. The probability boundary approach 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 numbers. As described in Amendment 1, use of the 95 percent probability boundary (versus the 70, 80, and 90 probability boundaries) as a proxy for EFH was preferred 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 includes, on average, 95 percent of the points used to generate the probability boundary for a specific species and life stage.

Per 600.805(b)(2), EFH may be described and identified in the United States' Exclusive Economic Zone (EEZ), as defined in §600.10 and in waters outside of the EEZ that are within the scope of the "waters of the United States", as defined in 33 CFR 328.3 . § 600.805(b)(2) . Furthermore, Councils or NMFS may describe, identify, and protect habitats of managed species beyond the exclusive economic zone; however, such habitat may not be considered EFH for the purposes of sections 303(a)(7) and 305(b) of the Magnuson-Stevens Act (50 CFR §600.805(a)(2)). Given these aspects of the EFH regulations, NMFS is carrying forward previous decisions regarding analytical procedures from Amendment 1 that the 95 percent probability boundary should be clipped, or made to match, the existing shoreline and/or the EEZ boundary, depending on where the overlap occurred, as part of the preferred method for delineating EFH boundaries. Based on the recommendations of NMFS scientists in the Northeast and Southeast Fisheries Science Centers during Quality Assurance/Quality Control (QA/QC) and peer review, in cases where it made biological sense NMFS also clipped polygons to specified features or areas (e.g., bathymetric (depth) contours (isobaths), the continental shelf break, Chesapeake Bay). Aside from their inclusion in the maps, where appropriate these recommendations are incorporated in the EFH text descriptions in Chapter 6. For example, if scientific evidence suggests that a species is never found inshore of a depth of 200 meters (m), then the map would be clipped to exclude locations inshore of 200 m and the EFH text description would include a reference to this depth limit.

This approach to designating EFH is demonstrated for representative HMS in Appendix F. Maps depicting the results of analyses for all HMS (i.e., not just the representative species) are available in Appendix G and text descriptions reflecting the spatial boundaries and associated habitat characteristics are included in Chapter 6 for each species.

2.2 Habitat Area of Particular Concern (HAPC) Designations

To further the conservation and enhancement of EFH, the EFH guidelines (§ 600.815(a)(8)) require that FMPs identify specific types or areas of habitat within EFH as HAPCs 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; and
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. Designation of these areas as HAPCs is also intended to bring heightened awareness to the importance of the habitat. 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 adverse effects on EFH. HAPCs can also be used to target areas for research. HAPCs do not require any specific management measures, and a HAPC designation itself does not automatically result in closures or other fishing restrictions. Rather, if appropriate, any future measures to reduce fishing or other adverse effects on habitat would be proposed and analyzed separately and could include gear restrictions, time/area closures, or other measures to minimize impacts on habitat at such time as the information indicates such action is necessary to protect habitat.

In this final amendment, NMFS would modify two existing HAPCs and designate two new HAPCs. NMFS is not proposing any new regulations to protect habitat contained in existing or new HAPCs in this final amendment because NMFS has not identified information that indicates such measures are needed to avoid, minimize, or compensate for adverse effects of HMS fishing or other activities on EFH. The majority of HMS gears are fished in the water column, and do not have a direct impact on habitat. Gear types in Atlantic HMS fisheries which may come into contact with bottom habitats (i.e., BLL and gillnet) were previously determined to have minimal impacts on EFH in the 2006 Consolidated HMS FMP and Amendment 1. For example, those documents analyzed the impacts of shark BLL gear on EFH and determined that while BLL gear in general may adversely affect EFH, the BLL used in the HMS shark BLL fishery had no more than a minimal or temporary effect on the relevant EFH (see Amendment 1, Chapter 6). NMFS completed a review of bottom tending gears for this final amendment (see Chapter 4.9, below), and these conclusions were found to still hold true. EFH conservation recommendations that might be associated with BLL fishing impacts would be specific to individual projects that are subjected to future consultation.

Although adverse effects are not anticipated, NMFS has provided an example list of EFH conservation recommendations in Section 5.1.3 that could address shark BLL fishing impacts; these recommendations could apply to all areas designated as either EFH or HAPCs. This section is included to satisfy the EFH components of FMPs, specifically the Conservation and Enhancement requirements at §600.815(a)(6). Similarly, Chapter 4.9 of this final amendment evaluates and provides EFH conservation recommendations regarding the potential adverse effects of fishing with any other HMS gear types on designated and proposed EFH and HAPCs.

Prior to the implementation of Amendment 10, HAPCs existed for two Atlantic HMS: sandbar sharks and spawning bluefin tuna. Several areas were identified in the 1999 FMP as HAPCs for sandbar sharks, including waters off Chesapeake Bay (Virginia and Maryland), Delaware Bay (Delaware and New Jersey), Great Bay (New Jersey), and the Outer Banks off North Carolina

(NMFS 1999). In Amendment 1, a HAPC was designated for spawning bluefin tuna in the Gulf of Mexico and the existing HAPCs for sandbar sharks were maintained.

In Amendment 10, NMFS considered the alternatives below for modifying existing HAPCs or designating new HAPCs that meet one or more of the criteria in the EFH guidelines, based upon information gathered during the 5-Year Review process, information provided by scientific experts, information provided by the Atlantic HMS Advisory Panel, information provided by the public, and from other information gathered during development of this final amendment.

Alternative 3: Evaluate and, if warranted, modify current HAPCs for Bluefin Tuna

Alternative 3a: No action - Retain current HAPCs for Bluefin Tuna

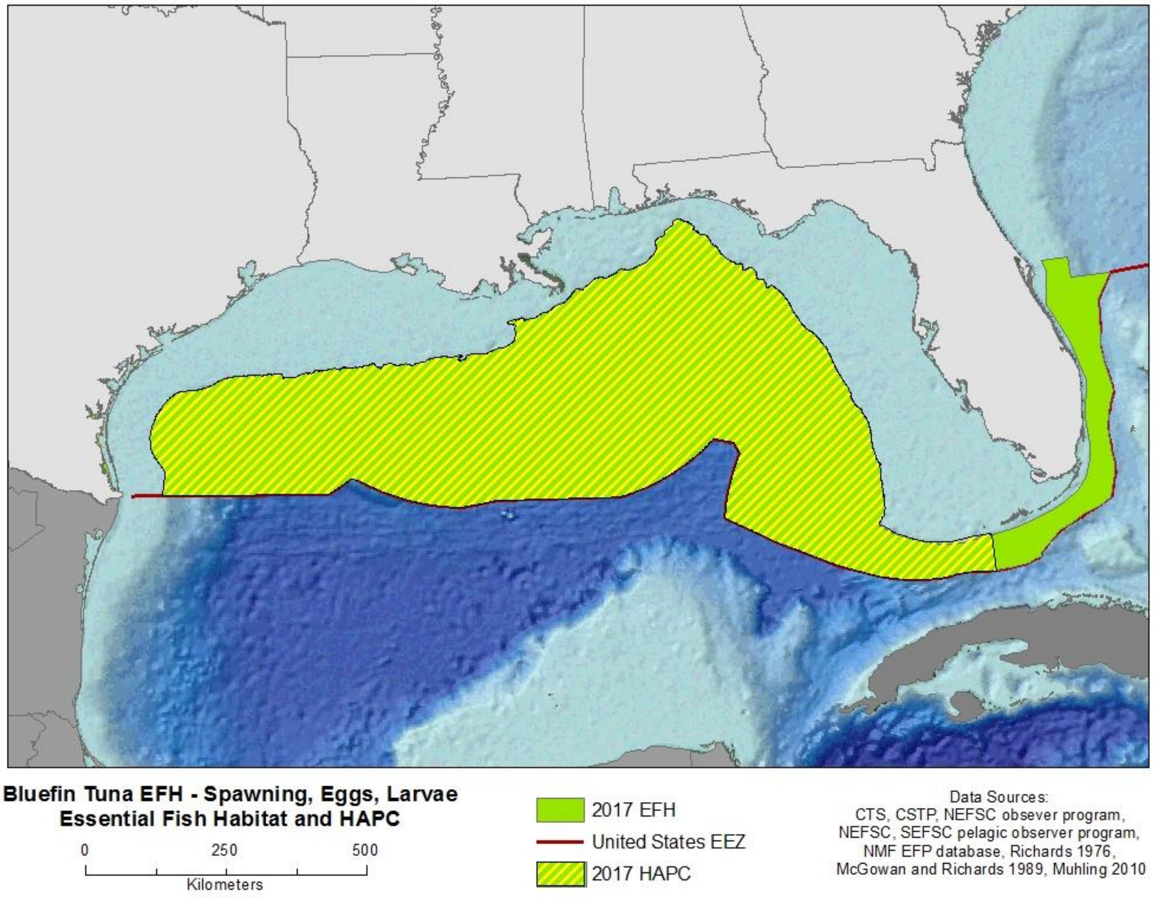
This alternative would retain the current HAPCs for Atlantic bluefin tuna spawning, eggs, and larvae life stage in the Gulf of Mexico. During development of the Final Atlantic HMS EFH 5-Year Review, NMFS received public comment indicating that the agency should, at a minimum, retain the geographic area and scope of the current HAPC due to the unique ecological function of the Gulf of Mexico in western Atlantic bluefin tuna life history.

This alternative would not designate any new HAPCs based on new information assessed during the 5-Year Review process, information provided by scientific experts, information provided by the Atlantic HMS Advisory Panel, information provided by the public, and from other information gathered during development of this final amendment.

Alternative 3b: (*Preferred*) Modify current HAPC for bluefin tuna

This alternative would modify the current HAPC for spawning bluefin tuna in the Gulf of Mexico. New information and research in recent years on bluefin tuna life history, migration, and pelagic habitat utilization indicate that changes to the current bluefin HAPC boundaries are warranted. During development of the Final Atlantic HMS EFH 5-Year Review, NMFS received public comment indicating that the agency should at a minimum retain the geographic area and scope of the current HAPC due to the unique ecological function of the Gulf of Mexico in western Atlantic bluefin tuna life history. New literature published by Muhling et al. (2010) suggests moderate (20-40 percent) probabilities of collecting larvae in areas of the eastern Gulf of Mexico that are not completely covered by the existing HAPC. Based on this information, NMFS would extend the HAPC in the Gulf of Mexico from its current boundary of 86° W longitude (long.), eastward to 82° W long. The HAPC extends from the 100 meter isobaths to the EEZ. NMFS did not identify new information that warranted adjustments from the landward boundary. Councils or NMFS may describe, identify, and protect habitats of managed species that are beyond the EEZ; however, such habitat may not be considered EFH for the purposes of the requirements under sections 303(a)(7) and 305(b) of the Magnuson-Stevens Act (§600.805(a)(2)). Given these aspects of the EFH regulations, EFH and the HAPC were clipped, or made to match, the seaward EEZ boundary. Muhling et al. (2010) noted that larval bluefin were absent from continental shelf waters or waters with continental shelf origin characterized by low surface temperatures or salinities in early spring. NMFS larval bluefin data utilized in EFH analyses were also primarily from areas off the continental shelf (see Appendix F). Therefore, the literature and new information collected for this final amendment supports the continued use of the 100 m bathymetric line, which is close to the edge of the continental shelf in many locations within the Gulf of Mexico, as the landward extent of the HAPC.

The modified HAPC would include a majority of the locations where bluefin tuna larval collections have been documented by NMFS and in recent studies; would overlap with updated adult and larval bluefin tuna EFH; would incorporate all areas identified by Muhling et al. (2010) as having a moderate probability of catching larval bluefin tuna; and would incorporate areas identified as the primary spawning locations for bluefin tuna by Teo et al. (2007). As Figure 2.1 indicates, this HAPC would encompass much, but not all, of the areas included in the updated bluefin tuna EFH designations for the spawning, egg, and larval life stages.



Data Sources:
CTS, CSTP, NEFSC obsever program,
NEFSC, SEFSC pelagic observer program,
NMF EFP database, Richards 1976,
McGowan and Richards 1989, Muhling 2010

Figure 2.1 Preferred Alternative 3b: Modified HAPC and 2017 EFH for Bluefin Tuna

Alternative 4: Evaluate and, if warranted, modify current HAPCs for sandbar sharks

Alternative 4a: No action - Retain current HAPC sandbar shark

This alternative would retain, without modification, the current HAPCs for neonate/YOY and juvenile sandbar shark in four discrete coastal locations within the Mid-Atlantic. This alternative would also not designate any new HAPCs based on new information assessed during the 5-Year Review process, information provided by scientific experts, information provided by the Atlantic HMS Advisory Panel, information provided by the public, and from other information gathered during development of this final amendment.

Alternative 4b: (*Preferred)* Modify current HAPC for sandbar shark

This alternative would modify the current HAPC for sandbar shark along the Atlantic coast. The EFH regulations at §600.815(a)(8) require that FMPs "identify specific types or areas of habitat *within* EFH as habitat areas of particular concern" (emphasis added). As discussed in Chapter 4, the HAPC for sandbar shark designated in 1999 is outside the geographic boundaries of the most recent EFH designation (Amendment 1) for sandbar shark and thus is inconsistent with this regulatory requirement. Alternative 2 is preferred because it would allow this final amendment to update EFH for sandbar shark to include areas within Chesapeake Bay and Delaware Bay, and exclude Pamlico Sound. This alternative would therefore adjust the boundaries of the HAPC so that it is contained within the geographic boundaries of the sandbar shark EFH as further updated in this final amendment. These changes would include additional areas in Delaware Bay and Chesapeake Bay to reflect updated EFH designations and adjustment of the HAPC boundaries around the Outer Banks of North Carolina to exclude habitats within Pamlico Sound.

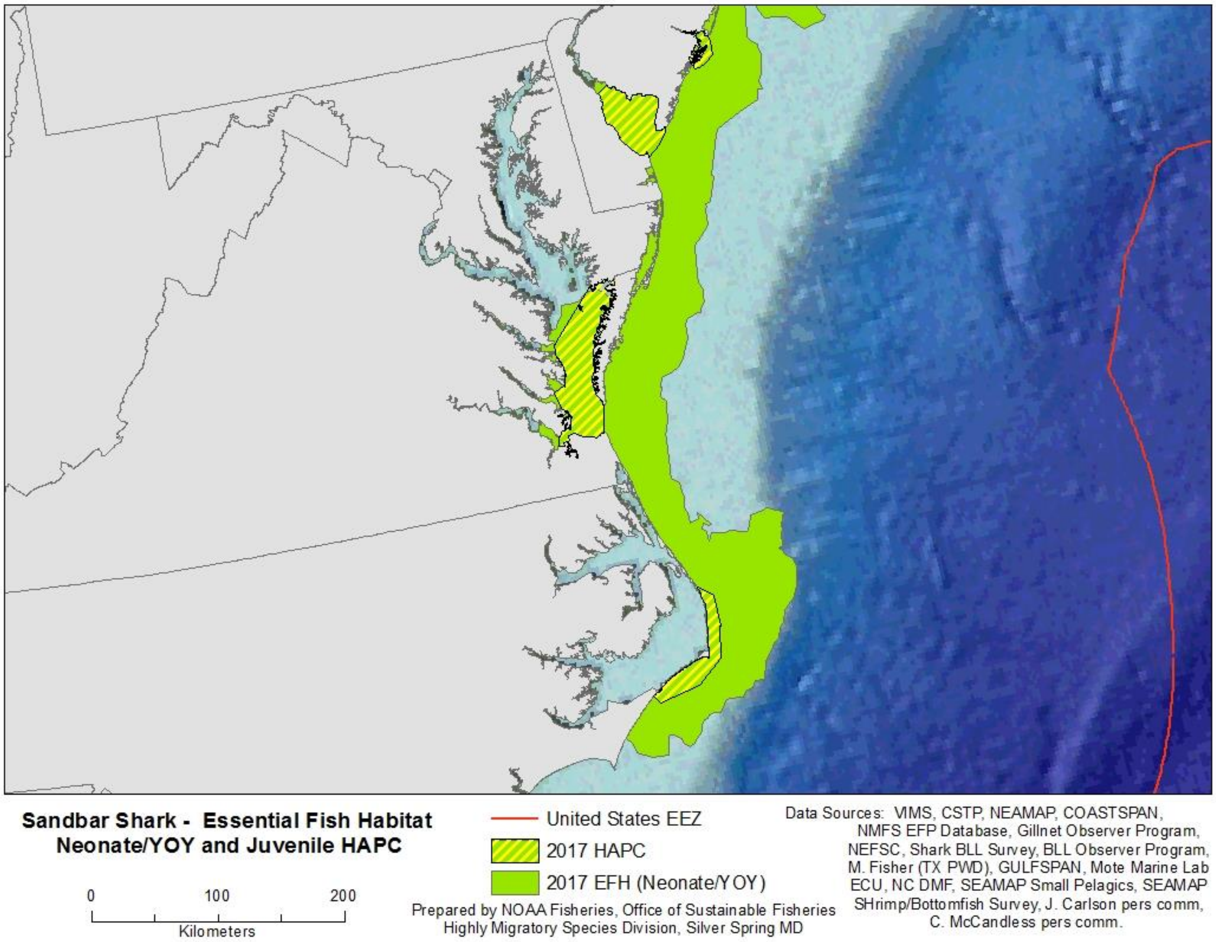


Figure 2.2 Preferred Alternative 4b: Modified HAPC and 2017 EFH for Sandbar Shark

Alternative 5: Evaluate and, if warranted, establish new HAPCs for Lemon Sharks

Alternative 5a: No action - Do not create a HAPC for lemon sharks

This alternative would not designate a new HAPC based on new information assessed during the 5-Year Review process, information provided by scientific experts, information provided by the Atlantic HMS Advisory Panel, information provided by the public, and from other information gathered during development of this final amendment for lemon sharks off the central and southeastern Atlantic coast of Florida.

Alternative 5b: (Preferred) Create a new HAPC for lemon sharks between Jupiter Inlet, Florida and Cape Canaveral, Florida

This alternative would designate a new HAPC for lemon sharks between Jupiter Inlet, Florida and Cape Canaveral, Florida based upon tagging studies and public comments received that expressed concern about protection of habitat in locations where aggregations of lemon sharks are known to occur (Figure 2.3). NMFS received information from the public expressing concern about a spatially discrete, high density juvenile lemon shark nursery within the Cape Canaveral region of southeastern Florida. Studies have shown that aggregations of juvenile lemon sharks have appeared annually since 2003 within sheltered longshore troughs and the shallow open surf zone adjacent to Cape Canaveral (Reyier et al. 2008), and that those sharks retain a high degree of site fidelity (Reyier et al. 2014). The preferred new HAPC would encompass the coastal region immediately surrounding Cape Canaveral, and would extend seaward 12 kilometers (km) from the beach (Reyier, unpublished data, as cited in Reyier et al. 2014).

NMFS also received information from the public expressing concern about a spatially discrete, high density adult lemon shark aggregation site off Jupiter Inlet, in southeastern Florida. Large, adult lemon sharks were noted by the recreational dive community to form aggregations (50-100 individuals) off Jupiter Inlet in 20-35 m of water between December and April of 2007-2011 (Kessel et al. 2014). Based on research by Kessel et al. (2014), the adult aggregations are located between 26º50’ N latitude (lat.) and 27º04’ N lat. The seaward extent of the HAPC is the same as the seaward extent of EFH in this area, both of which are inclusive of point data for individual sharks presented in Kessel et al. (2014).

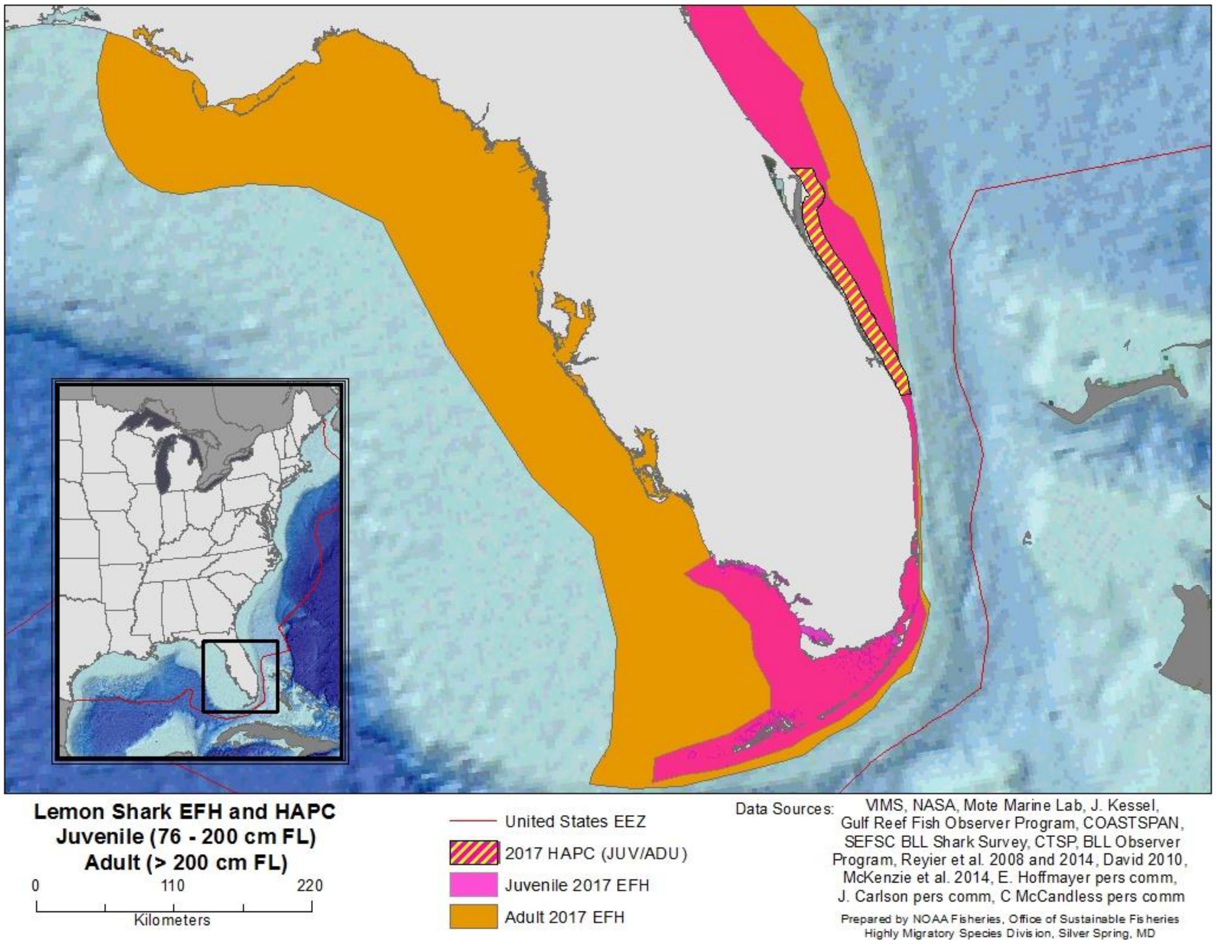


Figure 2.3 Preferred Alternative 5b: HAPC and 2017 EFH for Juvenile and Adult Lemon Shark

Alternative 5c: Create a new HAPC for lemon sharks in the vicinity of Cape Canaveral, Florida

This alternative would designate a new HAPC for juvenile lemon sharks off Cape Canaveral, Florida based upon tagging studies and public comments received that expressed concern about protection of habitat in locations where aggregations of lemon sharks are known to occur (Figure 2.4). NMFS received information from the public expressing concern about a spatially discrete, high density juvenile lemon shark nursery within the Cape Canaveral region of southeastern Florida. Studies have shown that aggregations of juvenile lemon sharks have appeared annually since 2003 within sheltered longshore troughs and the shallow open surf zone adjacent to Cape Canaveral (Reyier et al. 2008), and that those sharks retain a high degree of site fidelity (Reyier et al. 2014). The HAPC would encompass the coastal region immediately surrounding Cape Canaveral, and would extend seaward 12 km from the beach (Reyier, unpublished data, as cited in Reyier et al. 2014). The southern extent of the HAPC would extend 12 km from the beach at the Port Canaveral jetty. If selected, this alternative would create a single HAPC for lemon sharks. In comparison to alternative 5b, this alternative only uses the bounding areas around the known aggregation sites for lemon sharks in the Cape Canaveral region identified in Reyier et al. 2008 and Reyier et al. 2014 as the extent of a HAPC rather than extending the HAPC south to the Jupiter Inlet area.

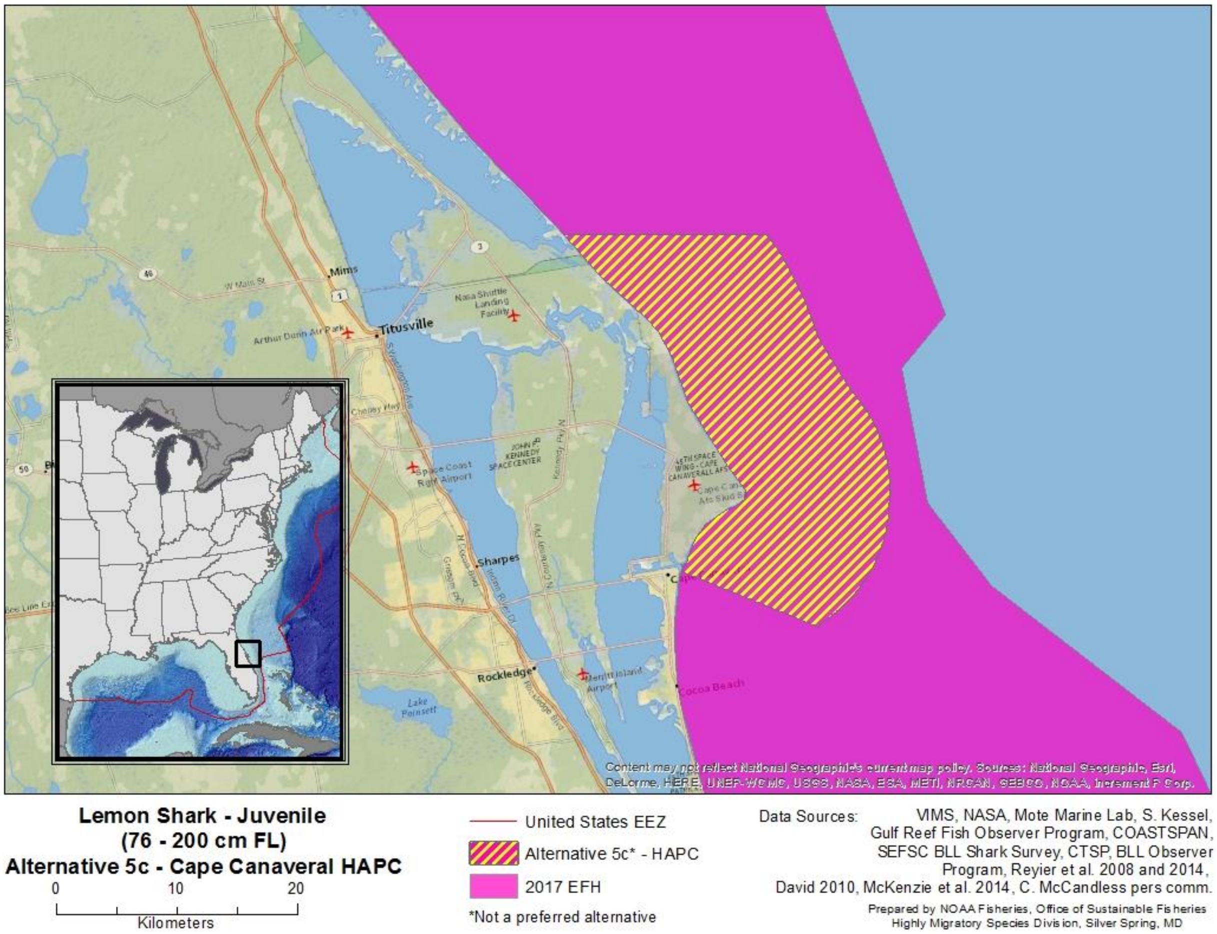


Figure 2.4 Alternative 5c: HAPC and 2017 EFH for Lemon Shark off Cape Canaveral, FL

Alternative 5d: Create a new HAPC for lemon sharks in the vicinity of Jupiter Inlet, Florida

This alternative would designate a new HAPC for juvenile lemon sharks off Jupiter Inlet, Florida based upon tagging studies and public comments received that expressed concern about protection of habitat in locations where aggregations of lemon sharks are known to occur (Figure 2.5). NMFS received information from the public expressing concern about a spatially discrete, high density adult lemon shark aggregation site off Jupiter Inlet, in southeastern Florida. Based on research by Kessel et al. (2014), the HAPC would extend from 26º50' N lat. to 27º04' N lat. The seaward extent of the HAPC is the same as the seaward extent of EFH in this area, both of which are inclusive of point data for individual sharks presented in Kessel et al. (2014). If selected, this alternative would create a single HAPC for lemon sharks. In comparison to Alternative 5b, this area only uses specific coordinates referenced by Kessel et al. (2014) (between 26º50' N lat. and 27º04' N lat.) to delineate the boundaries of the HAPC, rather than extending the HAPC northward to Cape Canaveral.

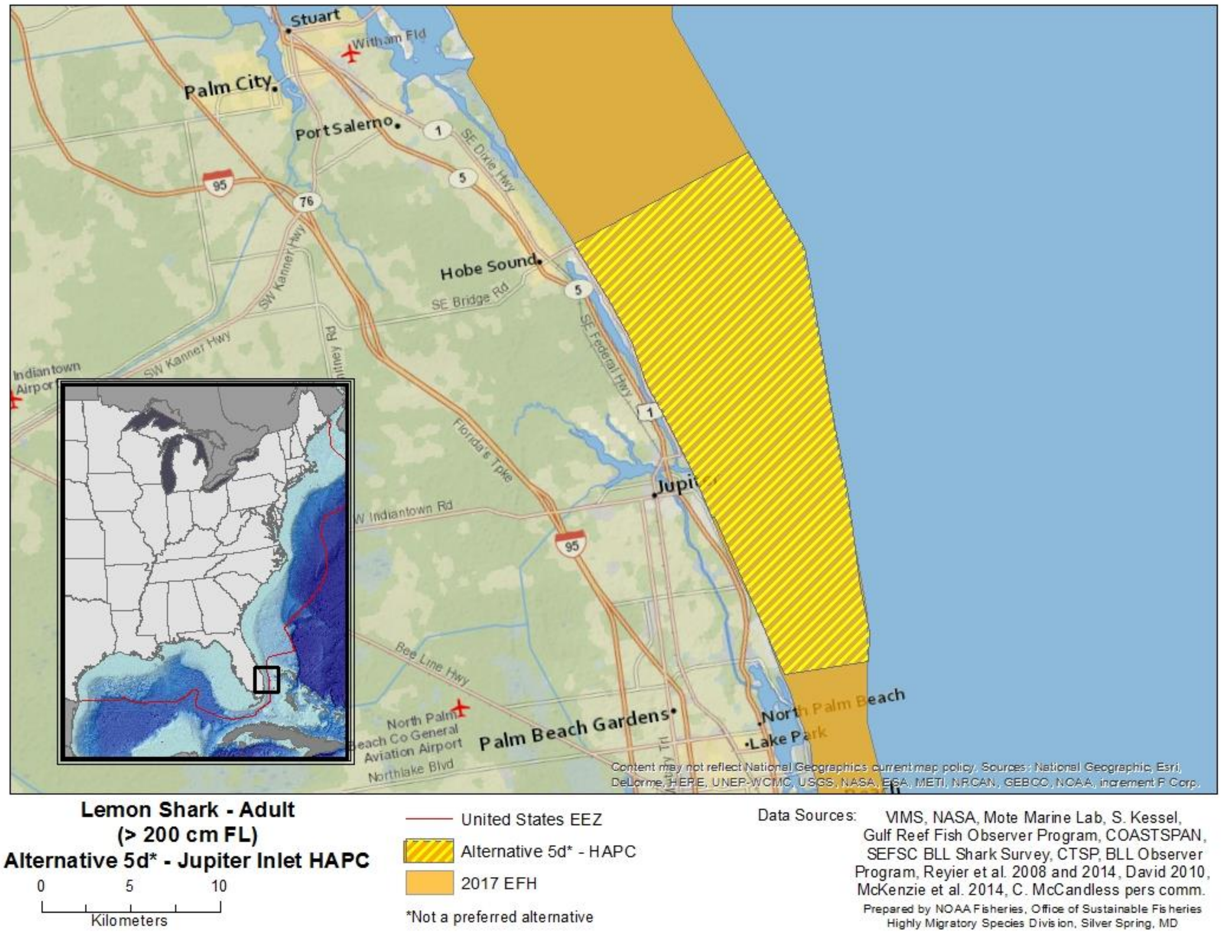


Figure 2.5 Alternative 5d: HAPC and 2017 EFH for Lemon Shark off Jupiter Inlet, Florida

Alternative 6: Evaluate and, if warranted, establish new HAPCs for Sand Tiger Sharks

Alternative 6a: No action - Do not create HAPCs for Sand Tiger Sharks

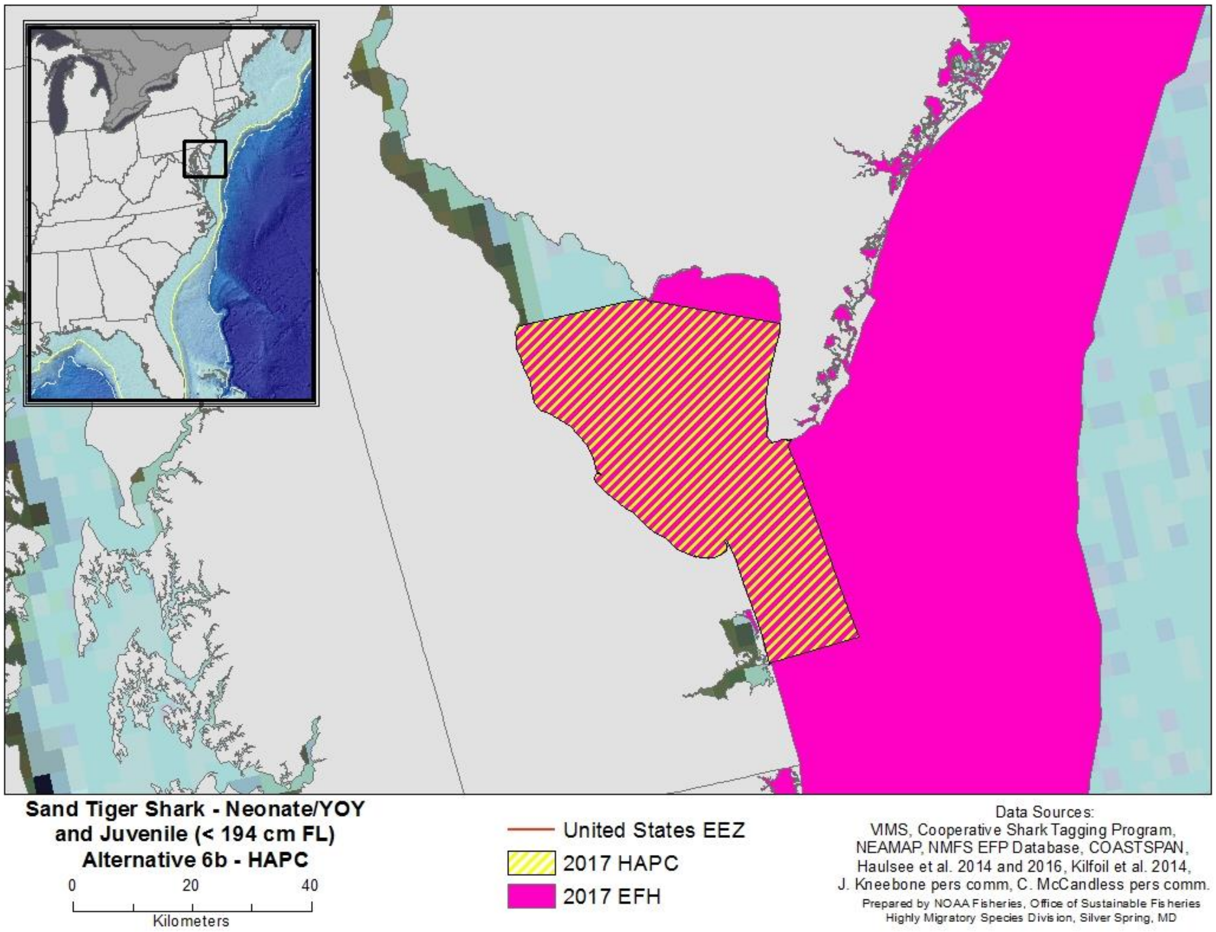
This alternative would not designate new HAPCs based on new information assessed during the 5-Year Review process, information provided by scientific experts, information provided by the Atlantic HMS Advisory Panel, information provided by the public, and from other information gathered during development of this final amendment for sand tiger sharks off the central and southeastern Atlantic coast of Florida.

Alternative 6b: (Preferred) Create two HAPCs: (1) Delaware Bay for all life stages of sand tiger shark and (2) Plymouth, Kingston, Duxbury (PKD) bay system in coastal Massachusetts for neonates/YOY and juvenile sand tiger sharks

This alternative would designate a new HAPC in Delaware Bay based on data collected by the NEFSC, Haulsee et al. (2014 and 2016), and Kilfoil et al. (2014) indicating that Delaware Bay constitutes important habitat for sand tiger sharks (Figure 2.6). The Cooperative Atlantic States Shark Pupping and Nursery (COASTSPAN) survey conducted in Delaware and New Jersey state waters reported from 2009 to 2014 consistently, extensive seasonal use of the Delaware Bay by all life stages of sand tiger sharks (NMFS 2009-2016; McCandless unpubl. data). Additionally, tagging research suggests high inter-annual site fidelity of sand tiger sharks for this region (Haulsee et al. 2016).

This alternative would also designate a HAPC in the PKD bay system in coastal Massachusetts for juveniles and neonate sand tiger sharks in the Cape Cod region based on data collected by the NEFSC (and others) and scientific research published by Kneebone et al. (2012 and 2014) (Figure 2.7). Tagging data suggests that tagged neonates and juveniles are seasonally distributed within the estuary and also exhibit inter-annual site fidelity for the PKD bay system.

This alternative would create two HAPCs for sand tiger sharks. As discussed in further detail in Chapter 4, this alternative is preferred because it encompasses all of the areas identified by Haulsee et al. (2014 and 2016), Kilfoil et al. (2016), Kneebone et al. (2012 and 2014), and NMFS scientists (C. McCandless pers comm), which appear to be important for sand tiger sharks, and therefore, incorporates the best and most recent biological information available.



Data Sources:
VMS, Cooperative Shark Tagging Program,
NEAMAP, NMFS EFP Database, COASTSPAN,
Haulsee et al. 2014 and 2016, Kilfoil et al. 2014,
J. Kneebone pers comm, C. McCandless pers comm.
Prepared by NOAA Fisheries, Office of Sustainable Fisheries
Highly Migratory Species Division, Silver Spring, MD

Figure 2.6 Preferred Alternative 6b(1): HAPC for all life stages of Sand Tiger Shark in Delaware Bay and 2017 EFH for Neonate/YOY and Juvenile Life Stages

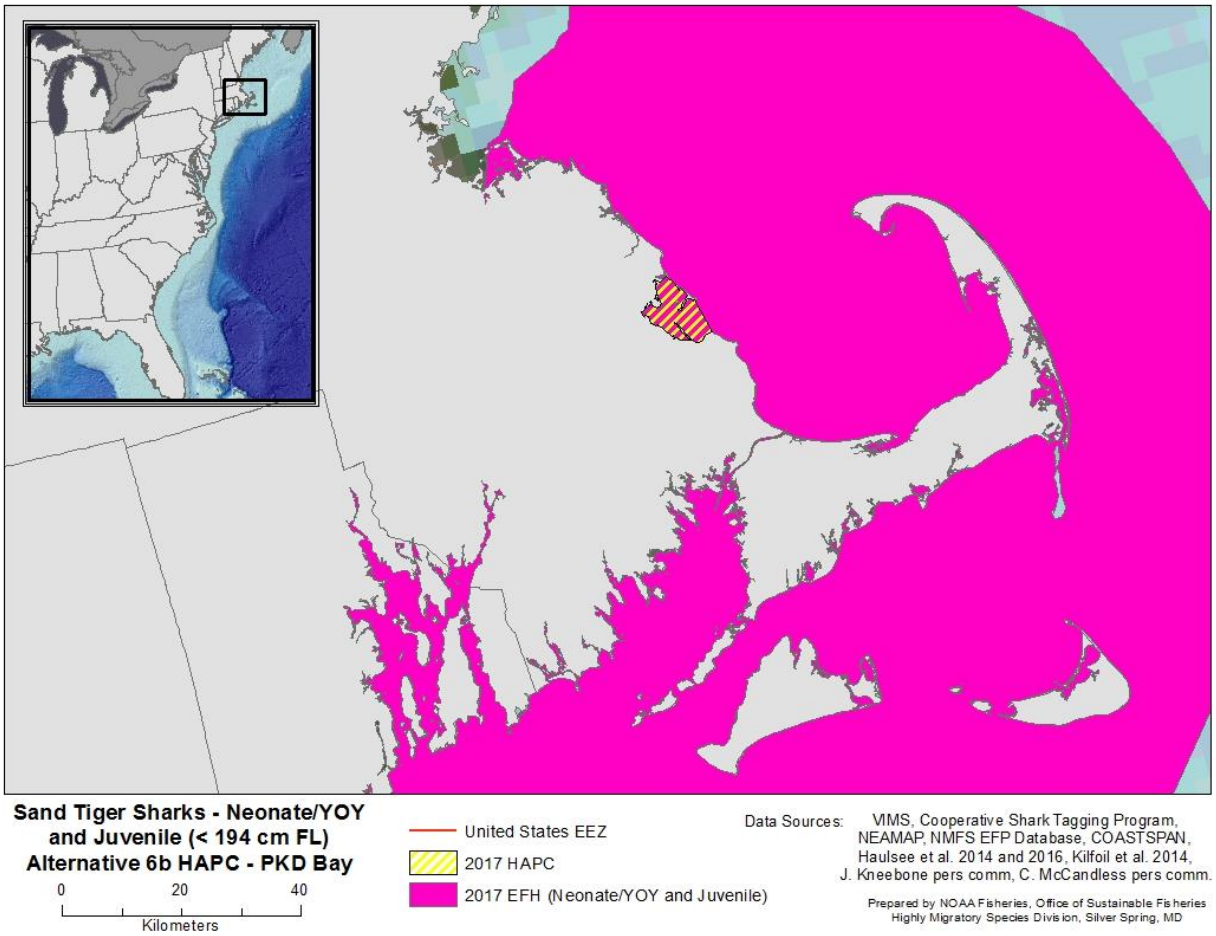


Figure 2.7 Preferred Alternative 6b(2): 2017 EFH (Neonate/YOY and Juvenile) and HAPC for Juvenile Sand Tiger Sharks in the PKD Bay System

2.3 Alternatives Considered but not Further Analyzed

2.3.1 HAPC for Larval Billfishes

In the Final HMS EFH 5-Year Review, NMFS recommended that this final amendment evaluate potential HAPCs for larval billfishes using the following text:

Larval distribution of billfishes (blue and white marlin, sailfish, roundscale spearfish, and longbill spearfish) is the subject of ongoing research within the Florida Straits, Gulf of Mexico, and the U.S. Caribbean, suggesting that these areas could be considered primary spawning grounds for billfishes. During the upcoming amendment to update HMS EFH, NMFS will evaluate whether these studies have provided findings to warrant HAPC designation for billfishes.

Evaluation of larval billfish research and data completed for this final amendment indicated that the reported distribution of larval billfish was largely reflective of the locations sampled (i.e., in locations where sampling occurred, billfish larvae were found). Furthermore, the majority of those larvae were identified only as "Istiophorid;" therefore, species-specific distribution could not be analyzed. At that broad level of taxon and apparent extent of habitation, NMFS was unable to specify an area (or areas) that met a HAPC criterion; therefore, no HAPC designation for larval billfish is identified as an alternative in this final amendment. The species-specific research summarized in the Final HMS EFH 5-Year Review and species-specific larval data analyses conducted for this final amendment were, however, applied in the updated EFHs for spawning, eggs, and larvae.

2.3.2 HAPC for White Shark

In the Final HMS EFH 5-Year Review, NMFS identified the presence of white shark pup and juvenile life stages and rising population of pinnipeds as reason to consider HAPC designations for white sharks in this final amendment using the following text:

[NMFS] will consider identifying white shark HAPCs that cover possible nursery grounds (based on distribution of pups and small juveniles) in the northern Mid-Atlantic, and aggregation sites off the coast of Massachusetts (due to rising pinniped populations).

NMFS considered a potential HAPC in the northern Mid-Atlantic and southern New England for neonate/YOY and juvenile white sharks. Curtis et al. (2014) noted a center of distribution for records of white shark interactions in the northern mid-Atlantic based on landings and observer data; recreational tournament information; scientific research surveys; information from commercial and recreational fishermen, and scientists; newspaper articles, and scientific literature. Of these, 97 percent of the neonate/YOY and 50 percent of juvenile white shark records were from this area. Most YOY shark observations occurred between Great Bay, New Jersey and Shinnecock Inlet, New York. Depth and temperature associations were noted for YOY and juveniles; however, this report alone was not enough to support any one HAPC criterion. NMFS also received public comment in favor of protecting young white sharks in this area. However, the commenter did not identify or provide empirical evidence to support specific bounding coordinates for a HAPC (see Appendix H). For this amendment, NMFS examined additional data and literature that might support HAPC designation; however, the findings were insufficient to identify a discrete area that meets the criteria for a HAPC.

NMFS considered the white shark feeding grounds off Cape Cod as a potential HAPC. Gray seals (*Halichoerus grypus*) stocks have recovered off New England, and the behavior of seals and white sharks have been correlated (Moxley 2016). Skomal et al. (2012) noted an increasing trend in the number of white shark sightings and signs of white shark predation on seals in this area, and speculated that the increased number of sightings may be the result of a change in localized abundance of sharks due to higher prey density. NMFS considered that the uniqueness of the feeding site might warrant HAPC designation if it supports an important ecological function for white sharks; however, the presence of gray seals and white sharks is seasonal. The migratory nature and abundance of the gray seal colony may also fluctuate annually, which would alter the area's significance as a feeding ground for white sharks from one year to the next. Finally, Cape Cod is already a designated National Seashore, and pinnipeds are protected from human interaction (take) under the Marine Mammal Protection Act; therefore, NMFS found that the additional designation of HAPC under the Magnuson-Stevens Act is not necessary in this final amendment.

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3 DESCRIPTION OF THE AFFECTED ENVIRONMENT

3.1 Introduction

The components of the environment potentially "affected" by the proposed action are primarily the habitats for federally-managed Atlantic HMS. Thus, much of this chapter focuses on those habitats. Chapter 1, Table 1 provides a list of the Atlantic HMS for which habitats are described in the following 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 of varying water characteristics (e.g., dissolved oxygen (DO), temperature, chlorophyll (phytoplankton), and salinity) that influence the geographic migration patterns and seasonal presence of Atlantic HMS. 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 east coast of the United States. Variations in flow capacities through 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 habitat for Atlantic HMS.

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 use specific estuaries as pupping and nursery areas as adults during pupping season and throughout their neonate (newborn) and YOY 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 Atlantic HMS are most frequently associated. A more detailed description is contained in the 1999 Tunas, Swordfish, and Shark FMP.

3.2 Atlantic Ocean

Material in this section is a summary of information in Minerals Management Services (1992 and 1996, which we incorporate by reference. Original sources of information are referenced in those documents.

The region of the Atlantic Ocean within which EFH for federally managed Atlantic HMS is currently designated spans the area between the Canadian border in the north to the Dry Tortugas and southern boundary of the U.S. EEZ in the Gulf of Mexico in the south. It also includes the entirety of the U.S. Caribbean. This region 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 and Cape Canaveral region are examples of somewhat weaker zoogeographic boundaries along the Atlantic coast.

3.2.1 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 Atlantic 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 primarily occupy open ocean waters, they often 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 aggregate, pup, or give birth; these areas may then become nursery areas as the young develop. Examples include the Plymouth, Kingston, Duxbury (PKD) bay in Massachusetts; Great Bay, New Jersey, Chesapeake Bay, Maryland, and Delaware Bay, Delaware, which provide important nursery habitat for sandbar and sand tiger sharks; Bull’s Bay, South Carolina, and Terrebone Bay, Louisiana which are important blacktip shark nursery areas; and Jupiter Inlet and Cape Canaveral, Florida which provide important nursery habitat for aggregations of lemon sharks. Typically, the pups (which can include neonates and YOY) 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. For example, tagging studies have found high inter-annual site fidelity of neonate and juvenile sand tiger sharks within the Plymouth Kingston, Duxbury Bay system estuary in coastal Massachusetts (Haulsee et al. 2016). 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.

North of New Jersey, the coastline is comprised of an extensive of bays and estuaries that serve as essential fish habitat for several species of sharks (e.g., dusky sharks, sandbar sharks, sand tiger sharks). In Massachusetts, the northern geographical area is comprised of the Massachusetts Bay and Cape Cod Bay. Buzzards Bay, Martha's Vineyard, and Nantucket Islands can be found south of the cape. These sounds are comprised of coastal beaches, bays and estuaries associated with Nantucket and Vineyard Sounds. The main sources of local coastal pollution come from boating activities, marinas, mooring fields, private docks and piers, road runoff, and fishing. In New York, Great South Bay is formed by a barrier island (Fire Island) that runs along the shore of Long Island, New York. The bay is 76 km long and approximately 238 sq. km. In New Jersey's coastal waters, barrier islands and inlet systems from the Atlantic Ocean separate numerous coastal bays. These coastal bays and inlet systems serve as important pupping and nursery grounds for several species of sharks. For example, Delaware Bay and Great Bay, New Jersey, have shown to be active pupping grounds for sandbar sharks. Barnegat Bay extends along 48km of coast and is 2 to 6 km wide, spanning an area of 193 sq. km. The Mullica River-Great Bay estuary covers 267 sq. km and is shaped by several shallow bays connected by creeks and the Intracoastal Waterway. Delaware Bay is a temperate coastal plain estuarine system. The total area of the bay is approximately 2000 sq. km and has an extensive amount of shoals.

There are 36,000 sq. km of estuarine habitat along the Atlantic coast, of which approximately 68 percent 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 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 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 include elevated bacterial and suspended sediment levels. Non-point sources of pollution are considered one of the main causes of pollution. Elevated bacterial levels are 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 DO. 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 summarized above and not repeated here.

3.2.2 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, 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. Atlantic 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 in width, reaching a maximum of 150 km off New England near Georges Bank, and a minimum of 50 km offshore Cape Hatteras, North Carolina. 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, Massachusetts to Cape Hatteras, North Carolina 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 and as such prey availability varies as well. 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). For example, white sharks are largely distributed between the New York Bight and Cape Cod in the summer (Curtis et al. 2014); however sharks are aggregating in increasingly greater number off Cape Cod, between Wellfleet, Massachusetts and Monomoy Point, Massachusetts, possible in response to regional changes in seal abundance, creating important feeding grounds (Skomal et al. 2012). The shelf-edge habitat may range in water depth between 40 and 100 m. 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 off Cape Canaveral, Florida to a maximum of 120 km off Savannah, Georgia. The shelf is divided into three cross-shelf zones. Waters on the inner shelf (0-20 m) 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) 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).

A topographic irregularity southeast of Charleston, South Carolina, known as the Charleston Bump, is an area of productive sea floor, which rises abruptly from 700 to 300 m within a distance of about 20 km, 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. 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).

3.2.3 Pelagic Environment

Many Atlantic 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, and 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 to 100 km and reaches depths of 800 to 1,200 m.

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 through 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 lat., 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, it 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. An FMP for Pelagic Sargassum habitat in the South Atlantic Region was approved in 2003 and implemented strict restrictions on commercial harvest given its importance as a fish habitat. 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 Atlantic 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.

3.3 Gulf of Mexico

Material in this section is 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 Atlantic HMS are known to occur varies between the eastern and western Gulf, depending on the influence of the Loop Current.

3.3.1 Coastal and Estuarine Habitats

There are 6.12 million hectares (ha) of estuarine habitat among the five states bordering the Gulf. This includes 3.2 million ha of open water, 2.43 million ha of emergent tidal vegetation (including about 162,000 ha of mangroves), and 324,000 ha of submerged vegetation. Estuaries are found from east Texas through Louisiana, Mississippi, Alabama, and northwest Florida and encompass more than 62,000 km^2 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.

3.3.2 Continental Shelf and Slope Areas

The Gulf of Mexico is a semi-enclosed, subtropical sea with a surface area of approximately 1.6 million km^2. 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 wide, off the Mississippi River. The continental shelf width varies significantly from about 350 km off western Florida, 156 km off Galveston, Texas, and decreases to 88 km off Port Isabel near the Mexican border. The depth of the central abyss ranges to 4,000 m. 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, 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 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.

3.3.3 Physical Oceanography

The Gulf of Mexico receives large amounts of freshwater output from the Mississippi River as well as from a host of other drainage systems. Nutrient runoff from the Mississippi River has resulted in large hypoxic or low oxygen areas in the Gulf. This "dead zone" covers thousands of square kilometers during the summer, resulting in unfavorable habitat conditions for a wide variety of species. The size of the dead zone varies year to year, depending on environmental conditions, but in 2002 the zone covered 22,000 km^2 (Krug 2007).

Sea-surface temperatures in the Gulf range from nearly constant throughout (isothermal) (29-30 degrees Celsius (°C)) in August to a sharp horizontal gradient in January (25 °C in the Loop Current core to 14-15 °C along the northern shelf). The vertical distribution of temperature reveals that in January, the thermocline depth is about 30 to 61 m in the northeast Gulf and 91 to 107 m in the northwest Gulf. In May, the thermocline depth is about 46 m 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 and 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, 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, phytoplankton, or planktonic 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 offshore. In the Gulf, these fronts are the most commonly utilized habitat of the pelagic HMS.

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 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, 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 lat. and 93° W to 96° W long. 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.

3.4 U.S. Caribbean

Material in this section is 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.

3.4.1 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 (deeper than 15 m), 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 buildup 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.

3.4.2 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 in depth, and outer shelf waters range from 20 to 30 m 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 18-30 m. 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 to the southeast is Grappler Bank, a small seamount with its summit at a depth of 70 m. The central south coast broadens slightly to 15 km and an extensive seagrass bed extends nine km offshore to Caja de Muertos Island. Further westward, the shelf narrows again to just two km before widening at the southwest corner to over 10 km. 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 at its maximum. A broad expanse of the shelf is found between 14 and 27 m, 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.

3.4.3 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/s. It is located about 100 km 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. 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.

3.5 References

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4 ENVIRONMENTAL CONSEQUENCES OF THE ALTERNATIVES

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

Alternative 1 No Action – Retain current EFH designations established under Amendment 1, Amendment 3, and the Roundscale Spearfish Interpretive Rule (75 FR 57698).

Alternative 2 *Update all Atlantic HMS EFH designations with new data collected since 2009, using the EFH delineation methodology established under Amendment 1 (Preferred).*

As described in Chapter 2, the alternatives considered for evaluating current HAPCs and identifying new HAPCs are:

Alternative 3 Evaluate, and if warranted, modify current HAPC for bluefin tuna.

Alternative 3a – No Action. Retain current HAPCs for bluefin tuna.

Alternative 3b – *Modify current HAPC for bluefin tuna (Preferred)*

Alternative 4 - Evaluate, and if warranted, modify current HAPCs for sandbar shark.

Alternative 4a – No Action. Retain current HAPC for sandbar shark.

Alternative 4b – *Modify current HAPC for sandbar shark. (Preferred)*

Alternative 5 - Evaluate, and if warranted, establish new HAPCs for lemon sharks

Alternative 5a – No Action. Do not create new HAPCs for lemon sharks.

Alternative 5b – *Create a new HAPC for lemon sharks between Jupiter Inlet, Florida and Cape Canaveral, Florida. (Preferred)*

Alternative 5c – Create a new HAPC for lemon sharks in the vicinity of Cape Canaveral, Florida.

Alternative 5d – Create a new HAPC for lemon sharks in the vicinity of Jupiter Inlet, Florida.

Alternative 6 – Evaluate, and if warranted, establish new HAPCs for sand tiger sharks.

Alternative 6a – No Action. Do not create new HAPCs for sand tiger sharks.

Alternative 6b – *Create two HAPCs for sand tiger sharks: a new HAPC for all life stages of sand tiger shark in Delaware Bay and one for neonates/YOY and juvenile sand tiger sharks in the PKD bay system in coastal Massachusetts (Preferred)*

4.1 Essential Fish Habitat Designations

The following section describes the environmental, social, and economic impacts of the alternatives considered. For each of the alternatives discussed in this section, there are no short-term indirect or short- or long-term direct environmental, social, or economic consequences associated with identifying and describing EFH (i.e., impacts are neutral); however, the areas subject to EFH consultation would change if the designated EFH areas are increased or decreased in size. NMFS presumes that long-term indirect environmental, social, or economic consequences associated with identifying and describing EFH would be minor and positive due to the benefits of considering (and, when appropriate, providing recommendations to mitigate) the impacts of coastal and marine activities on Atlantic HMS fish habitat. Ecological, social, and economic impacts are discussed in greater detail under each alternative.

While designation of EFH does not result in any direct environmental, social, or economic impacts, it establishes a process whereby adverse effects on EFH must be carefully considered, analyzed, and, if necessary, avoided or minimized to prevent adverse effects on EFH. This is accomplished through a formal process of consultation between NMFS and other Federal agencies for all actions or proposed 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 and describing appropriate EFH is an important first step in ensuring that EFH is not degraded or harmed.

Measures to encourage the conservation and enhancement of EFH are described in Chapter 5, and these measures, EFH conservation recommendations, may be among those provided to an agency during an EFH consultation process. Since these EFH conservation recommendations are non-binding and are not specific to a particular project at this time, the description of these EFH conservation recommendations does not have an environmental consequence associated with their development as a part of this final amendment. Therefore, the EFH conservation recommendations are not analyzed in more detail in this section. However, NMFS' EFH implementing regulations require consideration of cumulative impacts of fishing and non-fishing activities on EFH by the cumulative impacts analysis is a component of an EA. Therefore, consideration of cumulative impacts under the EFH regulatory requirements are provided in a component of this environmental analysis for the final amendment under Section 4.8.

A detailed review of data sources, formatting procedures, analysis methodology, quality control processes, and mapping processes are provided in Appendix F. An example is also presented in Appendix F to demonstrate how analyses methodologies are used to derive updated bluefin tuna EFH boundaries.

4.1.1 Summary and Comparison of EFH Delineation Alternatives

Alternative 1 – No Action- Retain current EFH designations established under Amendment 1, Amendment 3, and the Roundscale Spearfish Interpretive Rule (75 FR 57698)

Alternative 2 – Update all Atlantic HMS EFH designations with new data collected since 2009, using the methodology established under Amendment 1 – Preferred.

Under Alternative 1, the no action alternative, EFH and the areas subject to subsequent consultation would not change nor be based upon the most recent fisheries data and published information available. Since the delineation of EFH by itself does not result in conservation or management actions and this Amendment does not propose associated management measures for EFH, NMFS anticipates that Alternative 1 would result in no (i.e., neutral) short- or long-term direct and indirect ecological, social, and economic impacts.

In addition to the status quo, a second alternative for EFH delineation includes an option to update Atlantic HMS EFH designations with new data collected since 2009, using the EFH delineation methodology established under Amendment 1. Only the No Action Alternative and the alternative to update the designations using the EFH delineation methodology established under Amendment 1 are considered because NMFS reviewed the EFH delineation methodology in the most recent EFH 5-Year Review, which indicated that utilization of the current EFH delineation methodology is still appropriate. Consultation with the Atlantic HMS Advisory Panel and the public during the comment period for the 5-Year Review did not yield additional suggestions on EFH delineation methods or suggest that continued use of the Amendment 1 methodology was not appropriate. More sophisticated models and statistical techniques are available (see Chapter 10 in the Final Atlantic HMS EFH 5-Year Review); however, these models require high-resolution CPUE or density data, or concurrent ecological data, which may not be available for Atlantic HMS. These advanced statistical methodologies cannot reasonably be considered because NMFS would only be able to use a fraction of the data collected for EFH analyses in the models (if any, given that these models are often developed with specific datasets in mind). NMFS therefore concluded that the methodology used in Amendment 1 continues to be appropriate for this Amendment and that there are no other reasonable alternatives to consider at this time.

Alternative 2 (the preferred alternative) includes the incorporation of new information and data into EFH analyses, and subsequent adjustment of text descriptions and EFH boundaries following a procedure that was used to designate EFH in Amendment 1 and is outlined in Appendix F. This preferred alternative is expected to result in neutral, short term, direct and indirect ecological, social, and economic impacts on the natural and human environment. 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. The areas subject to EFH consultation could change as a result of new information incorporated into the model, or if the designated EFH areas are increased or decreased in size. As such, if part or all of an action is funded, authorized, or undertaken by a federal agency or proposed to be undertaken by a federal agency, and the action will adversely affect EFH, then the federal agency is required to consult with

NMFS. NMFS provides written conservation recommendations on measures that would minimize, mitigate, or otherwise reduce the impacts of a proposed action on EFH. As required under MSA section 305(b)(4)(B), the federal action agency is then required to provide a detailed written response to the EFH conservation recommendations. The response must include a description of measures proposed by the agency for avoiding, mitigating, or offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with NMFS conservation recommendations, the federal agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects.

Updating EFH text descriptions and boundaries ensures that any consultation subsequently completed with the NMFS Office of Habitat Conservation or NMFS regional habitat conservation divisions, and resulting EFH conservation recommendations, are based on the best available information. The long term indirect impacts of Alternative 2 are expected to be minor and beneficial, as the consultation process would contribute to a reduction in adverse effects on EFH, and resulting EFH conservation recommendations would likely have a positive conservation benefit. Similarly, NMFS anticipates neutral short-term cumulative ecological, social, and economic impacts on the natural and human environment as a result of Alternative 2 beneficial, long term cumulative effects are likely to occur under Alternative 2 as a result of the habitat consultation process, as discussed above.

Under Alternative 2, the preferred alternative, all Atlantic HMS EFH designations would be updated with new data collected since 2009 using the methods described above that were established under Amendment 1. EFH would potentially be reduced in size for some species and increased for others, as detailed in maps shown in Appendix G, which shows the updated EFH for each species based on new data.

4.2 Habitat Areas of Particular Concern

As mentioned in Chapter 1, EFH regulatory guidelines encourage the Regional Fishery Management Councils and NMFS to identify HAPCs based upon the following criteria (§600.815(a)(8)):

(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; and/or
(iv) the rarity of the habitat type.

Through the course of the Atlantic HMS EFH 5-Year Review process, NMFS completed a literature and information review on Atlantic HMS. Through that process, NMFS identified those species for which new literature or information became available which identified discrete areas that might meet the HAPC criteria, and consulted with the Atlantic HMS Advisory Panel and the public on the possible identification and designation of HAPCs for Atlantic HMS. The alternatives included in this section therefore discuss the rationale and ecological benefits of modifying or designating a HAPC for the species so identified, which were: bluefin tuna, sandbar shark, lemon shark, and sand tiger shark. (See Section 2.3 for a review of HAPC alternatives for larval billfishes and white shark that were considered but not further analyzed.)

Similar to the reasons described for EFH, HAPCs are expected to have neutral, short-term, direct, and indirect ecological, social, or economic impacts. The intent of the HAPC designation is to identify areas that are known to be important to species that are in need of additional levels of protection from adverse effects. While no additional regulations are created by a HAPC designation, special attention and consideration is given to these areas during the subsequent development of management plans and in EFH consultations. Thus, a HAPC designation alone does not automatically result in time/area closures or other management measures designed to reduce or eliminate 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. Per NMFS Policy 03-201-15, "Guidance to Refine the Description and Identification of Essential Fish Habitat" (http://www.nmfs.noaa.gov/directives/), the purpose of identifying HAPCs is to focus conservation efforts on localized areas within EFH that are vulnerable to degradation or especially important ecological for managed fish. HAPCs may also be used to target areas for area-based research. Therefore, in general, NMFS expects that the indirect long-term effects of HAPC implementation would likely be minor and beneficial. Any subsequent management actions related to or affecting areas of HAPC designation would have appropriate effects analyses at that time. No such measures are proposed at this time and thus additional analyses are outside the scope of this proposed action.

4.2.1 Summary and Comparison of HAPC Alternatives

Alternative 3 – Evaluate and, if warranted, modify current HAPC for bluefin tuna.

Alternative 3a – No Action Alternative. Retain current HAPC for bluefin tuna.

This alternative would retain the current HAPCs for Atlantic bluefin tuna spawning, eggs, and larvae life stage in the Gulf of Mexico and for neonate/YOY. During development of the Final Atlantic HMS EFH 5-Year Review, NMFS received public comment indicating that the agency should at a minimum retain the geographic area and scope of the current HAPC due to the unique ecological function of the Gulf of Mexico in western Atlantic bluefin tuna life history.

This alternative would not modify HAPCs to reflect new information assessed during the 5-Year Review process (specifically, Muhling et al. (2010), which identified moderate probabilities of encountering bluefin tuna larvae in the eastern Gulf of Mexico); or information provided by scientific experts, the Atlantic HMS Advisory Panel, the public, and gathered during development of this final amendment.

Since updating HAPC boundaries in itself does not result in management and conservation actions and no proposed measures restricting fishing or non-fishing activities are being made in association within the current HAPCs in this alternative, NMFS anticipates that short- and long-term direct and indirect ecological, social, and economic effects of adopting this alternative would be neutral.

This alternative is not preferred because it would not incorporate and consider the best available scientific information in considering a HAPC designation for, among other things, purposes of focusing conservation efforts, informing the public of areas that could receive additional scrutiny from NMFS with regard to adverse effects on EFH, or promoting area-based research. Therefore, it would be considered inconsistent with National Standard 2, and would not meet the purpose and need for this action.

Alternative 3b – Modify current HAPC for bluefin tuna – Preferred.

This preferred alternative would modify the current HAPC for the Spawning, Eggs, and Larval life stage of bluefin tuna in the Gulf of Mexico. Specifically, NMFS would change the boundary of the existing bluefin tuna HAPC to encompass a larger area within the Gulf of Mexico (Figure 4.1). New information and research in recent years on bluefin tuna life history, migration, and pelagic habitat utilization indicate that changes to the current bluefin HAPC boundaries are warranted. During development of the 5-Year Review, NMFS received public comment indicating that the agency should at minimum retain the current HAPC due to the unique ecological function of the Gulf of Mexico in western Atlantic bluefin tuna life history. The HAPC would thus be modified based upon information gathered during the 5-Year Review process, provided by scientific experts, information provided by the Atlantic HMS Advisory Panel, information provided by the public, and from other information gathered during development of this final amendment.

Under this preferred alternative, NMFS would adjust the HAPC by extending the eastward boundary from 86ºWlong. to 82ºW long. Seaward and landward extents would remain as identified in Amendment 1 (NMFS 2009) due to a lack of new information suggesting that modifications to the seaward and landward extent were warranted. Muhling et al. (2010) noted that larval bluefin were absent from continental shelf waters or waters with continental shelf origin characterized by low surface temperatures or salinities in early spring. NMFS larval bluefin data utilized in EFH analyses were also primarily from areas off the continental shelf (see Figure F 1 in Appendix F). Therefore, the literature and new information collected for the final amendment supports the continued use of the 100 m bathymetric line, which is close to the edge of the continental shelf in many locations within the Gulf of Mexico, as the landward extent of the HAPC. Information concerning the probability of capturing larval bluefin tuna in the central Gulf of Mexico (Muhling et al. 2010), and recent satellite tagging data (e.g., Galuardi et al. 2010; Richardson et al. 2016) all support the retention of the United States' EEZ as the seaward extent of the HAPC due to the prevalence of data points, moderate probabilities of catching larval bluefin, and numerous tracks of adult spawning size bluefin tuna, respectively, in the central Gulf of Mexico.

Recent literature supports the eastward expansion of the HAPC. Spawning bluefin tuna, eggs, and larvae are likely concentrated in specific areas of the Gulf of Mexico in response to variability in oceanographic conditions associated with the Loop Current, which does move through regions that are to the east of the current HAPC. New literature published by Muhling et al. (2010) also indicated moderate (20-40 percent) probabilities of collecting larvae in areas of the eastern Gulf of Mexico which are not completely covered by the existing HAPC, based on a model from a time series of larval distribution data in the Gulf of Mexico to define associations between larval bluefin catch locations and environmental variables. Satellite tag data of spawning size bluefin indicates that these fish are frequently present in parts of the eastern Gulf of Mexico at times of year when spawning is purported to occur (Galuardi et al. 2010; Lutcavage et al. 2012; Richardson et al. 2016).

The Gulf of Mexico is considered to be the primary breeding ground for western Atlantic bluefin tuna, and the HAPC would cover what is recognized as the primary spawning grounds for the stock. The HAPC would not cover all hypothesized spawning locations of bluefin tuna. NMFS analysis of larval fish data for this final amendment identified approximately 1,126 locations where larval bluefin have been captured in ichthyoplankton tows within the United States' EEZ (Figure F 1in Appendix F shows locations in the Gulf of Mexico). The current HAPC encompasses 77.6 percent of these locations (n = 874). Extending the eastern boundary of the HAPC to 82ºW long. would include an additional 193 locations where bluefin larvae were captured in the SEAMAP ichthyoplankton trawl surveys into the HAPC. Approximately 95 percent of all locations where larval billfish were located in the ichthyoplankton surveys within the United States' EEZ would be included in the HAPC.

Additionally, as Figure 2.1 in Section 2.2 indicates, this HAPC encompasses much, but not all, of the areas included in the updated bluefin tuna EFH designations for the spawning, egg, and larval life stages. The areas not included in the proposed updated HAPC, but which are considered EFH for this life stage, include the Florida Straits and the Slope Sea (areas designated as EFH in the Slope Sea are not shown in Figure 2.1 , see Appendix G for EFH maps). McGowan and Richards (1989), in an analysis of larval bluefin tuna collected in the Florida Straits, note in their conclusions that larvae are mostly advected into these areas from the eastern Gulf of Mexico, and that these areas are unfavorable for growth and survival compared to the Gulf of Mexico (and therefore may not be as ecologically important for larval bluefin tuna). Richardson et al. (2016) noted small numbers of bluefin tuna larvae collected on the Slope Sea off the northeastern United States. Areas of the Slope Sea identified in Richardson et al. (2016) as potential bluefin spawning grounds are not included in the HAPC because the sampling design was largely opportunistic, the paper did not include specific habitat analyses for larval bluefin tuna, and the number of bluefin larvae collected in this area was low (although CPUE was high). Additional research is needed to further evaluate the Slope Sea area as a potential spawning ground and verify its ecological importance to the bluefin tuna stock.

There are some areas where larval bluefin tuna were collected outside of the United States' EEZ that are also not included in the proposed updated EFH or the HAPC. Muhling et al. (2011) described collection of larval bluefin tuna within and south of the Yucatan Channel, outside of documented Western Atlantic spawning grounds. The location and ambient currents in these cases suggested that they were spawned outside of the Gulf of Mexico, however the numbers of larval bluefin tuna collected in these areas were small; the ecological importance of these areas is still unknown; and the areas identified by Muhling et al. (2011) are outside the United States' EEZ and therefore cannot be designated as EFH or as a HAPC.

The area preferred to be delineated as a HAPC would meet the HAPC criteria of having "strong ecological importance of the habitat" and the "rarity of the habitat." As mentioned above, this area meets the HAPC criteria of having "strong ecological importance" as it constitutes an important habitat for spawning, eggs, and larval bluefin. Additionally, since this spawning ground is recognized by ICCAT as the only primary spawning grounds for this stock of bluefin tuna, the HAPC also covers a discrete area that is rare and thus meets the criterion for HAPC designation regarding consideration of the "rarity" of the habitat. The modified HAPC area would include a majority of the locations where bluefin tuna larval collections have been documented in the Gulf of Mexico by NMFS and in recent studies; would overlap with updated adult and larval bluefin tuna EFH; would incorporate all areas identified by Muhling et al. (2010) as having a moderate probability of catching larval bluefin tuna; and would incorporate areas identified as the primary spawning locations for bluefin tuna by Teo et al. (2007). 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 modification of a HAPC needs to be large enough to account for variability in spawning location. The updated HAPC would encompass most, but not all, of the EFH identified for this life stage; however, given the variability of currents and the available research depicting spawning areas and distribution (or probability of occurrence) of larvae, it would still be appropriate to retain a larger HAPC for this life stage. The HAPC modifications in Alternative 4b would encompass more of the primary spawning areas, which can vary from year to year depending on oceanographic conditions.

NMFS did not consider additional alternatives for extending the Gulf of Mexico HAPC because the scientific basis used to develop this alternative - Muhling et al. 2010 - did not indicate variations in the ecological importance of different portions of the Gulf of Mexico for bluefin spawning, eggs, and larvae. The model output presented in Muhling et al. 2010 was for the Gulf of Mexico; individual areas within the eastern Gulf of Mexico were not discussed in the context of valuation of habitat or providing additional management protection for bluefin tuna. Furthermore, Muhling et al. (2010) notes that "Physical and biological conditions for both larvae and adults in the GOM show high spatial and temporal variability, as a result of the dynamic oceanography of the GOM…variability in the position and strength of [warm eddies and cold-core eddies] is likely to drive the area, persistence and suitability of habitat favorable for larval bluefin tuna growth and survival…". Although Muhling found that the most favorable habitat was located in the western Gulf of Mexico (and is therefore already included in the current HAPC), moderate numbers of bluefin tuna larvae were found in the eastern Gulf of Mexico, favorability of the habitat varied by year, and some locations had a higher inferred probability of collecting bluefin tuna indicating that eastern Gulf of Mexico was ecologically important. Since Muhling et al. (2010) did not provide information that would support that some subsections of the eastern Gulf of Mexico were more important than others and instead provided information for the Gulf of Mexico as a whole, NMFS did not identify a scientific basis for the development of alternatives that would, for example, explore the impacts of incrementally adding portions of the Gulf of Mexico to the current HAPC. Therefore, NMFS identified a single alternative to extend the Gulf of Mexico HAPC based on the full model output from Muhling et al. 2010, given the variability in oceanographic conditions and the ecological importance of the Gulf of Mexico as a whole for bluefin tuna spawning, eggs, and larvae.

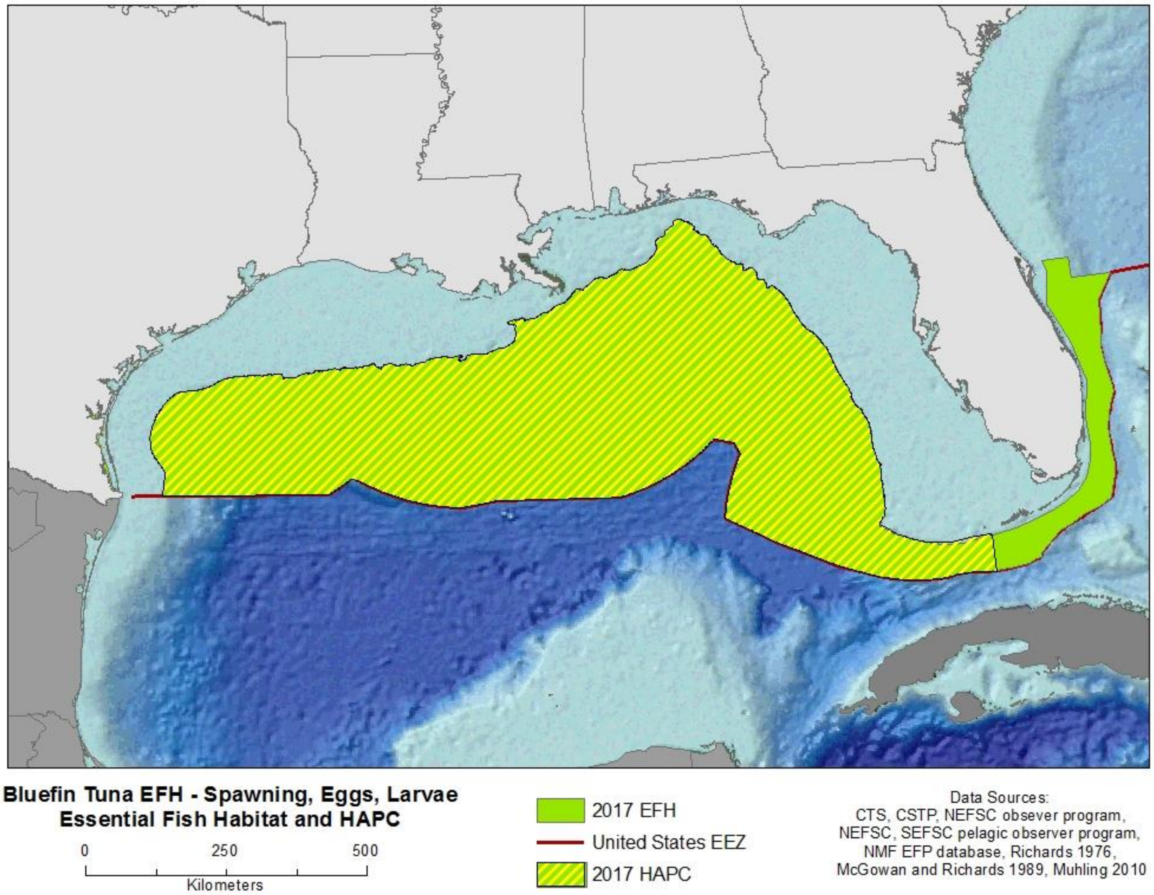

Figure 4.1 Preferred Updated EFH and HAPC for the bluefin tuna spawning, eggs, and larval life stage in the Gulf of Mexico the Florida Straits.

NMFS expects that the short-term direct and indirect ecological, social, and economic effects of modifying the HAPC for spawning bluefin tuna in the Gulf of Mexico would be neutral, as designation itself does not result in conservation or management actions, and this final amendment does not implement associated management measures for this HAPC. However, in comparison to the No Action alternative, NMFS expects that the long-term indirect ecological, social, and economic effects of Alternative 3b would be minor and beneficial. Expanding the HAPC would permit the incorporation and consideration of the best available scientific information in considering a HAPC designation for, among other things, purposes of focusing conservation efforts and avoiding adverse effects on EFH through the EFH consultation process, inform the public of areas that could receive additional scrutiny from NMFS with regards to adverse effects on EFH, and/or promote additional area-based research on spawning grounds and larval distribution of western Atlantic bluefin tuna).

Alternative 4 – Evaluate and, if warranted, modify current HAPC for sandbar shark

Alternative 4a – No Action. Retain current HAPC for sandbar shark

This alternative would retain, without modification, the current HAPCs for neonate/YOY and juvenile sandbar shark in four discrete coastal locations within the Mid-Atlantic. This alternative would also not designate any new HAPCs based on new information assessed during the 5-Year Review process, provided by scientific experts, information provided by the Atlantic HMS Advisory Panel, information provided by the public, and from other information gathered during development of this final amendment.

Since updating HAPC boundaries in itself does not result in management and conservation actions and no proposed measures restricting fishing or non-fishing activities are being made in association with the current HAPCs in this alternative, NMFS anticipates that short- and long-term direct and indirect ecological, social, and economic effects of adopting this alternative would be neutral.

This alternative is not preferred because it would maintain a HAPC outside the EFH range established in Amendment 1 and the proposed updated EFH range and thus would be inconsistent with the regulatory requirement that HAPCs be within the range of EFH 600.815(a)(8). Furthermore, it would not incorporate and consider the best available scientific information in considering a HAPC designation for, among other things, purposes of focusing conservation efforts, informing the public of areas that could receive additional scrutiny from NMFS with regard to adverse effects on EFH, or promoting area-based research. Therefore, this alternative would be inconsistent with National Standard 2 and would not meet the purpose and need for this action.

Alternative 4b – Modify current HAPC for sandbar shark – Preferred

This preferred alternative would modify the current HAPC for sandbar shark along the Atlantic coast based upon information gathered during the 5-Year Review process, provided by scientific experts, information provided by the Atlantic HMS Advisory Panel, information provided by the public, and from other information gathered during development of this final amendment. Modification would include changing the boundary of the existing HAPC to encompass different areas. The current HAPC for sandbar shark was designated in 1999 as part of the 1999 FMP for Atlantic Tunas, Swordfish, and Sharks. The boundaries of the HAPC were contained within the boundaries of EFH designated at that time. However, when EFH was updated for sandbar shark in 2009 as part of Amendment 1 to the 2006 Consolidated HMS FMP, the boundaries of the HAPC were not adjusted to reflect the updated boundaries of EFH. In particular, the 2009 EFH designations did not include inshore waters of Pamlico Sound, Chesapeake Bay, or Delaware Bay (Figure 4.2). Per the regulations at §600.815(a)(8), FMPs "identify specific types or areas of habitat *within* EFH as habitat areas of particular concern" (emphasis added). The current sandbar shark HAPC does not overlap with the currently designated sandbar shark EFH and thus is inconsistent with the regulatory requirement that HAPCs be within the area of EFH designation. Furthermore, under Preferred Alternative 2, this final amendment would modify areas within Chesapeake Bay and Delaware Bay that would be identified as EFH, and areas within Pamlico Sound would no longer be considered EFH. This preferred alternative therefore would adjust the boundaries of the HAPC so that it is contained within the sandbar shark EFH as further updated in this final amendment in accordance with the regulations concerning HAPCs (Figure 4.2 and Figure 4.3).

Changes to the sandbar shark HAPC include expansion of the HAPC area to the Delaware Bay and Chesapeake Bay to reflect updated EFH designations. Specifically, Chesapeake Bay, Grubbs and Musick (2007) note that the nursery grounds are located in the lower estuary (usually in locations with a salinity higher than 20.5 ppt and depth greater than 5 m); however, given the natural fluctuation in oceanographic conditions within the Chesapeake Bay system, the HAPC (and EFH) are clipped to the innermost points of distribution within the estuary system. Salinity was not noted to be a limiting factor in the distribution of sharks throughout Delaware Bay except in the immediate vicinity of the mouth of two rivers (McCandless et al. 2007); therefore the EFH and HAPC were not restricted to lower portions of the bay. Changes to the sandbar HAPC also include adjustment of the HAPC boundaries around the Outer Banks of North Carolina (i.e., removal of Pamlico Sound). NMFS biologists recommended removal of areas in Pamlico Sound because they were not as important as areas on the seaward side of the Outer Banks (C. McCandless, pers comm).

Much of the recent literature on sandbar shark assessed in the Final Atlantic HMS EFH 5-Year Review came from the recent SEDAR 21 assessment for sandbar shark, and focused more specifically on the assessment of life history parameters for purposes of a stock assessement. A comprehensive analysis of sandbar shark nursery areas is available in McCandless et al. (2007), and much of this literature constitutes best available published scientific information concerning mid-Atlantic sandbar shark nursery grounds. The updated areas we propose to identify as HAPCs are still considered to be important pupping and nursery grounds for sandbar shark. The areas included in the updated HAPC all meet at least one of the requirements for HAPC designation, specifically “the importance of the ecological function provided by the habitat.” Chesapeake Bay is considered to be the largest nursery area for sandbar sharks in the western Atlantic (Grubbs et al. 2007), and therefore, the habitat meets the criteria of providing an important ecological function. Young sandbar shark in the Chesapeake Bay are thought to be particularly susceptible to fishing and non-fishing impacts due to the aggregative behaviors undertaken while in nursery areas (Grubbs et al. 2007). Delaware Bay is also considered to be an important nursery ground for sandbar shark (thereby meeting the criteria of a HAPC due to its ecological importance), with evidence that large numbers of sandbar sharks exhibit high degrees of inter-annual site fidelity for up to five years following birth (McCandless et al. 2007). Tagging data presented in McCandless et al. (2007) and Grubbs et al. (2007) indicate that YOY sandbar sharks from both Chesapeake Bay and Delaware Bay overwinter off the coast of North Carolina, in the region designated as the southernmost portion of the sandbar shark HAPC (Figure 4.2). Because this habitat is considered a coastal wintertime nursery, and is heavily used by sandbar shark, this area meets the HAPC criteria due to its important ecological function. The northernmost area designated as part of the sandbar shark HAPC has been noted in the literature to encompass nursery grounds for both neonate and juvenile sandbar sharks (McCandless et al. 2002; Merson and Pratt 2007), and therefore, has also been recognized for its important ecological function to the stock.

NMFS expects that the short-term direct and indirect ecological, social, and economic effects of modifying the HAPCs for neonate/YOY sandbar shark coast of the Outer Banks (North Carolina), in Chesapeake Bay (Virginia and Maryland), Delaware Bay (Delaware and New Jersey) and in the Mullica River-Great Bay system (New Jersey), would be neutral. Designation of a HAPC in itself does not result in consideration or management actions, and no additional associated management measures are being proposed in this final amendment. However, in comparison to the No Action alternative, NMFS expects that the long-term indirect ecological, social, and economic effects of Alternative 4b would be minor and beneficial. This preferred alternative would permit the incorporation and consideration of the best available scientific information in considering a HAPC designation for, among other things, purposes of focusing conservation efforts through the EFH consultation process, inform the public of areas that could receive additional scrutiny from NMFS with regards to adverse effects on EFH, and/or promote additional area-based research on pupping grounds and nursery areas for sandbar shark in the Mid-Atlantic Bight region.

Given that NMFS has not identified new literature suggesting these areas are no longer important to sandbar, and the continued prevalence of sandbar shark neonates (and juveniles) in these areas (per continued sampling in these areas by the NEFSC), retention of the HAPCs with the minor adjustments discussed (i.e., adjustments to reflect data points in Chesapeake Bay and Delaware Bay, and removal of Pamlico Sound) are preferred. The preferred alternative meets the purpose and need by updating the HAPC in accordance with the best available information concerning sandbar shark and sandbar shark EFH. Continued recognition of these areas as HAPCs will help NMFS identify actions to encourage conservation and enhancement of sandbar EFH in future Habitat Consultations.

NMFS did not identify additional alternatives for sandbar shark HAPC modifications that would meet the purpose and need of the amendment because the proposed modifications are based on updating the current HAPC to be consistent with the EFH geographical requirements. There is no variation on this requirement that would both satisfy the EFH regulations and the existing scientific recommendations about what should be a HAPC for sandbar sharks (e.g., NMFS did not identify additional areas that should be added to the HAPCs through the 5-Year Review process; NMFS did not identify literature or new data which provided a rationale for the outright removal of any of the four HAPCs; and these areas are still recognized as important nursery grounds for sandbar shark (C. McCandless, NOAA NEFSC, pers. comm.)).

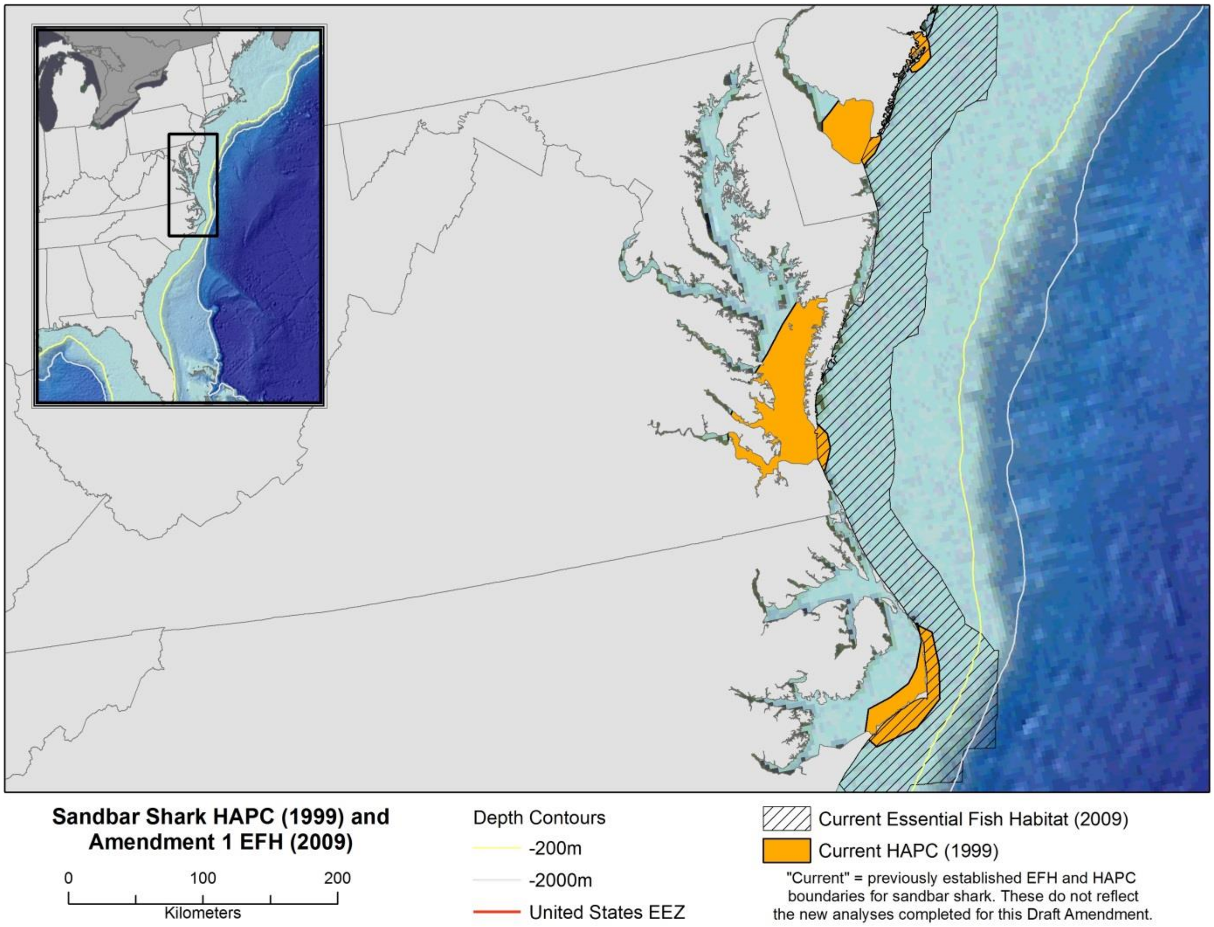

Figure 4.2 Current EFH and HAPC for Neonate/YOY Sandbar Shark

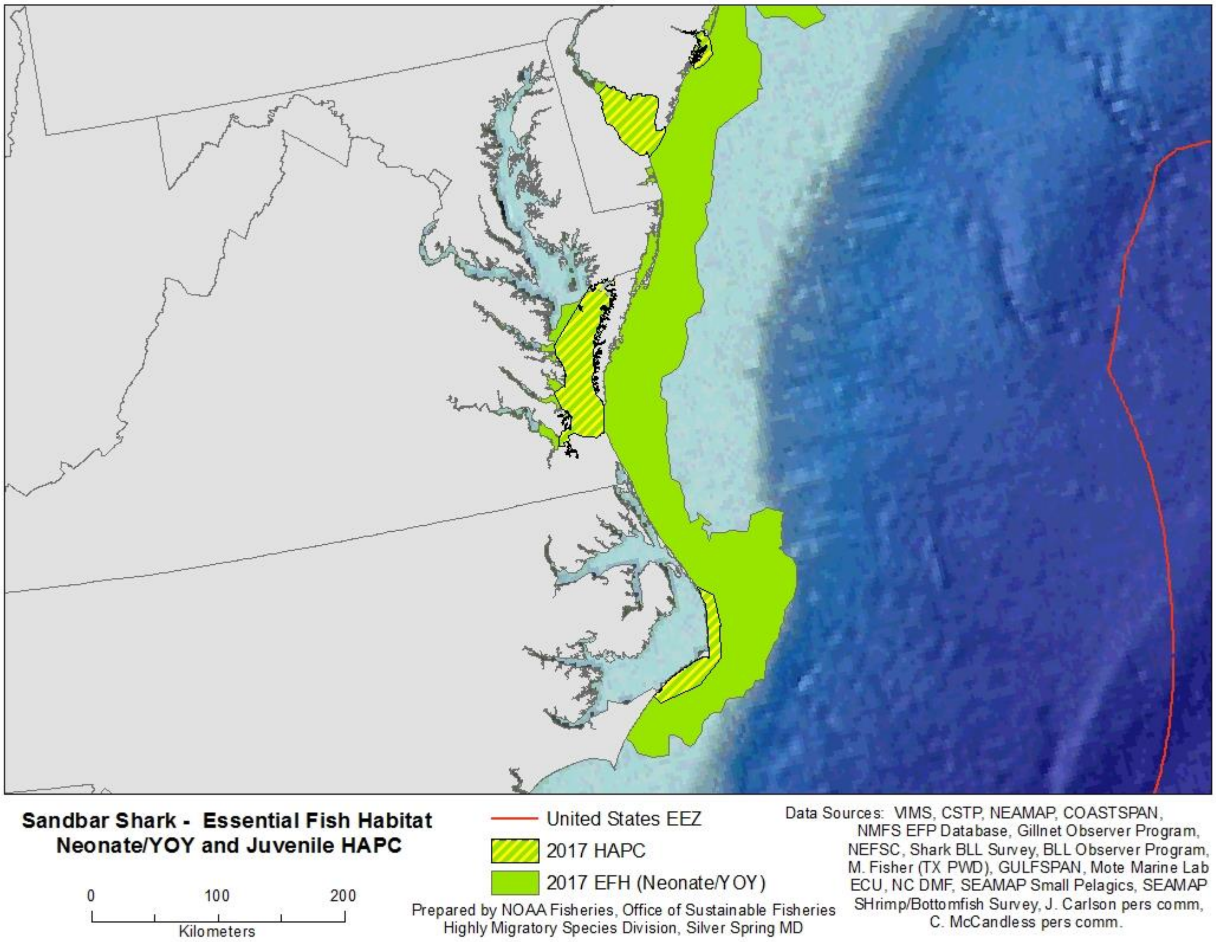

Figure 4.3 Preferred Updated EFH and HAPC for neonate sandbar shark

Alternative 5 – Evaluate and, if warranted, establish new HAPCs for lemon sharks.

Alternative 5a – No Action. Do not create a HAPC for lemon sharks.

This alternative would not designate new HAPCs based on new information assessed during the 5-Year Review process, information provided by scientific experts, information provided by the Atlantic HMS Advisory Panel, information provided by the public, and from other information gathered during development of this final amendment for lemon sharks off the central and southeastern Atlantic coast of Florida.

Since updating HAPC boundaries in itself does not result in management and conservation actions and no proposed measures restricting fishing or non-fishing activities are being made in association with the current HAPCs in this alternative, NMFS anticipates that short- and long-term direct and indirect ecological, social, and economic effects of adopting this alternative would be neutral.

This alternative is not preferred because it would not incorporate and consider the best available scientific information in considering a HAPC designation for, among other things, purposes of focusing conservation efforts, informing the public of areas that could receive additional scrutiny from NMFS with regard to adverse effects on EFH, or promoting area-based research. Therefore, it would be considered inconsistent with National Standard 2, and would not meet the purpose and need for this action.

Alternative 5b – Create a new HAPC for juvenile and adult lemon sharks between Jupiter Inlet Florida and Cape Canaveral Florida – Preferred

This preferred alternative would designate a new HAPC for lemon sharks between Jupiter Inlet, Florida and Cape Canaveral, Florida based upon tagging studies and public comments received that expressed concern about protection of habitat in locations where aggregations of lemon sharks are known to occur. NMFS also evaluated information gathered during the 5-Year Review process, information provided by scientific experts, information provided by the Atlantic HMS Advisory Panel, and other information gathered during development of this final amendment. NMFS received a petition from the public on December 8, 2015, requesting that NMFS postpone the opening of the 2016 shark commercial fishing season out of concern for the aggregations of lemon sharks that aggregate off Jupiter Inlet, and subsequent public commenters noted continued concerns for lemon shark aggregations at the spring 2016 HMS Advisory Panel.

Under this preferred alternative, a new lemon shark HAPC would be created which encompasses coastal region immediately surrounding Cape Canaveral that have been identified as important for juvenile lemon sharks (Reyier et al. 2008 and 2014), areas surrounding Jupiter Inlet that have been identified as important for adult lemon sharks (Kessel et al. 2014), and the habitat corridor linking the two areas (Figure 4.4). As discussed below, genetics and tagging data have connected the two areas. The 12 km seaward extent (based on unpublished tagging data cited in Reyier et al. 2014) also encompasses most of the tagging data presented in Kessel et al. (2014). Kessel et al. (2014) identified the areas between from 26º50’ N lat. to 27º04’ N lat. as ecologically important for adult lemon sharks; therefore, the HAPC would extend southward to the 26º50’ N lat. line.

Recently, new research and information has become available which suggests that areas off south central and southeastern Florida provides important nursery grounds and aggregation sites for multiple life stages. Reyier et al. (2008 and 2014) hypothesized that a juvenile lemon shark nursery ground may exist in the Cape Canaveral region. The hypothesized nursery area is adjacent to the Kennedy Space Center and the Cape Canaveral Air Force Station. Anthropogenic activities, including public beach access, in the area has been restricted due to security reasons since the 1950s. Additional restrictions on activities in nearshore waters established a de-facto no-take marine reserve between 2001 and 2007 (Reyier et al. 2008). Aggregations of juvenile lemon sharks have been known to appear annually since 2003 within sheltered longshore troughs and the shallow open surf zone adjacent to Cape Canaveral (Reyier et al. 2008) and retain a high degree of site fidelity from November through February (Reyier et al. 2014). These aggregations were noted to remain intact under normal wintertime conditions, but were disbanded following cold weather events accompanied by precipitous drops in water temperature. Tagging data suggested that under these conditions, individuals migrated southward along the coast of Florida, and may return to the Cape Canaveral region as temperatures return to near-normal wintertime conditions (Reyier et al. 2014). Reyier et al. (2008 and 2014) speculate that the geophysical and oceanographic conditions in the Cape Canaveral region create a climatic transition zone that may create a barrier to northward migration for lemon sharks (however lemon sharks remain in this area at times when water temperatures to the north are well within tolerance limits); or that the area could constitute productive foraging ground or provide refuge from predators.

Additionally, large, adult lemon sharks were noted by the recreational dive community to form aggregations (50-100 individuals) off Jupiter Inlet in 20-35 m of water between December and April of 2007-2011 (Kessel et al. 2014). Kessel et al. (2014) hypothesized that southward migrating sharks ceased migration when they encountered the warm waters of the Gulf Stream and aggregated in reef and wreck structure surrounding Jupiter Inlet.

In this preferred alternative, NMFS combined the two areas into one HAPC. Analyses completed by Kessel et al (2014) suggested that adult lemon sharks off Jupiter Inlet may be genetically related to juvenile lemon sharks overwintering around Cape Canaveral; however the Jupiter Inlet adults were genetically differentiated from juvenile lemon sharks sampled in the Florida Keys. This suggests that juveniles in Cape Canaveral and adults in Jupiter Inlet might be part of the same, genetically distinct population of sharks; however, the timing of recruitment by Cape Canaveral juveniles into the adult aggregations off Jupiter Inlet is unclear (Reyier et al. 2014). Furthermore, tagging data implies connectivity between the two locations. Kessel et al. (2014) noted that the Cape Canaveral array contained the largest number of long distance transmitter detections of Jupiter-tagged sharks. Conversely, the sharks tagged by Reyier et al. (2014) were noted to make southward movements along the Florida coast during the overwintering period during times when water temperatures at the Cape Canaveral array were unusually cold, however, when temperature fluctuations were less extreme juveniles only departed from Cape Canaveral habitats temporarily during the overwinter period. Habitats between Cape Canaveral and Jupiter Inlet are likely part of the migration pathway and are thus included in the HAPC.

At this point, the exact functionality of the habitats in Cape Canaveral and Jupiter Inlet for southeastern United States lemon sharks is not fully understood (but speculated upon in Reyier et al. 2008 and 2014, and Kessel et al. 2014); similarly the importance of habitats between Cape Canaveral and Jupiter Inlet is unclear. However, identifying this area as a HAPC would increase federal agency scrutiny of activities, focus research activities, and draw additional public attention to habitats that could be important for lemon sharks.

Collectively, these habitats meet several of the criteria that should be considered for a HAPC. These habitats occur near a heavily populated area of southeastern Florida. As previously mentioned, the military restrictions on public beach access provided a *de facto* protection for juvenile nursery sharks; however, if policies for access and resource use around Cape Canaveral change, the aggregations could become more susceptible to recreational fishing. Reyier et al (2008) also noted concerns about the effects of shoreline hardening, sand mining, and ongoing sand bypass activities associated with the Port Canaveral jetty. These activities could affect the processes that guide alongshore trough formation and shoals that are the habitat for the aggregations (Reyier et al. 2008). Therefore, these sites could meet the HAPC criteria of being sensitive to human-induced environmental degradation or development activities. Reyier et al. (2014) suggests that the Cape Canaveral region might “constitute the single most valuable winter nursery for lemon sharks in U.S. waters north of the Florida Keys – Florida Bay region” as “…this aggregating behavior has not been noted for juveniles elsewhere along the U.S. Atlantic coast.” The Cape Canaveral region might therefore meet the HAPC criteria of being ecologically important to juvenile sharks as wintertime nursery grounds, and could also be considered fairly rare for this sub-population since it is only location where juveniles are known to exhibit aggregative behavior along the Atlantic coast.

The criteria which must be considered for a HAPC could also be applied to the Jupiter Inlet aggregations of lemon sharks. Kessel et al. (2014) speculates that the specified artificial reef sites along the 15-30m reef lines may provide daytime resting locations (nighttime foraging activities were hypothesized to be completed elsewhere), and that the aggregative behavior may make these sharks susceptible to fishing activity. Therefore, these sites may have an important ecological function as a daytime refuge. Furthermore, both locations were noted by Kessel et al. (2014) and Reyier et al. (2008 and 2014) to be climactic transition zones, and the behavior of animals in these locations was strongly associated with water temperature. Behavior of lemon sharks may thus be influenced by changes in local oceanographic patterns, which could happen as a result of climate change (Kessel et al. 2014); utilization and distribution of sharks across these habitats, and the migratory corridor connecting them, could therefore be broadly affected by human-induced environmental degradation (thereby meeting one of the requirements for a HAPC).

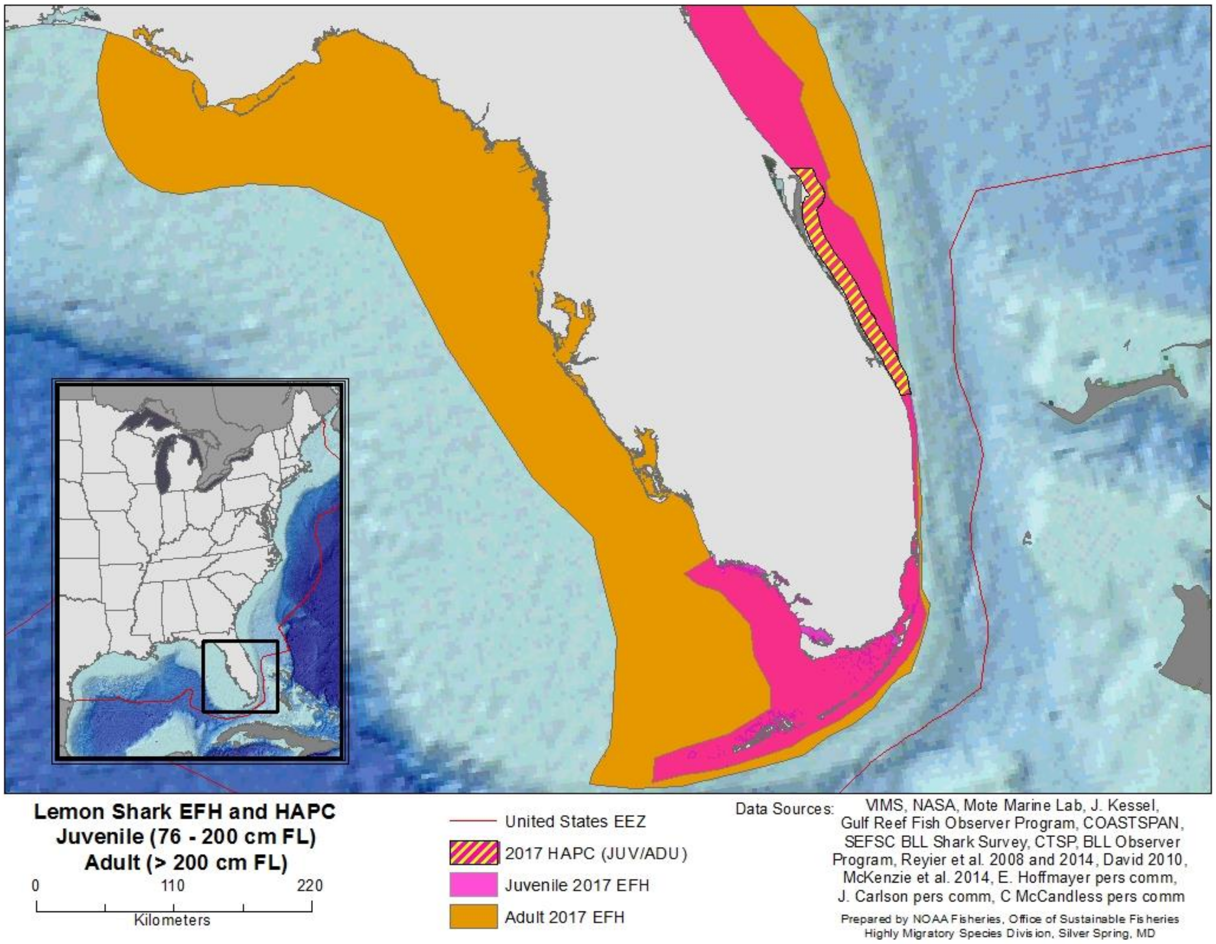

Figure 4.4 Updated lemon shark EFH for adults and juveniles, and an area considered for HAPC designation for lemon sharks between Cape Canaveral and Jupiter Inlet, Florida.

NMFS expects that the short-term direct and indirect ecological, social, and economic effects of creating a HAPC for lemon sharks off the coast of southeastern Florida would be neutral. Designation of a HAPC in itself does not result in consideration or management actions and no additional associated management measures are preferred in this Amendment. However, in comparison to the no action alternative, NMFS expects that the long-term indirect ecological, social, and economic effects of Alternative 5b would be minor and beneficial. This preferred alternative would permit the incorporation and consideration of the best available scientific information in considering a HAPC designation for, among other things, purposes of focusing conservation efforts through the EFH consultation process, inform the public of areas that could receive additional scrutiny from NMFS with regards to adverse effects on EFH, and/or promote additional area-based research on lemon sharks and lemon shark habitat utilization off the southeastern United States.

The preferred alternative meets the purpose and need by updating the HAPC in accordance with the best available information concerning lemon shark and lemon shark EFH. Continued recognition of these areas as HAPCs will help NMFS identify actions to encourage conservation and enhancement of lemon shark EFH in future EFH consultations.

Alternative 5c – Create a new HAPC for lemon sharks in the vicinity of Cape Canaveral, Florida.

This alternative would designate a new HAPC for juvenile lemon sharks off Cape Canaveral, Florida based upon new information considered during the 5-Year Review process, provided by scientific experts, information provided by the Atlantic HMS Advisory Panel, information provided by the public, and from other information gathered during development of this final amendment. Specifically, NMFS identified research (including tagging studies) published by Reyier et al. (2008 and 2014) concerning a spatially discrete, high density juvenile lemon shark nursery within the Cape Canaveral region of southeastern Florida (Figure 2.4). Studies have shown that aggregations of juvenile lemon sharks have appeared annually since 2003 within sheltered longshore troughs and the shallow open surf zone adjacent to Cape Canaveral (Reyier et al. 2008), and that those sharks retain a high degree of site fidelity to the aggregation sites (Reyier et al. 2014).

The HAPC would encompass the coastal region immediately surrounding Cape Canaveral, and would extend seaward 12 km from the beach (Reyier, unpublished data, as cited in Reyier et al. 2014). The southern extent of the HAPC would extend 12 km from the beach at the Port Canaveral jetty. These boundaries would encircle the known aggregation sites and follow recognizable boundaries identified in Reyier et al. (2008). If selected, this alternative would create a single HAPC for lemon sharks. In comparison to Alternative 5b, this alternative only uses the bounding areas around the known aggregation sites for lemon sharks in the Cape Canaveral region identified in Reyier et al. (2008) and Reyier et al. (2014) as the extent of a HAPC rather than an extending the HAPC south to the Jupiter Inlet area.

This area meets several of the criteria that must be considered to designate a HAPC. Reyier et al. (2008) noted that the military restrictions on public beach access (due to activities associated with the launch facility at Kennedy Space Center and security measures associated with Cape Canaveral Air Force Station) provided a *de facto* protection for juvenile nursery sharks since the 1950s; however there are limited areas where recreational use of the shoreline is authorized in three locations by military employees. Furthermore, between 2001 and 2007, nearshore activities (including vessel based fishing) were restricted due to elevated security around the Air Force base. However, if policies for access and resource use around Cape Canaveral change, the aggregations could become susceptible to recreational fishing. This study also notes concerns about the effects of shoreline hardening, sand mining, and ongoing sand bypass activities associated with the Port Canaveral jetty. These activities could affect the processes that guide alongshore trough formation and shoals that are the habitat for the aggregations (Reyier et al. 2008). Therefore, these sites could meet the HAPC criteria of being sensitive to human-induced environmental degradation or development activities. Reyier et al. (2014) suggests that the Cape Canaveral region might “constitute the single most valuable winter nursery for lemon sharks in

U.S. waters north of the Florida Keys – Florida Bay region" as "…this aggregating behavior has not been noted for juveniles elsewhere along the U.S. Atlantic coast." The Cape Canaveral region might therefore meet the HAPC criteria of being ecologically important to juvenile sharks as wintertime nursery grounds, and could also be considered fairly rare for this sub-population since it is only location where juveniles are known to exhibit aggregative behavior along the Atlantic coast.

NMFS expects that the short-term direct and indirect ecological, social, and economic effects of creating a HAPC for lemon sharks off the coast of Cape Canaveral, Florida would be neutral. Designation of a HAPC in itself does not result in consideration or management actions and no additional associated management measures are preferred in this Amendment. However, in comparison to the no action alternative, NMFS expects that the long-term indirect ecological, social, and economic effects of Alternative 5c would be minor and beneficial.

This alternative does not encompass all of the areas identified in recently published literature as potentially important aggregation sites for lemon sharks (i.e., Kessel et al. 2014). This alternative is not preferred because it would not incorporate and consider the best available scientific information in considering a HAPC designation for, among other things, purposes of focusing conservation efforts, informing the public of areas that could receive additional scrutiny from NMFS with regard to adverse effects on EFH, or promoting area-based research. Therefore, it would be considered inconsistent with National Standard 2, and would not meet the purpose and need for this action.

Alternative 5d – Create a new HAPC for adult lemon sharks in the vicinity of Jupiter Inlet, Florida.

This alternative would designate a new HAPC for lemon sharks in the vicinity of Jupiter Inlet, Florida, based upon new information identified in the 5-Year Review; public comments received that expressed concern about protection of habitat in locations where aggregations of lemon sharks are known to occur; information provided by scientific experts and by the Atlantic HMS Advisory Panel; and from other information gathered during development of this final amendment. Specifically, NMFS identified new research by Kessel et al. (2014) that identified a spatially discrete adult lemon shark aggregation sites associated with artificial reefs and the natural reef line in the vicinity of Jupiter Inlet. NMFS also received a petition from the public on December 8, 2015, requesting that NMFS postpone the opening of the 2016 shark commercial fishing season out of concern for the aggregations of lemon sharks that aggregate off Jupiter Inlet, and subsequent public commenters noted continued concerns for lemon shark aggregations at the Spring 2016 HMS Advisory Panel.

Under this alternative, a new lemon shark HAPC would be created which encompasses coastal region immediately surrounding Jupiter Inlet that have been identified as important for adult lemon sharks (Kessel et al. 2014) (Figure 2.5). The 12 km seaward extent (based on unpublished tagging data cited in Reyier et al. 2014) also encompasses most of the tagging data presented in Kessel et al. 2014. This boundary is also consistent with the outer edge of the proposed updated EFH that would be implemented if Preferred Alternative 2 is selected. Kessel et al. (2014) identified the areas between from 26º50' N lat. to 27º04' N lat. as ecologically important for adult lemon sharks; therefore, the HAPC would use these latitudinal lines as the northern and southern extent. If selected, this alternative would create a single HAPC for lemon sharks. In comparison to Alternative 5b, this alternative only uses the areas identified in Kessel et al. (2014) as the extent of a HAPC rather than an extending the HAPC north to the Cape Canaveral area.

The criteria which must be considered for a HAPC could be applied to the habitats utilized by the Jupiter Inlet aggregations of lemon sharks. Kessel et al. (2014) speculated that the specified artificial reef sites along the 15-30m reef lines may provide daytime resting locations (nighttime foraging activities were hypothesized to be completed elsewhere), and that the aggregative behavior may make these sharks susceptible to fishing activity. Therefore, these sites may have an important ecological function as a daytime refuge. Furthermore, the Jupiter Inlet area was noted to be climactic transition zones, and the behavior of animals in these locations was associated with water temperature. Behavior of lemon sharks may thus be influenced by changes in local oceanographic patterns, which could happen as a result of climate change (Kessel et al. 2014); utilization and distribution of sharks within this area could therefore be broadly affected by human-induced environmental degradation (thereby meeting one of the requirements for an HAPC).

NMFS expects that the short-term direct and indirect ecological, social, and economic effects of creating a HAPC for lemon sharks off the coast of southeastern Florida would be neutral. Designation of a HAPC in itself does not result in consideration or management actions and no additional associated management measures are preferred in this final amendment. However, in comparison to the no action alternative, NMFS expects that the long-term indirect ecological, social, and economic effects of Alternative 5d would be minor and beneficial.

This alternative does not encompass all of the areas identified in recently published literature as potentially important aggregation sites for lemon sharks (i.e., Reyier et al. 2008 and 2014). This alternative is not preferred because it would not incorporate and consider the best available scientific information in considering a HAPC designation for, among other things, purposes of focusing conservation efforts, informing the public of areas that could receive additional scrutiny from NMFS with regard to adverse effects on EFH, or promoting area-based research. Therefore, it would be considered inconsistent with National Standard 2, and would not meet the purpose and need for this action.

Alternative 6 – Evaluate and, if warranted, establish new HAPCs for sand tiger sharks.

Alternative 6a – No Action. Do not create a HAPC for sand tiger sharks.

This alternative would not designate a new HAPC based on new information assessed during the 5-Year Review process, information provided by scientific experts, information provided by the Atlantic HMS Advisory Panel, information provided by the public, and from other information gathered during development of this final amendment for sand tiger sharks off the central and southeastern Atlantic coast of Florida.

Since updating HAPC boundaries in itself does not result in management and conservation actions and no measures restricting fishing or non-fishing activities are preferred in association with the current HAPCs in this alternative, NMFS anticipates that short- and long-term direct and indirect ecological, social, and economic effects of adopting this alternative would be neutral.

This alternative is not preferred because it would not incorporate and consider the best available scientific information in considering a HAPC designation for, among other things, purposes of focusing conservation efforts, informing the public of areas that could receive additional scrutiny from NMFS with regard to adverse effects on EFH, or promoting area-based research. Therefore, it would be considered inconsistent with National Standard 2, and would not meet the purpose and need for this action.

Alternative 6b – Create a new HAPC for sand tiger sharks in Delaware Bay and in coastal Massachusetts – Preferred.

This preferred alternative would designate new HAPCs for sand tiger sharks in Delaware Bay and/or in coastal Massachusetts based upon information gathered during the 5-Year Review process, provided by scientific experts, information provided by the Atlantic HMS Advisory Panel, information provided by the public, and from other information gathered during development of this final amendment. Kernal density estimation model output suggested that the entirety of Delaware Bay should be included as EFH for all life stages of sand tiger sharks, and that the PKD bay system should be included as EFH for neonate and juvenile sand tiger sharks. The prevalence of new survey and tagging data points north of Cape Cod would warrant an extension of EFH for neonate/YOY and juvenile sand tiger sharks into these areas in this update (Kneebone et al. 2014).

This preferred alternative would designate a new HAPC for all life stages of sand tiger shark in Delaware Bay based on data collected by the NEFSC, Teter et al. (2015), Haulsee et al. (unpublished data, American Fisheries Society Annual Meeting 2014) and Haulsee et al. (2016), and Kilfoil et al. (unpublished data, American Fisheries Society Annual Meeting 2014) indicating that Delaware Bay might constitute important habitat for sand tiger sharks (Figure 4.5) The published works by Teter et al. (2015) and Haulsee et al. (2016) do not include geographic information describing the inshore distribution of sand tigers into the Delaware River. The inshore extent of the HAPC is designated based on scientific recommendations from NOAA scientists involved in the COASTSPAN survey (C. McCandless pers comm). Specifically, the inshore extent of the HAPC reflects a line drawn from Port Mahon to Egg Point Island; the HAPC also excludes an area rarely used by sand tiger sharks and for which NMFS has few data points, that is north of a line between Egg Point Island and Bidwell Creek (on the Cape May peninsula).

The COASTSPAN survey conducted in Delaware and New Jersey state waters reports consistent seasonal use of Delaware Bay by all life stages of sand tigers from 2009 to 2014 (NOAA 2009, 2010, 2011, 2012, 2013, 2014). A pop-up satellite archival tags (PSAT) and acoustic tag study conducted on sand tiger sharks in Delaware Bay in 2008 noted seasonal departures of sand tiger sharks from Delaware Bay by October and subsequent annual return to Delaware Bay the following summer (Teter et al. 2015). Additional tagging research also suggested high inter-annual site fidelity of sand tiger sharks for this region (Haulsee et al., unpublished data, American Fisheries Society Annual Meeting 2014; Haulsee et al. 2016). Kilfoil (2014) noted high abundance of sand tigers in Delaware Bay and nearby coastal regions (specifically, between the mouth of the Delaware River and Cape Henlopen, Delaware). Acoustic tracking suggested that areas just outside Delaware Bay might also be important core use areas (i.e., an area that contains a high proportion of detections and/or is heavily utilized by tagged animals). Based upon research presented in Kilfoil 2014 and recommendations from NMFS scientists ((D. Fox, pers comm; C. McCandless, pers comm), NMFS has included areas just outside of Delaware Bay as part of the HAPC.

This preferred alternative would also designate a HAPC in the PKD bay system in coastal Massachusetts for juveniles and neonate/YOY sand tiger in the Cape Cod region based on data collected by the NEFSC, among others, and scientific research published by Skomal (2002), and Kneebone et al. (2012, 2014) (Figure 4.6). Tagging data suggest that tagged neonates and juveniles are seasonally distributed within the estuary (June through October). Tagged animals both consistently used habitats for extended periods of time, and exhibited inter-annual site fidelity for the PKD bay system. The core use areas were within the northern units of the bay system (Duxbury and Kingston Bays); however, Kneebone et al. (2012) noted detections of tagged animals throughout the system. Therefore, the proposed HAPC is inclusive of the entire PKD bay system. Kneebone et al. (2012, 2014) hypothesized that the lack of large predators and an abundance of prey (e.g., menhaden, crabs, etc) made this system a productive nursery ground for young sand tiger sharks.

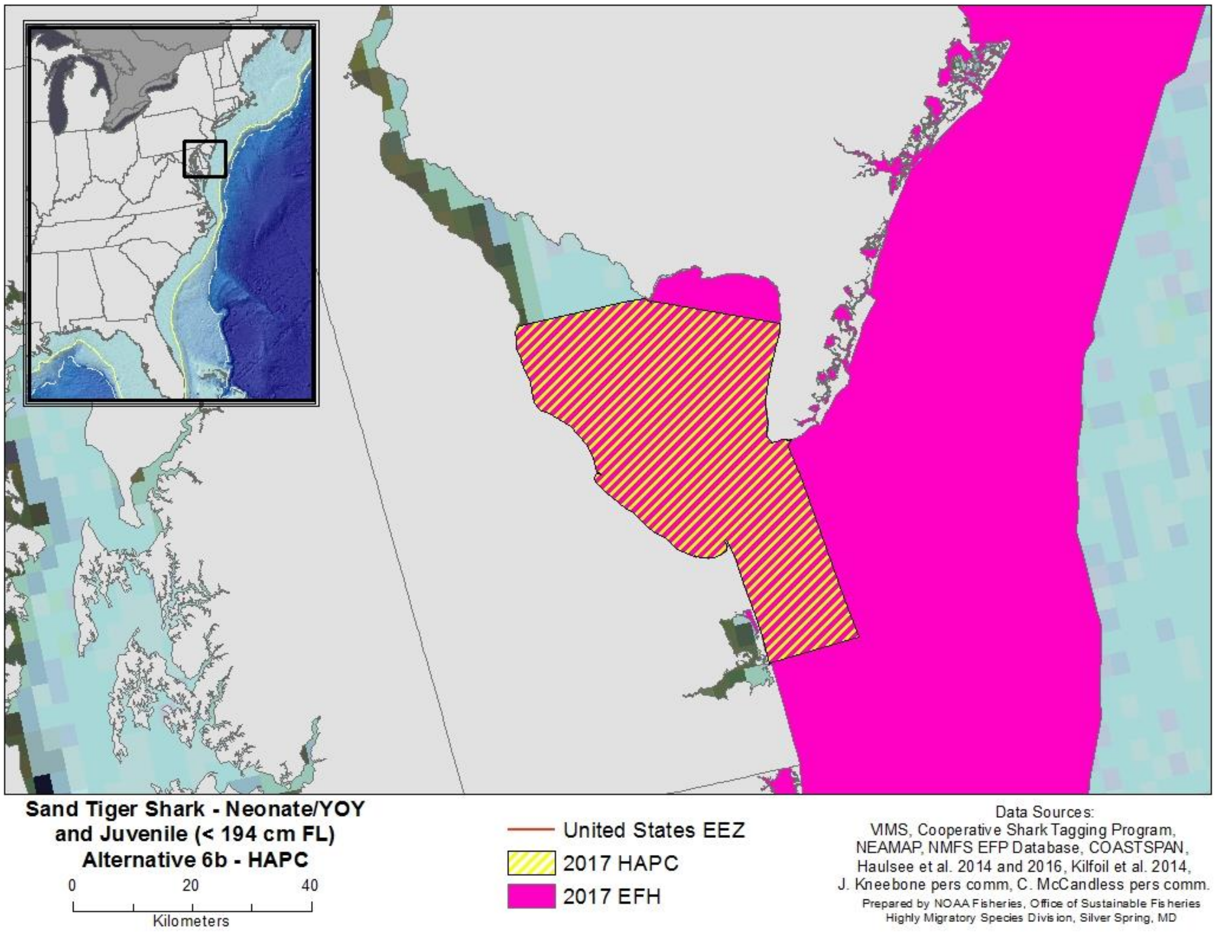

Figure 4.5 Sand Tiger Shark HAPC for all Life Stages in Delaware Bay

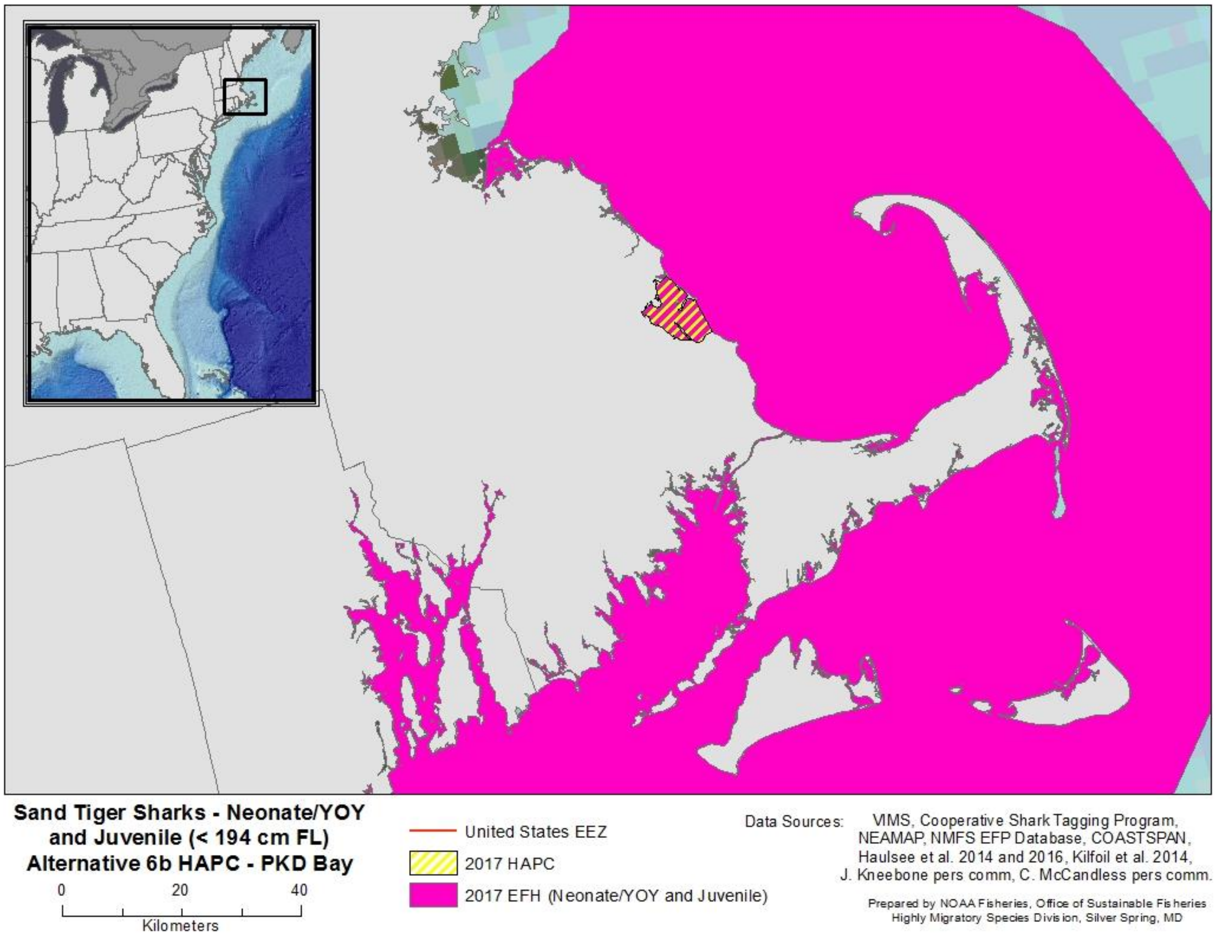

Figure 4.6 Sand Tiger Shark HAPC for Neonates/YOY and Juveniles in the PKD Bay System

Collectively, the new HAPCs would meet at least one, and possibly more, of the criteria that must be considered for HAPC designation. Delaware Bay and the PKD bay systems are recognized nursery areas for sand tiger sharks, and therefore provide a highly important ecological function to the Atlantic stock of sand tiger sharks. Additionally, both areas could be susceptible to anthropogenic activities that may degrade the environment or result in increased development pressure on the habitat. Kilfoil and colleagues (unpublished data) concluded that the high concentration of sharks and increasing anthropogenic stress (i.e., coastal development and shore fishing targeting sand tiger sharks) might warrant the development of a HAPC in and around Delaware Bay. Sand tiger sharks were once highly abundant in Massachusetts, but due to heavy exploitation in commercial fisheries in the early 1900s, populations declined. Increasing numbers of sand tigers have been reported by commercial and recreational fishermen in the Massachusetts region (Kneebone et al. 2012, citing J Chisholm and GB Skomal, unpublished data). Kneebone et al. (2012) noted that the distribution of sharks within the PKD system may be a function of sharks avoiding areas with high levels of anthropogenic activity (but recommend additional research on the subject). See Chapter 6 for the description of life history and EFH for sand tiger shark.

NMFS has not included additional alternatives which evaluate the creation of a single HAPC (one in each of the separate identified areas) because there is no scientific information available which compares the value and ecological importance of the habitats in Delaware Bay versus the habitats in the PKD bay system; therefore there is no scientific rationale to support the selection of a single area over another and additional alternatives would not meet the purpose and need of the final amendment.

NMFS expects that the short-term direct and indirect ecological, social, and economic effects of creating HAPCs for sand tiger sharks in Delaware Bay and in the PKD bay system would be neutral. Designation of a HAPC in itself does not result in consideration or management actions and no additional associated management measures are preferred in this final amendment. However, in comparison to the no action alternative, NMFS expects that the long-term indirect ecological, social, and economic effects of Alternative 5d would be minor and beneficial. This preferred alternative would permit the incorporation and consideration of the best available scientific information in considering a HAPC designation for, among other things, purposes of focusing conservation efforts through the EFH consultation process, inform the public of areas that could receive additional scrutiny from NMFS with regard to adverse effects on EFH, and/or promote additional area-based research on sand tiger populations and sand tiger habitat utilization in Delaware Bay and coastal Massachusetts.

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 2 and HAPC Alternatives 3b, 4b, 5b, and 6b, as described and analyzed earlier in this chapter. Chapter 6 and Appendix G provide subsequent information on these preferred alternatives to fulfill the requirements of the Magnuson-Stevens Act.

4.4 Impacts on Essential Fish Habitat

The actions being considered in this final amendment, to update EFH and update and designate new HAPCs, would not result in any adverse effects on EFH of Atlantic HMS or other federally managed species. The focus of this final amendment is to update existing EFH and HAPCs as well as establish new HAPCs for certain HMS. Since no associated conservation and management measures are preferred in this final amendment, there would likely be no change in fishing effort and thus no direct impacts on EFH. Having updated EFH designations for HMS could potentially increase the long-term productivity of the environment. Furthermore, NMFS has reviewed fishing and non-fishing effects on EFH in Chapter 4.9 (both HMS EFH and the EFH of other federally managed species) and determined that HMS fishing activities would likely have minimal to no adverse effect on EFH.

4.5 Impacts on Protected Resources

The actions being considered in this final amendment, to update EFH and update and designate new HAPCs, would not result in any short or long-term direct or indirect adverse ecological impacts on protected resources. Since the amendment affects habitat designations and no management measures are being proposed in this final amendment, no impacts on protected resources are anticipated with these habitat designations.

4.6 Environmental Justice Concerns

Executive Order 12898 requires agencies to identify and address disproportionately high and adverse environmental effects of its regulations on minority and low-income populations. To determine whether environmental justice concerns exist, the demographics of the affected area should be examined to ascertain whether minority populations and low-income populations are present. If so, a determination must be made as to whether implementation of the alternatives may cause disproportionately high and adverse human health or environmental effects on these populations.

Community profile information are available in the 2006 Consolidated HMS FMP (Chapter 9), a report by MRAG Americas and Jepson (2008) titled "Updated Profiles for HMS Dependent Fishing Communities" (Appendix E of Amendment 2 to the 2006 Consolidated HMS FMP), and in the 2012 HMS SAFE Report. The MRAG report updated community profiles presented in the 2006 Consolidated HMS FMP and provided new social impacts assessments for HMS fishing communities along the Atlantic and Gulf of Mexico coasts. The 2011 and 2012 SAFE Reports (NMFS 2011, 2012) include updated census data for all coastal Atlantic states, and some selected communities that are known centers of HMS fishing, processing, or dealer activity. Demographic data indicate that coastal counties with fishing communities are variable in terms of social indicators like income, employment, and race and ethnic composition.

The actions being considered in this final amendment, to update EFH and update or designate new HAPCs, would not result in any adverse impacts on the human environment. Since no management measures are being proposed in this final amendment that would alter the current use of the environment, there would likely be no environmental justice concerns due to this final amendment.

4.7 Coastal Zone Management Act (CZMA)

Following publication of a Notice of Availability for Draft Amendment 10 (81 FR 62100; September 8, 2016), a consistency determination was submitted to the states on September 12, 2016, to initiate review by the responsible state agencies under section 307 of the CZMA. Under 15 C.F.R. § 930.41, states and/or U.S. territories have 60 days to respond after the receipt of the consistency determination and supporting materials. States can request an extension of up to 15 days. If a response is not received within those time limits, NMFS can presume concurrence (15 C.F.R. § 930.41(a)). Twelve states/commonwealths replied within the response time period that the draft amendment was consistent, to the extent practicable, with the enforceable policies of their CMPs (Georgia, South Carolina, Alabama, Mississippi, Louisiana, Rhode Island, Florida, North Carolina, New Jersey, Virginia, Delaware, and Connecticut). Another nine states/commonwealths (Maine, New Hampshire, Massachusetts, New York, Maryland, and Texas, Puerto Rico, Pennsylvania, U.S. Virgin Islands) did not respond within the response time period, nor did they request an extension in the comment period; therefore, NMFS presumes their concurrence. NMFS has therefore determined that the measures in Amendment 10 are consistent to the maximum extent practicable with the enforceable policies of the coastal states in the Atlantic, Gulf of Mexico, and U.S. Caribbean.

4.8 Cumulative Impacts

"Cumulative impacts are 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… Cumulative impacts can result from individually minor, but collectively significant actions taking place over a period of time" (50 CFR 600.815(a)(5) (see also 40 CFR §1508.7). A cumulative impact includes the total effect on a natural resource, ecosystem, or human community due to past, present, and reasonably foreseeable future activities or actions of federal, non–federal, public, and private entities. Cumulative impacts may also include the effects of natural processes and events, depending on the specific resource in question. Cumulative impacts include the total of all impacts to a particular resource that have occurred, are occurring, and would likely occur as a result of any action or influence, including the direct and reasonably foreseeable indirect impacts of a federal activity. The goal of this section is to describe the cumulative ecological, economic and social impacts of past, present and reasonably foreseeable future actions with regard to the management measures presented in this document.

The actions being considered in this final amendment, to update EFH and update designate new HAPCs, would not result in any cumulative impacts on the human environment. Since no management measures are preferred in this final amendment that would alter the current use of the environment, there would likely be no changes in the short term use of the environment. Thus, no cumulative impacts are expected.

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5 ANALYSIS OF FISHING AND NON-FISHING EFFECTS

5.1 Analysis of Fishing Effects

The Magnuson-Stevens Act and the EFH regulations (600.815(a)(2)) 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 effects if there is evidence that a fishing practice is having more than a minimal and not temporary adverse effect on EFH.

To determine if fishing gears may adversely affect EFH and if that effect can be minimized, 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.

5.1.1 HMS Fisheries Gear Effects

Most HMS reside in the upper part of the water column and habitat preferences are likely influenced by oceanic factors such as current confluences, temperature edges, and surface structure. Most HMS gears are fished in these areas and do not pose any adverse effects on HMS EFH. NMFS completed reviews of fishing gear impacts in the 1999 FMP, Amendment 1 to the 1988 Billfish FMP, the 2006 Consolidated HMS FMP, Amendment 1 to the 2006 Consolidated HMS FMP, and the 2015 Final 5-Year Review of Atlantic HMS EFH. These analyses determined that the majority of HMS gears are fished within the water column and do not make contact with the sea floor. Shark BLL gear is an HMS gear that does make contact with the bottom, and NMFS conducted an additional review of BLL gear impacts to EFH (benthic substrate and coral habitat) in Amendment 1 to the Consolidated HMS FMP. Some shark species prefer benthic habitats, but shark BLL gear does not pose a threat to the EFH because it occurs in mainly sandy/mud areas and would have temporary and minimal impacts to the substrate.

The shark BLL fishery is prohibited from operating in the Marine Protected Areas (MPAs), HAPCs, and time/area closures that were established by the Caribbean and South Atlantic Fishery Management Councils to protect vulnerable deep water coral habitats. Since shark BLL gear is prohibited in these areas, this gear will not have any effect on deep water coral HAPCs or EFH. Some protected areas established for deep water coral are shown in Figure 5.1.

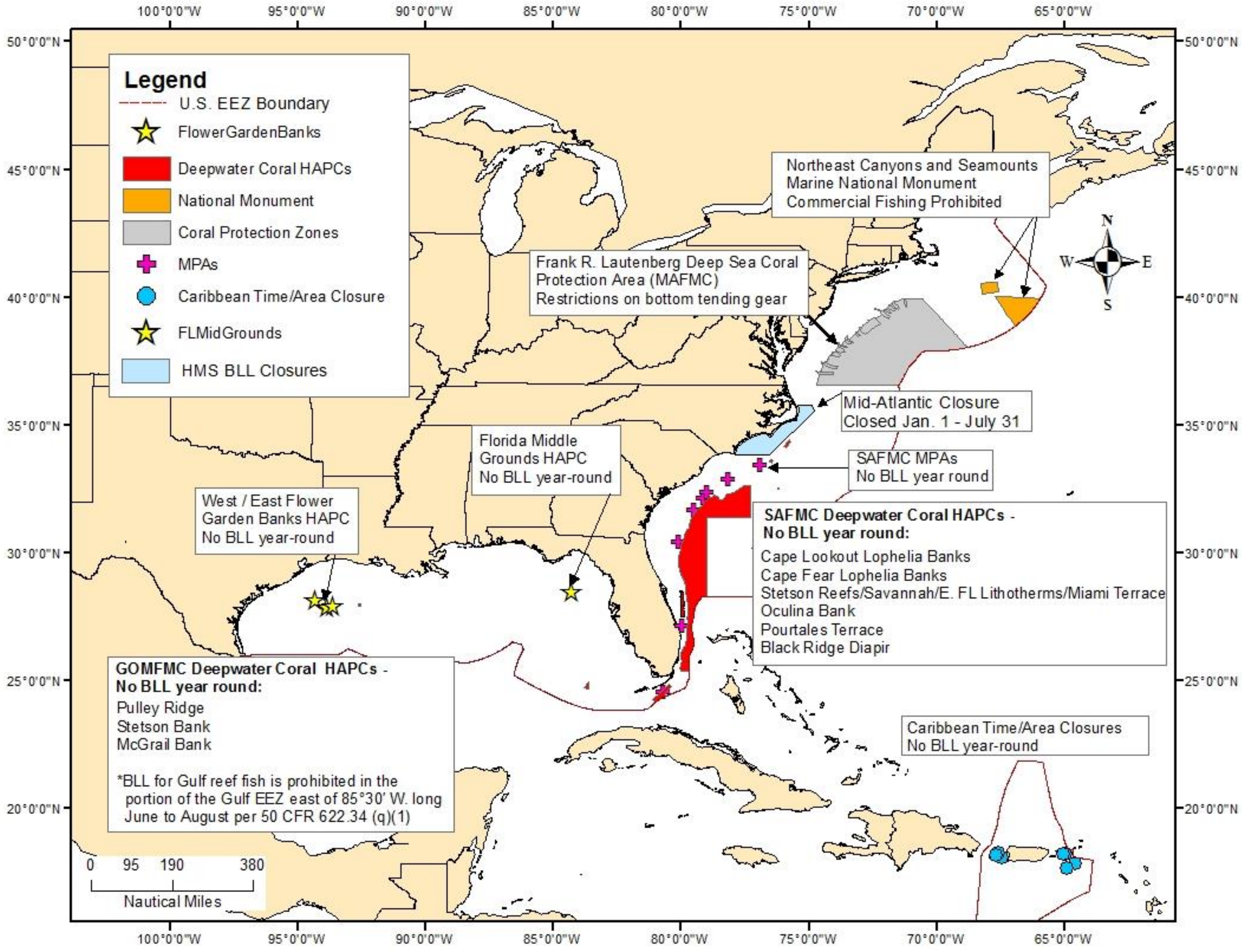

Figure 5.1 **Marine protected areas (MPAs), Habitat Areas of Particular Concern (HAPCs), and Time/area Closures that Restrict the use of BLL Gear in the Atlantic Ocean, Gulf of Mexico, and Caribbean Sea**

The impacts of shark BLL gear on hermatypic (reef-building) and shallow water corals recently listed under the Endangered Species Act (ESA) were assessed by NMFS in a Biological Evaluation prepared in October 2014. The analysis conducted in the October 2014 Biological Evaluation stated that, although observer reports indicated interactions between shark BLL gear and coral, sea fans, and other coral reef life occurs, these instances are very rare. The Biological Evaluation found that fishermen setting shark BLL gear prefer sandy bottom away from coral habitats and generally set gear on sandy bottoms. Using observer data from the shark BLL fishery, NMFS mapped current Gulf of Mexico coral EFH and sets of shark BLL gear that interacted with coral. Although there are coral interactions with shark BLL gear, NMFS only noted 16 interactions out of 614 observed sets between 2008 and 2013 (Figure 5.2). None of the 16 interactions occurred in coral EFH identified by the Gulf of Mexico Fishery Management Council or involved the newly listed corals species. If gear interactions were to occur, it would be due to unintentional gear drift. Although interactions between listed corals and shark BLL gear could cause long-term impacts to the reef habitat, minimal interactions occur on coral habitats spatially and temporally. NMFS has determined that the continued operation of the shark BLL fishery may affect, but not adversely affect, ESA and non-ESA listed deep water coral species or any of the designated coral EFH (NMFS 2014).

Both shallow and deep water coral interactions with BLLs could cause long-term impacts to the reef habitat but, due to minimal interactions with coral habitats spatially and temporally, NMFS does not anticipate any adverse effects on shallow or deep water coral with BLL gear.

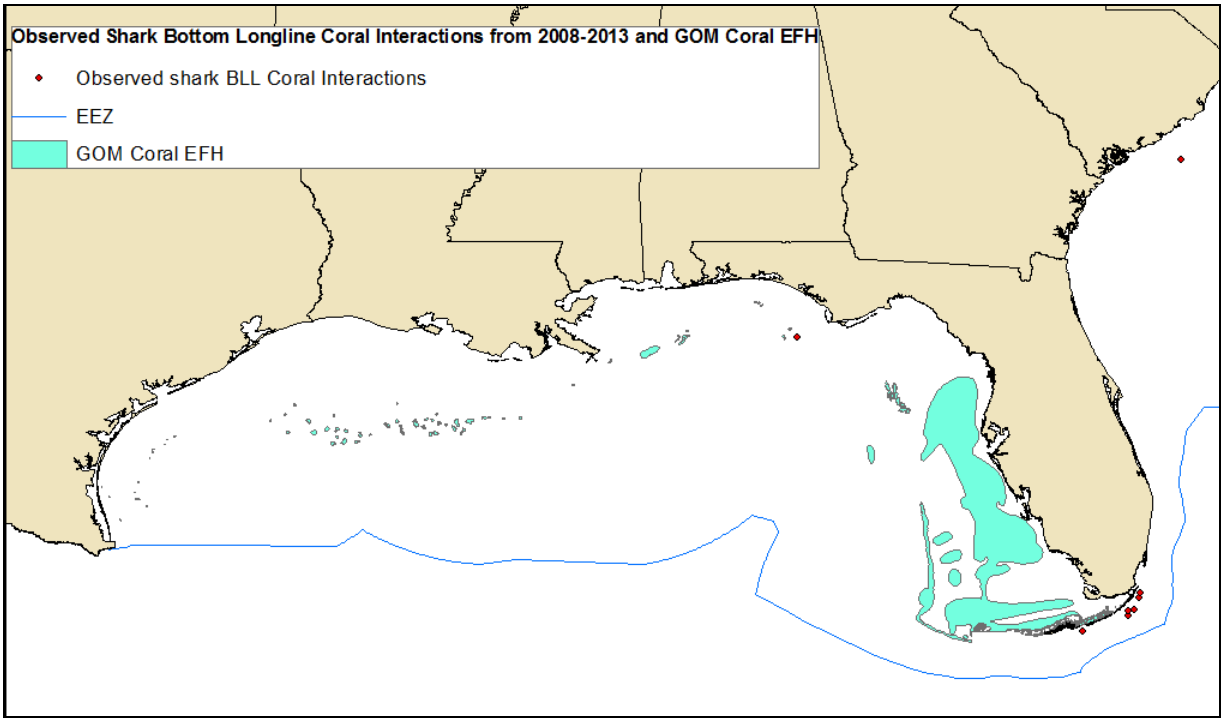

Figure 5.2 **Coral EFH in the Gulf of Mexico and Shark BLL Gear Interactions with Coral**

EFH of Council-managed fish species that spans from the Mid-Atlantic to the Gulf of Mexico likely overlaps in areas that the shark BLL fishery operates. 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 (February 7 2007, 72 FR 5633). Although BLL fishing for sharks occurs in other areas of EFH, it is anticipated to not have detrimental impacts to EFH because it occurs in mainly sandy/mud areas. Reef habitat EFH for many Council-managed species is not expected to be adversely affected by shark BLL fisheries based on known issues with gear entanglement and the of possibly loss of gear in coral areas and the correlation of observed BLL sets to coral EFH (Figure 5.2) Thus, fishermen can be presumed to actively avoid these coral reef areas. Non-reef species may also reside in sensitive habitats identified by the Councils as EFH where shark BLL fishing occurs. In 2004, the Northeast Fisheries Science Center (NEFSC) published a technical memorandum that evaluated different gear types and their effects on EFH (NMFS-NE-181). Each gear was scored by the NEFSC from 0-14 with 14 having the highest impact on EFH. The

NEFSC gave BLL gear a score of 0 due to limited information on benthic habitat effects and the temporary nature of the gear (Stevenson et al. 2004). NMFS therefore anticipates minimal adverse effects on EFH of Council-managed species by the Atlantic shark BLL fishery, and determines that the shark BLL fishery would not have significant adverse effects on EFH based on the data that are available at this time.

NMFS has conducted a literature review to investigate additional impacts of HMS fishing gears on Atlantic HMS EFH since Amendment 1 and the Final Atlantic HMS EFH 5-Year Review document. During this review, NMFS did not find any significant changes in effects to HMS EFH from HMS and non-HMS fishing gears since the gear analysis was conducted for Amendment 1 and the Final Atlantic HMS EFH 5-Year Review document. An analysis of ESA listed and non-listed coral EFH and shark BLL interactions was conducted by NMFS and considered in this final amendment. While long-term negative effects could occur on coral habitats from shark BLL gear, the adverse effects are expected to be minimal due to infrequent interactions. EFH for Council-managed fish species was also considered in this analysis and shark BLL gear was determined to not have adverse effects on those species' EFH.

5.1.2 Forage Species

During the development of the Atlantic HMS EFH 5-Year Review, NMFS received public comment related to the impacts to Atlantic HMS related to fishing for their preferred forage species. The comments concluded that intense fishing pressure, causing changes in stock abundance and structure on forage species, could alter the migrations and overall life history of Atlantic HMS. The commenter also indicated that additional research is needed to confirm these potential impacts to Atlantic HMS related to forage species.

Forage species are managed by the Regional Fishery Management Councils in the Atlantic region. The Mid-Atlantic Fishery Management Council has initiated an omnibus FMP amendment to assess unmanaged forage fish populations (http://www.mafmc.org/actions/unmanaged-forage). On March 24, 2017, the Mid-Atlantic Fishery Management Council published a proposed rule (82 FR 18882, April 24, 2017) to implement management measures in an omnibus amendment that includes, but is not limited to, annual landings limit, possession limits, and permitting and reporting requirements for unmanaged forage species as well as species currently managed within Mid-Atlantic Federal waters. The goal of the amendment is to prevent the development/expansion of new and existing commercial fisheries on forage species until the Council has had the opportunity to analyze the impacts of those changes to forage fish harvest on existing fisheries, communities, and marine ecosystem. Public comment period ended on May 30, 2017.

5.1.3 Actions to Minimize the Adverse Effects of Fishing on EFH

The analysis in this EA identified the same adverse effects of fishing on EFH as has been previously identified in the EAs for Amendment 1 to the 2006 Consolidated Atlantic HMS FMP. Therefore, the actions that NMFS identified to minimize these adverse effects in that prior analysis continue to apply for analysis of this action. These actions are listed below and outlined in Amendment 1, Amendment 3, and the interpretive rule for white marlin and roundscale spearfish:

- Vessels fishing with BLL gear should avoid or reduce BLL effort on corals, gorgonians, or sponge habitat in order to 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 entangled.
- If gear is lost, diligent efforts should be undertaken to recover the lost gear.

5.1.4 Other Recommended Actions To Minimize the Adverse Effects of Fishing on EFH

NMFS recommends that more research be conducted on the effects of fishing gear on Atlantic HMS EFH within U.S. waters. NMFS will continue to work with Regional Fishery Management Councils and Interstate Marine Fisheries Commissions to minimize gear effects to the extent practicable in areas where HMS EFH is delineated.

5.2 Analysis of Non-Fishing Effects

The EFH regulations (50 CFR 600.815(a)(3) and (4)) require FMPs to identify non-fishing related activities 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.

NMFS conducted thorough reviews on the effects of non-fishing activities in the 2006 Consolidated HMS FMP and Amendment 1 to the 2006 Consolidated HMS FMP; neither of which is repeated in detail here. The purposes of the non-fishing effects analysis in this EA is to evaluate those impacts that are most likely to adversely affect HMS EFH and any new information available relevant to those impacts.

5.2.1 Review Approach and Summary of Findings

The review of habitat use for HMS identified both benthic and water column habitats in coastal, estuarine, and offshore areas as HMS EFH; although in many cases the particular habitat characteristics that influence species habitat use are not clearly understood or identified. Many of these habitat characteristics appear to be related to water quality (e.g., temperature, salinity, DO); therefore, water quality degradation is a primary focus in this section. When analyzing the adverse effects that water quality changes can have on HMS EFH, it is important to examine all habitats, including offshore areas which can be affected by actions that originate in coastal habitats (both terrestrial and aquatic) and adjacent estuaries. Many HMS aggregate over submarine canyons or along river plumes; these physiographic features can serve as conduits for currents moving from inshore out across the continental shelf and slope, while carrying and redistributing contaminants from the nearshore realm to offshore habitats.

Land-Based Activities that May Adversely Affect HMS EFH

NMFS conducted thorough reviews of land-based activities that may adversely affect HMS EFH in the 2006 Consolidated Atlantic HMS FMP and Amendment 1. These two documents found coastal development and agriculture to be the main sources of land-based impacts through water run-off.

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; point and non-point source discharges of nutrients, chemicals, and cooling water into streams, rivers, estuaries and ocean waters; and, destruction of coastal wetlands that filter sediments, nutrients, and contaminants. In addition, hydrological modifications associated with coastal development alter freshwater inflow to coastal waters, resulting in changes in salinity, temperature, and nutrient regimes, and thereby contributing to further degradation of estuarine and nearshore marine habitats.

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. Nutrient over-enrichment with subsequent deoxygenation of surface waters may also adversely affects EFH. 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.

Coastal and Offshore Activities That May Adversely Affect HMS EFH

NMFS conducted thorough reviews of coastal and offshore activities that may adversely affect HMS EFH in the 2006 Consolidated Atlantic HMS FMP and Amendment 1. These two documents found eight broad activity categories that adversely affect HMS EFH: dredging and disposal of dredging material, navigation, marinas and recreational boating, marine sand and mineral mining, ocean dumping, petroleum exploration and development, liquefied natural gas (LNG), and renewable energy projects.

Dredging and disposal of dredging material can result in 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).

Navigation-related threats to 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. 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. Wakes from vessel operation may also exacerbate shoreline erosion, affecting habitat modification and potential degradation.

Marinas and recreational boating are increasingly popular uses of coastal areas. Adverse effects caused by pollutants associated with marinas include lowered DO, 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 adverse effects 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.

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. Deep borrow pits created by mining may become seasonally or permanently anaerobic.

Ocean dumping of hazardous and/or toxic materials (e.g., industrial wastes) containing concentrations of heavy metals, pesticides, petroleum products, radioactive wastes, and pathogens, in the ocean degrades water quality and benthic habitats.

Petroleum exploration and development can adversely affect HMS EFH through 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. On April 20, 2010, an explosion and subsequent fire damaged the Deepwater Horizon MC252 oil rig, which capsized and sank approximately 50 miles southeast of Venice, Louisiana. Oil flowed for 86 days into the Gulf of Mexico from a damaged wellhead on the seafloor.

For LNG facilities, a major concern is the saltwater intake system used to heat LNG and regasify it before piping to shore, which could subject early life stages of marine species to entrainment, impingement, thermal shock, and water chemistry changes.

Alternative energy includes, but is not limited to wind, wave, solar, underwater current, and generation of hydrogen. Construction, maintenance, and operation for these installations can disturb water quality in HMS EFH. The Bureau of Ocean Energy Management provides state-by-state summaries and documentation of offshore energy development projects (including Environmental Assessments and Environmental Impact Statements, public hearing and public comment documentation, and information on leases) at the following website: https://www.boem.gov/Renewable-Energy-State-Activities/

Additionally, the Federal Energy Regulatory Commission is responsible for authorizing the siting and construction of onshore and near-shore LNG import or export facilities under Section 3 of the Natural Gas Act. The Federal Energy Regulatory Commission provides maps showing proposed and potential LNG projects, as well as Environmental Assessments and Environmental Impact Statements at the following website: https://www.ferc.gov/industries/gas/indus-act/lng.asp

Lastly, the U.S Maritime Administration licenses LNG and oil import and export port facilities under the Deepwater Port Act. More information can be found at the following website: https://www.marad.dot.gov/ports/office-of-deepwater-ports-and-offshore-activities/

Climate Change

In its most recent assessment, the Intergovernmental Panel on Climate Change (IPCC) of the United Nations Environment Program reiterated findings from previous assessments - that the earth is warming as evidenced by widespread observations of increases in global air and ocean temperatures, melting of snow and ice, and rising global average sea level (IPCC 2014). The International Symposium on the Effects of Climate Change on the World's Oceans (May 19-23, 2009, Gijon, Spain) also concluded that the global warming trend and increasing emissions of carbon dioxide and other greenhouse gases are already affecting environmental conditions and biota in the oceans on a global scale (Valdes et al. 2009). Ocean warming has affected global fisheries in the past four decades, as evidenced by Cheung et al. (2013)'s analysis of indices of inferred temperature preferences for exploited species. Similar conditions are occurring in U.S. waters. The third national climate assessment, "Climate Change Impacts in the United States" (Melillo et al. 2014), concluded that marine ecosystem processes have been affected by climate change and that large-scale shifts in marine species ranges, seasonal timing, and migrations have occurred and are very likely to continue.

The amount of information available on climate impacts to marine systems has increased substantially in recent years; however still, relatively little is known about impacts to Atlantic HMS, many of which have very broad thermal tolerances. It is difficult to predict climate-induced responses of marine fish populations, particularly those on a higher trophic level, due to exposure to a complex mix of changing abiotic (e.g., temperature, salinity, pH) and biotic (e.g., abundance and distribution of predators and prey) conditions (Hollowed et al. 2013) and inconsistent and incomplete data (Murawski 2013).

The CLIOTOP (climate impacts on top ocean predators) program was initiated in 2004, with the general objective to organize a worldwide effort that would further understanding of impacts of both climate variability and fishing on pelagic ecosystems (Hobday et al. 2013). Results of this effort and other research have provided some HMS-specific climate research, mostly in Pacific regions, and widely applicable modelling strategies (e.g., Earth System Model). In the recent FAO review of physical and ecological impacts of climate change on marine fisheries, Barange and Perry (2009) assert that current knowledge about a species' life history stages in past and current climates, along with observations on climate change and research on climate change effects, can be used as a basis to discuss potential current or future effects of climate change on the species, short of projection. The Atlantic Bluefin Tuna Status Review Team (SRT 2011) used this approach and reviewed available literature on bluefin tuna life stages and trophic dynamics to identify potential areas of vulnerability for this species relative to climate changes. Sources of assessment information and modelling or framework approaches are briefly described in the next few paragraphs. Application of modelling or framework assessments described in the following paragraphs to Atlantic HMS could provide useful information to support refinement of EFH designations.

The potential impacts of climate change, from the organism to ecosystem level, are detailed in the "Ocean Systems" chapter of the IPPC's 2014 review of climate-induced impacts, adaptions, and vulnerabilities to ocean systems (Portner et al. 2014). It describes expected changes in physical and chemical variables including temperature, salinity, carbon dioxide-induced acidification, hypoxia, light, and nutrients, and highlighted recent studies with examples of observed changes. The chapter also described types of expected concurrent responses of organisms to multiple climate-induced drivers, and the effect of organismal responses on food web dynamics to identify ecosystem considerations.

In their review of projected impacts of climate change on marine fish and fisheries, Hollowed et al. (2013) noted that the marine science community is now regularly using projections released by the IPCC to make qualitative and quantitative assertions about marine ecosystem responses to climate change and ocean acidification. Murawski (2013) stated that coupled models, with nested atmosphere, land, ocean, and biological components, are currently being used. Climate-driven changes in the environment may affect the physiology, phenology, and behavior of marine fish at any life-history stage, and any of these effects may result in population-level changes in distribution and/or abundance that can be identified by modelling exercises.

Frameworks that can be used broadly for assessing impacts or vulnerability to impacts have also been developed. Pettigas et al. (2013) developed a framework that integrates requirements in all life stages to assess impacts across the entire life cycle and then applied it to case studies of species important in regional fisheries. The framework includes a review of habitats required by each life stage, habitat availability, and connectivity between habitats, and then explores how each could be altered by climate change. The key results of this study were that climate-driven changes in larval dispersion seemed to be the major unknown and that species with specific habitat requirements for spawning or nursery grounds display "bottlenecks" in their life cycle.

The IPCC assessment (Portner et al. 2014) reported some general projections of impacts to global fisheries. Climate change is projected to cause a large-scale redistribution of global catch potential, with an average 30 to 70 percent increase in yield at high latitudes. Redistribution between areas, with average catch potential remaining unchanged, is projected for mid-latitudes. Acidification and hypoxia is expected to reduce maximum catch potential through 2050 in the North Atlantic and northeast Pacific. Responses of exploited marine species may interact with other stressors such as overfishing to exacerbate the impacts of climate change. Considerable social economic disruption for small island nations and large industrial fleets may occur because of climate change (Hobday et al. 2013).

Several studies have specifically considered the potential impacts of climate change on HMS. These studies use a variety of methods, and as a result, the conclusions for the same species can vary. Simpler models make fewer assumptions, but can miss important ecological processes. Most of these studies took place in areas other than the western North Atlantic, and application of the findings are not particularly relevant to Atlantic HMS, depending upon the circumstances of the study, such as the physical and biological characteristics of the regional ecosystem, and the effect of climate-related factors driving the response. Modelling exercises that show specific responses of non-Atlantic ecosystems are less useful for determining relevant impacts to Atlantic HMS, but do illuminate the types of impacts and/or responses that could occur in the northwest Atlantic ecosystem. The studies that are most relevant to Atlantic HMS management are summarized below.

Table 2 Studies Evaluating Climate Change Impacts on HMS

Study	Region	Species
Chang et al. 2013	Tropical Atlantic	Swordfish
Dueri et al. 2013	Worldwide	Skipjack
Ganachaud et al. 2013	Pacific	Bigeye, Yellowfin, Albacore, and Skipjack tunas
Hobday et al. 2011	Pacific	Swordfish, Yellowfin tuna, Albacore tuna
Lehody et al. 2013	Pacific	Skipjack tuna
Liu et al. 2012	Gulf of Mexico	Bluefin tuna
Muhling et al. 2015	Gulf of Mexico, Caribbean	Bluefin tuna, Skipjack
Muhling et al. 2014	Gulf of Mexico, Caribbean	Bluefin tuna, Skipjack, Swordfish
Muhling et al. 2011	Gulf of Mexico	Bluefin tuna
Morrison et al. 2015	Northwest Atlantic	Dusky, Sand tiger, and Porbeagle sharks
Prince et al. 2010	Tropical Northeast Atlantic	Billfishes, Tunas
Sequeira et al. 2014	Worldwide	Whale shark
SRT 2011[1]	Gulf of Mexico, Atlantic	Bluefin tuna
Stramma et al. 2012	Tropical Northeast Atlantic	Billfishes, Tunas
Trenkel et al. 2014	North Atlantic	Albacore tuna, Bluefin tuna, Swordfish, Blue marlin

Trenkel et al. (2014) reviewed the current state of knowledge regarding the ecology of widely distributed pelagic fish stocks in the North Atlantic basin, including albacore and bluefin tuna, swordfish, and blue marlin, with an emphasis on their role in the food web. This information was used as a starting point for a EURO-BASIN[2] evaluation of environmental factors (including

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[1] Studies cited by the SRT review are not included in Table 2.

[2] EURO-BASIN is the European branch of the international BASIN (Basin-scale Analysis, Synthesis, and Integration) program which focuses on climate and human forcing, ecosystem impact, and consequences for living resources management in the North Atlantic

climate change) and fishing factors that could influence population dynamics and distribution of these species, and the North Atlantic ecosystem as a whole.

Prince et al. (2010) and Stramma et al. (2012) found that climate-related changes to ocean chemistry and the mixed layer depth exacerbated vertical habitat compression for some billfish and tuna in the tropical Northeast Atlantic. Off the west coast of Africa, high-oxygen demand HMS were closer to the surface and more vulnerable to fishing gear because of the current-related DO profile of this region.

Muhling et al. (2014) summarized recent collaborative climate change research activities on HMS in the Gulf of Mexico and Caribbean Sea by NOAA and partners. In addition to a summary of the findings on bluefin and skipjack tunas by Muhling et al. (2015, below), Muhling et al. (2014) reported on a study investigating the potential for building size-dependent models of temperature habitat for HMS. Preliminary results of the analysis of swordfish geographic distribution by size found that larger swordfish (particularly females) are associated with relatively cooler waters. Other ongoing collaborative research includes modelling broad-scale patterns of environmental variability, studies in larval ecology, and modelling of larval distribution and abundance.

Sequeira et al. (2014) used 30 years of whale shark observations by tuna purse seine fishermen from the Atlantic, Indian, and Pacific Oceans to build a model of environmental variables that would predict future distribution of the species. According to the results of their model, which used unchecked carbon emission scenarios of changes to sea surface temperature, suitable habitat for whale sharks in the Atlantic and Indian Oceans would shift towards the poles by 2070, accompanied by an overall range contraction.

In an initial review of potential climate-related impacts to bluefin tuna, the SRT identified projected temperature increases in the Gulf of Mexico as a potential physiological stressor for bluefin tuna during spawning (SRT 2011). In the initial review, the SRT noted that average ambient temperatures measured during bluefin spawning activity ranged from 23.5 to 27.3 °C (Teo et al. 2007), and that bluefin tuna have been found to withstand temperatures ranging from 3 to 30 °C (Block et al. 2001). Although bluefin tuna are believed to use deep diving to thermoregulate, spawning behavior may preclude thermoregulation behavior (Teo et al. 2007). Block et al. (2005) indicated that thermal stress appeared to be contributing to mortality of pelagic longline-caught bluefin tuna on the Gulf of Mexico spawning grounds. The SRT considered that increases in ocean temperature could mirror those forecasted for air temperature by the IPCC (2007; i.e., 0.2 °C increase per decade), and added ten decade's worth of temperature increase (i.e., a total of 2.0 °C) to the temperatures reported by Teo et al. (2007), estimating that Gulf of Mexico temperatures during bluefin tuna spawning season could reach 25.5 to 29.3 °C by the turn of the century. Further, Muhling et al. (2011) modeled a variety of climate change simulations in the Gulf of Mexico specifically to quantify potential effects of warming on the suitability of the Gulf of Mexico as a spawning ground for bluefin tuna. Model results showed that bluefin tuna were indeed likely to be vulnerable to climate change impacts with increasing water temperature, affecting spawning times and locations, as well as larval growth, feeding, and survival (Muhling et al. 2011). In a follow-up modelling exercise, Liu et al. (2012) used a downscaled high-resolution ocean model to look at potential changes to the Loop

Current induced by climate change. The current effect of the Loop Current is to warm the Gulf of Mexico; however, in this study, volume transport by the Loop Current was projected to be considerably reduced (20-25 percent) as a result of climate induced reductions to the Atlantic Meridional Overturning Circulation. The reduction in the Loop Current would have less of a warming impact in the Gulf of Mexico, particularly in the northern basin. Liu et al. (2012) indicated that this reduction in warming was underestimated by the low-resolution model used by Muhling et al. (2011). Muhling et al. 2015 updated their previous study to account for the importance of regional scales as indicated in Liu et al. (2012), and again showed marked temperature induced habitat loss for both adult and larval BFT in the spawning grounds in the northern Gulf of Mexico, supporting their previous conclusions. However, as indicated in Liu et al. (2012), habitat loss in this study was somewhat mitigated by the slowing of the Caribbean Current-Loop Current system. This study also showed an increase in skipjack spawning and larval habitat, suggesting that influences of climate change on highly migratory Atlantic tuna species are likely to be substantial, and strongly species-specific.

In its review of the potential impacts of climate change on bluefin tuna, the SRT also investigated the potential direct and indirect impacts of ocean acidification. Fabry et al. (2008) reviewed the potential impacts of ocean acidification on marine fauna and ecosystem processes, and found that marine fish were physiologically highly tolerant of carbon dioxide. Ishimatsu et al. (2004) found that hatchling stages of some species appeared fairly sensitive to pH decreases on the order of 0.5 or more, but high carbon dioxide tolerance developed within a few days of hatching.

The SRT found that effects of ocean acidification might be more likely to impact bluefin tuna via trophic dynamics. Orr et al. (2005) reported that acidification would likely lead to dissolution of shallow-water carbonate sediments and could affect marine calcifying organisms, including pteropods which are an important component of the plankton in many marine ecosystems. Yamada and Ikeda (1999) found increased mortality for certain arthropod plankton (krill and certain copepods) with increasing exposure time and decreasing pH. Larval *Thunnus* spp. have been found to feed primarily on copepods (Catalan et al. 2007; Llopiz and Cowen 2009) and appear to exhibit selective feeding behavior (Llopiz and Cowen 2009). Chase (2002) identified squid as one of several important food sources for bluefin tuna caught off New England. Epipelagic squid (e.g., *Illex* and *Loligo* spp.) have been found to be highly sensitive to carbon dioxide because of their unique physiology (Portner et al. 2004; Seibel 2007). The SRT noted that as pelagic predators, bluefin tuna are considered opportunistic and loss of one food source may not have negative consequences.

NOAA is taking several steps to address the potential impacts of climate change on managed resources, including the development of vulnerability assessments and a climate science strategy. In addition, the NMFS Office of Habitat Conservation is working on EFH consultation guidance related to climate change that could be incorporated into future EFH conservation recommendations.

NOAA developed "Methodology for assessing the vulnerability of fish species to changing climate" (Morrison et al. 2015) with the goal of developing a nationally applicable framework for assessing the vulnerability of economically important species, The objectives for this study included developing a relative vulnerability rank for studied species, determining factors driving that rank, and identifying data gaps. The assessment was first applied to species in the northeast region (i.e., Cape Hatteras north to the Scotian Shelf), and included a regional perspective on the vulnerability of several highly migratory sharks (dusky, porbeagle, and sand tiger). A potential future step for incorporating climate change considerations into EFH designations for Atlantic HMS, and potentially other HMS management applications, could include conducting framework analyses such as Morrison et al. (2015) or the SRT's 2011 bluefin tuna review for each species, to identify vulnerabilities to climate change in life history or trophic dynamics. Similar to the bottleneck of vulnerability for bluefin tuna spawning in the Gulf of Mexico (Liu et al. 2012, Muhling et al. 2011, SRT 2011), other HMS may have particular climate related vulnerabilities. The release of the vulnerability analyses on porbeagle, sand tiger, and dusky sharks in 2015 (J. Hare et al., 2016, personal communication) illustrated the applicability of this approach to Atlantic HMS on a regional scale (i.e., Cape Hatteras to Scotian Shelf).

NOAA Fisheries has been developing Regional Actions Plans (RAPs) to guide the implementation of the NOAA Fisheries Climate Science Strategy (https://www.st.nmfs.noaa.gov/ecosystems/climate/national-climate-strategy), a proactive approach to increase the production, delivery, and use of climate-related information needed to fulfill NOAA Fisheries mandates. This plan outlines a strategy and specific actions to provide information, data, and services so decision makers are better prepared to respond to climate change effects on the region's species, including marine fish, corals, marine mammals, sea turtles, and the people who depend on them.

NOAA Fisheries finalized the Northeast Regional Action Plan (RAP) (http://www.st.nmfs.noaa.gov/ecosystems/climate/rap/northeast-regional-action-plan) and Gulf of Mexico RAP (http://www.st.nmfs.noaa.gov/ecosystems/climate/rap/gom-regional-action-plan) in December 2016. These RAPs aim to provide timely and relevant information on what's changing, what's at risk, and how to respond to changing conditions. These plans are focused on areas in the Northeast U.S. Shelf Ecosystem, which extends from North Carolina to Maine, and the Gulf of Mexico which are areas that supports important and highly productive commercial and recreational fisheries. The Southeast Fisheries Scientist Center developed a draft Regional Action Plan for the South Atlantic Region (http://www.st.nmfs.noaa.gov/ecosystems/climate/rap/southeast-regional-action-plan). NMFS solicited public comment on the South Atlantic RAP through March 24, 2017. The Caribbean Regional Action Plan is under development.

Oil/Gas Exploration Activities (Seismic Surveys)

Seismic surveys, such as those utilized in oil and gas exploration activities, are the subject of controversy due to projected impacts on protected resources (specifically cetaceans and sea turtles), EFH, and on fish and fisheries. The effects of seismic surveys have not been researched specifically on Atlantic HMS, but have been for some other fish species (e.g., Deffenbaugh 2002; Engas and Lokkenborg 2002; McCauley et al. 2002; Gordon et al. 2004; Popper et al. 2005; Weilgart 2013; BOEM 2014).

BOEM issued a Final Programmatic Environmental Impact Statement (PEIS) in February 2014 that assessed potential environmental impacts associated with the authorization of geological and geophysical survey activity in the Mid- and South-Atlantic outer continental shelf regions and adjacent state waters. The final PEIS, and supporting documentation, can be found at the following website: http://www.boem.gov/Atlantic-G-G-PEIS/. The analysis contained within the PEIS included Atlantic HMS in these regions (sharks and tunas but not billfish or swordfish) as part of an overall analysis of the effects on marine fisheries resources. The analysis includes a thorough review of the literature concerning seismic survey impacts on fish and other marine life.

NMFS Office of Habitat Conservation submitted comments on the BOEM Draft Programmatic EIS in December 2012, to which BOEM replied in 2014. BOEM agreed to review each application to conduct seismic surveys, and request from the applicant additional information deemed necessary to analyze impacts of the specific activity within specified locations or areas on marine protected species, archaeological resources, biological features, and EFH. During that review, BOEM would draft a site-specific environmental assessment with the EFH Assessment as an appendix. On the basis of the site specific environmental assessment and the EFH assessment, BOEM would then make a determination whether or not proposed specific activities would adversely affect EFH, which would then warrant an EFH consultation.

On November 18, 2016, NOAA released the Final Ocean Noise Strategy. The Ocean Noise Strategy is a NOAA initiative that seeks to guide the agency towards more comprehensive and effective management of ocean noise impacts over the next decade. More information can be found at http://www.cetsound.noaa.gov/.

5.2.2 EFH Conservation Recommendations

EFH conservation recommendations to prevent or mitigate adverse effects of previously analyzed non-fishing activities on EFH are included in the 2006 Consolidated Atlantic HMS FMP and Amendment 1 and are not repeated here.

At this time, climate change and seismic surveys are the only activities with potential to generate detrimental non-fishing effects on HMS EFH. Climate change impacts are global and ongoing with a wide range of causes and effects both inside and outside of fisheries. Specific EFH conservation recommendations to limit or mitigate climate change often have national and global implications that are outside the scope of this document. At this time, a vigilant review of emerging climate change effects on HMS distribution and migration is important to ensure HMS EFH is appropriately designated and that management measures are effective at maintaining sustainable HMS fisheries and habitat. While seismic testing and airguns are known to have detrimental effects on many species of fish (e.g., sciaenids, clupeids) and mammals, and may render pelagic habitats in the immediate area of surveys or testing temporarily unsuitable for many species, NMFS has not identified conclusive empirical evidence in the literature that Atlantic HMS or Atlantic HMS EFH are detrimentally affected by seismic testing or, assuming there are impacts, the extent of any impacts. NMFS recommends that additional research in this subject area be conducted to evaluate potential effects on Atlantic HMS and on HMS EFH.

5.2.3 Conclusions

With the exception of climate change and seismic testing, the adverse effects of non-fishing activities identified in this EA have not been previously analyzed. Although climate change will likely have some effect on HMS EFH, there is insufficient information at this time to assess the adverse effects on HMS EFH. Adverse effects from climate change would likely manifest through alterations in HMS distribution as ocean conditions change. Analyzing changes in distribution will occur over time. As noted under Future Recommendations, regular review of HMS EFH should continue to monitor HMS distribution for changes to EFH.

The Atlantic HMS Advisory Panel and some constituents expressed significant concern about the potential effects of seismic testing on Atlantic HMS and Atlantic HMS EFH. NMFS has not identified conclusive empirical evidence in the literature that Atlantic HMS or Atlantic HMS EFH are adversely affected by seismic testing. However, given that detrimental impacts have been observed in other species, there is a possibility that these activities may also generate detrimental impacts on Atlantic HMS or have an adverse effect on Atlantic HMS EFH. NMFS recommends that additional research in this subject area be conducted to evaluate potential effects on Atlantic HMS and on HMS EFH. NMFS will monitor scientific literature for papers dealing with seismic surveys, and will incorporate these findings into future evaluations of Atlantic HMS EFH as sufficient information regarding seismic survey impacts on HMS EFH becomes available.

5.2.4 Future Recommendations

Near-term adverse effects resulting from climate change on HMS EFH will likely include range and distribution shifts as water temperature changes. Seismic testing may adversely affect Atlantic HMS EFH. NMFS recommends continuing to monitor emerging research on climate change and seismic testing effects and continuing to regularly reassess the distribution of HMS and adjust HMS EFH boundaries accordingly.

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6 LIFE HISTORY ACCOUNTS AND EFH DESCRIPTIONS

6.1 Introduction to Life History Accounts and EFH Descriptions

This section fulfills the requirements for the EFH identification and designation component of FMPs, as described in 600.815(a)(1). 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 under Alternative 2 of this final amendment, which is identified as NMFS' preferred alternative. The year in which the most recent stock assessment (at the time of this publication) was conducted, and the entity that conducted it, are identified for each species in . Please refer to the annual Atlantic HMS Stock Assessment and Fisheries Evaluation Report for current information.

Following the EFH text descriptions for each species is a section entitled "Summary of Changes Made to EFH." Where applicable, this section is split into two paragraphs intended to: (1) describe updates to EFH boundaries and a rationale for changes between Amendment 1 and this Amendment (Amendment 10); and (2) describe updates to EFH boundaries and a rationale for changes between Draft Amendment 10 and Final Amendment 10. We have not made significant changes from the Draft to the Final. EFH has been refined in certain instances, as noted below, in response to updated information or information provided in comments. For example, since the draft was issued, datasets have been updated with additional data points, which has refined our understanding of species location and habitat. These datasets are Level 1, which indicate that presence/absence of a species in a habitat. In response to updated datasets, appropriate, slight modifications were made to incorporate possible habitat locations based on the best information available.

More generally, we have also updated the EFH written descriptions from those in the Draft EA for most species in response to comments asking that we provide more specific and descriptive information about landmarks, spatial range extents, and environmental/habitat characteristics presented in the life history section. Greater specificity in these descriptions will help facilitate the EFH consultation process later. Some edits were also made for consistency purposes across the descriptions.

6.2 Tunas

6.2.1 Atlantic Albacore Tuna (*Thunnus alalunga*)

Albacore tuna is a circumglobal, epipelagic species, and its life cycle is poorly known. In the Atlantic Ocean, albacore tuna range from between 40° and 45° N lat. to 40° S lat. ICCAT recognizes the existence of three stocks, including a northern and southern Atlantic stock (separated at 5° N lat.) and a Mediterranean stock (SCRS 2015). Some studies support the hypothesis of sub-populations in the North Atlantic and Mediterranean. 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.

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 tuna, and found 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. In the Bay of Biscay, albacore tuna CPUE exhibited a positive and significant correlation with anchovy abundance (Lezama-Ochoa et al. 2010).

Life history

Albacore tuna is 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 2 mL/L. Cosgrove et al. (2013) found tagged albacore exhibit shallow nocturnal depth preferences, but may dive depths of 781 m.

Although albacore is a temperate species, adults 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). Sexual maturity is considered to occur at about 90 cm fork length (FL) (age five) in the Atlantic, and at a smaller size (62 cm, age two) in the Mediterranean (ICCAT Manual 2006-2016). 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 five) to the productive waters in the northeastern Atlantic occurs in the summer while adults make the spawning migration to tropical waters. 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).

Scientific studies on albacore stocks in the North Atlantic, North Pacific, and the Mediterranean suggest that environmental variability may potentially have a serious impact on albacore stocks by changing availability on the fishing grounds, as well as productivity levels and potential Maximum Sustainable Yield (MSY) of the stock (SCRS 2015). Dufour et al. (2010) studied the historical arrival dates of migrating albacore tuna to the Bay of Biscay, and found that the tuna are arriving about 8 days earlier than 40 years ago and the mean catch latitude showed an increasing trend.

Growth and mortality

The maximum size of albacore tuna has been reported at 127 cm FL (Collette and Nauen, 1983). The expected life-span for albacore tuna is about 15 years. Mortality is higher for females (Collette and Nauen, 1983).

Essential Fish Habitat for Albacore Tuna

Figure G 1 - Figure G 2

Spawning, eggs, and larvae: Insufficient information available

Juveniles (< 90 cm FL): Offshore, pelagic habitats of the Atlantic ocean from the outer edge of the U.S. EEZ through Georges Bank to pelagic habitats south of Cape Cod, and from Cape Cod to Cape Hatteras, North Carolina. EFH also includes offshore pelagic habitats near the outer U.S. EEZ between North Carolina and Florida, and offshore pelagic habitats associated with the Blake Plateau. EFH also includes offshore pelagic habitats in the western and central Gulf of Mexico.

Adults (≥ 90 cm FL): Offshore, pelagic habitats of the Atlantic ocean from the outer edge of the U.S. EEZ through Georges Bank to pelagic habitats south of Cape Cod, and from Cape Cod to Cape Hatteras, North Carolina. EFH also includes offshore pelagic habitats near the outer U.S. EEZ between North Carolina and Florida, and offshore pelagic habitats associated with the Blake Plateau. EFH also includes offshore pelagic habitats in the western and central Gulf of Mexico.

Summary of Changes Made to EFH

EFH boundaries published in Amendment 1 for the juvenile and adult life stages have been updated in Final Amendment 10. Juvenile EFH boundaries were expanded in the South Atlantic due to the incorporation of new data into the Kernal Density Estimation / 95 Percent Volume Contour models and scientific recommendations from the SEFSC. Juvenile EFH boundaries were also designated in the Gulf of Mexico due to the incorporation of new data into the Kernal Density Estimation / 95 Percent Volume Contour models. Adult EFH boundaries were expanded in the Gulf of Mexico, South Atlantic, and Mid Atlantic due to the incorporation of new data into the Kernal Density Estimation / 95 Percent Volume Contour models.

There were no changes to EFH boundaries for North Atlantic albacore tuna from Draft Amendment 10 to Final Amendment 10.

6.2.2 Atlantic Bigeye Tuna (*Thunnus obesus*)

Scientific knowledge of Atlantic bigeye tuna is limited. Its range is almost the entire Atlantic Ocean from 50° N lat. to 45° S lat. It is rarely caught in the Gulf of Mexico, and some of the points currently included in the EFH maps may require further validation (J. Lamkin pers. comm.). 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), although distinct northern and southern stocks should not be disregarded (SCRS 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

Although its distribution with depth in the water column varies, bigeye tuna 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/L (Brill et al. 2005).

Bigeye tuna probably spawn between 15° N Ed and 15° S lat. 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 in this region occurs in January and February, whereas in the northwestern tropical Atlantic spawning occurs in June and July (SCRS, 1978, 1979). Matsumoto and Miyabe (2001) identified spawning sites offshore Dakar, Africa in the Atlantic Ocean just south of the Cape Verde islands.

Zhu et al. (2013) studied bigeye tuna captured in the Chinese longline fishery in the central Atlantic Ocean and found that the growth rate in the central Atlantic is slightly higher than the growth rate in the eastern Atlantic.

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

Figure G 3 - Figure G 4

Spawning, eggs and larvae:	Insufficient information available within the U.S. EEZ; however, the Gulf of Guinea, off the coast of Africa, is identified as important habitat for spawning adults, eggs and larvae.
Juveniles (< 100 cm FL):	Offshore pelagic habitats seaward of the continental shelf break between the seaward extent of the U.S. EEZ boundary on

	Georges Bank (off Massachusetts) and the Blake Plateau (off Florida's east coast). Localized patches of EFH from southeast Florida through the Florida Keys to pelagic habitats seaward of the edge of the West Florida Shelf. EFH also includes pelagic habitats in the central and western Gulf of Mexico from the Alabama/Florida border to areas offshore of Texas. Localized EFH in the southern U.S. Caribbean and northeast of Puerto Rico. In all areas juveniles are found in depths greater than 200 m.
Adults (≥ 100 cm FL):	Offshore pelagic habitats seaward of the continental shelf break between the seaward extent of the U.S. EEZ boundary on Georges Bank (off Massachusetts) and Cape Fear, North Carolina. EFH also includes pelagic habitats near the seaward edge of the U.S. EEZ off Georgia and the Blake Plateau, off southwestern portions of the West Florida Shelf, and in the central Gulf of Mexico in pelagic habitats roughly offshore between Apalachicola and the Louisiana/Texas border. In all areas adults are found in depths greater than 200 m.

Summary of Changes Made to EFH

EFH boundaries published in Amendment 1 have been updated in Final Amendment 10. Juvenile EFH boundaries were expanded in the Gulf of Mexico, South Atlantic, and Mid-Atlantic due to the incorporation of new data into the Kernal Density Estimation / 95 Percent Volume Contour models. Minor updates were made to Adult EFH boundaries in the Gulf of Mexico, South Atlantic, and Mid Atlantic due to the incorporation of new data into the Kernal Density Estimation / 95 Percent Volume Contour models.

In the Final Amendment, EFH boundaries were modified from those in Draft Amendment 10 to exclude areas less than 200 m in depth in both the Gulf of Mexico and Atlantic. As explained in Section 2.1 under the Description of Alternative 2 and Appendix F (see "Approaches Used to Analyze and Map Data" for a review on how data were adjusted along features), this update was included in response to comments from SEFSC recommending that these changes be made in order to reflect all available information on distribution and habitat utilization, and thus meets the requirement that these updates be based on the best scientific information.

6.2.3 Atlantic Bluefin Tuna (*Thunnus thynnus*)

New satellite and archival (i.e., "electronic") tagging and other studies conducted since publication of Amendment 1 to the Consolidated HMS FMP have added to the body of knowledge regarding bluefin tuna life history, seasonal movements and distribution, vertical distribution and diving behavior, and association with certain physical and biological environmental characteristics.

Atlantic bluefin tuna are managed by ICCAT as western and eastern stocks separated by a management boundary at the 45° W meridian. The two-stock hypothesis was supported by the Atlantic Bluefin Tuna SRT's recent, thorough review of the ecological, physical, genetic, and behavioral evidence for distinction of Atlantic bluefin tuna populations as required by the Endangered Species Act (ABT SRT 2011)[3]. Further evidence of meta- or subpopulations for each stock was also considered; however, the SRT found the only conclusive evidence (under ESA definitions) for two differentiated stocks (i.e., Mediterranean and Gulf of Mexico). The SRT acknowledged evidence suggesting that there may be two discrete populations within the Mediterranean, but did not have enough information to determine the significance of these populations to the species as a whole. Since the SRT determination, additional data from an archival tag study (Aranda et al. 2013) further supported two Mediterranean metapopulations.

Bluefin tuna are highly migratory and in the Western Atlantic generally range from 45° N lat. to the equator, but have also supported short-term fisheries off Brazil and in the North Sea (Fromentin 2010). Fromentin et al. (2013) used ecological niche mapping to explain the expansion of bluefin tuna into the equatorial Atlantic off Brazil, and identified a temporary pathway of favorable habitat linking distributions in the North and South Atlantic. Based on this work, the authors hypothesized that changes in environmental conditions associated with climate change could result in a northerly (i.e., to 60° N lat.) expansion of bluefin tuna distribution.

The prevailing assumptions have been that mature western bluefin tuna follow an annual cycle of foraging off the eastern United States and Canadian coasts from June through March. In April and May, they migrate to spawning grounds in the Gulf of Mexico and Straits of Florida (Mather et al. 1995; Block et al. 2005, Walli et al. 2009). However, several recent studies found that some bluefin of purported spawning size/age did not enter identified spawning areas in spring (Block et al. 2005, Galuardi et al. 2010), and Richardson et al. (2016) found larvae in the Slope Sea of the Mid-Atlantic bight. These findings are further addressed under the *Life History* section.

After leaving the western spawning areas, bluefin tuna generally move back to foraging grounds of the Gulf Stream and waters overlying the North American continental shelf and slope, including the South and Mid-Atlantic Bight, the Gulf of Maine, and the Nova Scotia Shelf (Block et al. 2005, Lawson et al. 2010). Bluefin tuna were also documented moving to the central North Atlantic in the vicinity of 40° W long., east of the Flemish Cap (Block et al. 2005; Walli et al. 2009). One of the most significant findings of the last ten years is the increased

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[3] On May 24, 2010, the Center for Biological Diversity petitioned NMFS to list Atlantic bluefin tuna as endangered or threatened under the Endangered Species Act (ESA). NMFS evaluated the petition as required by the ESA, determined that the petitioned action may be warranted, and published a positive 90 day finding (75 FR 57431). A status review was conducted under the requirements of the ESA and published on May 20, 2011.

degree of mixing of eastern and western stocks on foraging grounds of the western and central North Atlantic.

In a study analyzing archival tag data from 1999 to 2005, Lawson et al. (2010) described the movement of bluefin into western Atlantic foraging grounds of the Gulf of Maine, Canadian shelf, and nearby off-shelf waters, and their vertical distribution during occupancy. Throughout this study, bluefin spent most of their time in the upper 10 m of the water column and occupied a relatively constant ambient temperature regime, with monthly median sea surface temperature (SST) between 16 and 19 °C.

In March through April, tagged fish arrived in the study region and occupied weakly stratified, off-shelf waters along the edge of the Gulf Stream. As shelf waters warmed into the summer, the fish shifted distribution shoreward onto the shelf. Dives were more frequent and faster in descent, but shorter in duration and shallower in the stratified shelf waters of summer and fall compared to dives in spring off-shelf waters. The fish departed shelf waters by November.

The study showed strong correlation between diving behavior and the thermal structure of the water column. Based on physiological studies that showed that the capacity of the cardiac system to supply oxygen to the muscles is reduced in colder waters, the authors believed that their observations supported the hypothesis that bluefin use oscillatory diving behavior as a thermoregulatory strategy. They hypothesized that both the timing of the horizontal seasonal shift of bluefin onto the continental shelf and diving behavior appeared to relate to a trade-off between thermal constraints and increased prey resources, and would likely vary in other regions depending upon regional factors.

Golet et al. (2013) studied distribution of commercial sized (greater than 185 cm) bluefin tuna schools in the Gulf of Maine. They constructed a 28-year (1979-2005) time series of commercial bluefin tuna catches and sightings from fishermen’s logbooks, which showed a gradual eastward shift of commercial sized bluefin tuna school distribution towards offshore and Canadian waters. The authors associated this shift in size distribution to the changes in size and abundance of Atlantic herring.

Wilson and Block (2009) classified daily vertical profiles of archival and PSAT tagged bluefin tuna into three types, with the goal of inferring habitat use from diving behavior. V-shaped profiles, the most abundant of the three, were associated with unproductive regions, and purported to be used for transiting or searching for prey. U-shaped profiles were associated with putative foraging behavior, and geographically distributed across known productive feeding grounds, including the Gulf of Maine, Grand Banks, and Flemish Cap. The dive characteristics (i.e., length and depth of dive, etc.) were shown to vary between region, likely because of oceanographic features or prey distribution. The authors hypothesized that two other areas in which a great number of U-shaped dives were found (Florida/Bahamas, Northeast Atlantic) may be important for feeding or satisfying other physiological needs. The third profile type occurred in shallow coastal areas or colder northern regions, and those dives were considered to be restricted due to water depth or temperature profile.

Galuardi and Lutcavage (2012) developed and deployed mini PSAT on juvenile bluefin tuna (aged 2-5) captured in coastal recreational fisheries off Cape Cod from 2005 to 2009, and described vertical and horizontal movement of tagged juveniles. Natal origins of tagged fish had not been determined at the time of publication, and may have included some eastern fish, although none showed trans-Atlantic movement during the study. Summer distributions of tagged fish were more constricted, and restricted to coastal areas, the Gulf Stream margin and shelf break north of Cape Hatteras to the southern Gulf of Maine. Fall months showed a southern migration along the shelf break to the South Atlantic bight and northern Bahamas, and an increase in spatial dispersal, while spring months showed the reverse trend. Core use areas were most dispersed in winter. Winter and spring distributions in the South Atlantic bight were coincident with Gulf Stream position.

PSAT tagged juveniles experienced a wide range of sea temperatures (4 to 26 °C) and showed seasonal patterns of temperature preference and variability. They spent the majority of time at relatively shallow depth (less than 20 m); however bluefin tuna are known for vertical habitat utilization, making dives as deep as 500 to 1,000 m. From January to May, average depth distribution was greater with increased variability than summer months. Two core use areas were identified for winter (January through March) centered around 100 m (12 °C) and 40 m (21 °C). In summer, tagged fish were primarily found near the surface at temperatures from 15 to 20 °C. Spring and fall temperature and depth were transitional between summer and winter findings.

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). Butler et al. (2010) found that menhaden (*Brevoortia brevoortia*) comprised almost 95percent (by weight) of the diet of sampled bluefin tuna off the North Carolina coast during the winters of 2006-2009. Logan et al. 2011 found that juvenile bluefin tuna (60-150 cm curved fork length (CFL)) fed mainly on zooplanktivorous fishes and crustacteans. Sand lance was the main prey of young bluefin in the mid-Atlantic bight.

Predators of adult bluefin tuna include toothed whales, swordfish, and sharks (Tiews 1963; Chase 2002). Golet et al. (2013) showed a positive correlation between bluefin tuna school positions with the amount of herring captured in fishery independent surveys suggested that ontogenetic shifts in diet of several trophic levels occurred between 1 and 2 year old bluefin tuna and adults.

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 was assumed that there is a single annual spawning period. However, recent tagging data and the presence of small (less than 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). Richardson et al. (2016) presented what they described as unequivocal evidence that bluefin tuna also spawn in the Slope Sea of the North Atlantic (i.e., between approximately 37° and 43° N lat.). In this study, the authors collected 67 larval bluefin tuna from June 23 to August 9, 2013. Based on analysis of transport time and growth rates, they determined that over 60 percent of these fish could not have been spawned in the Gulf of Mexico.

The findings of Richardson et al. (2016) could be the basis for other research results that did not support the presumption that all Western Atlantic bluefin tuna spawning activity occurred in the Gulf of Mexico. Block et al. (2005) found that bluefin tuna smaller than 200 cm CFL did not enter identified spawning areas, and Galuardi et al. (2010) had similar findings from an archival tagging study for over 50 percent of tagged bluefin longer than 230 cm. Several other hypotheses have been proposed to explain these findings, including the possibility that bluefin tuna are not obligate annual spawners. Recent satellite tagging studies on Southern bluefin tuna in the Tasman Sea (Evans et al. 2012) have also brought into question the assumption that bluefin tuna are obligate annual spawners. A decadal scale decrease in somatic condition and lipid stores for Atlantic bluefin sampled in the Gulf of Maine was described by Golet et al. 2007, who hypothesized that their physiological condition may have impacted reproductive patterns and resulted in skipped spawning and changes in migratory behavior (Goldstein et al. 2007).

Atlantic bluefin tuna have not been observed spawning (Richards 1991); however, work has identified putative breeding behaviors by bluefin tuna while in the Gulf of Mexico (Teo et al. 2007a and 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). Teo and Block (2010) proposed a further revision to putative breeding locations by analyzing pelagic observer program data, and found that bluefin CPUE in the Gulf of Mexico tended to increase in areas with cyclonic eddies.

Larval presence has been confirmed in the Gulf of Mexico (Richards 1991) and larvae have been found as far north as the Slope Sea (Richardson et al. 2016), although their presence was previously associated with advection from the Florida Straits and not from offshore spawning (McGowan and Richards 1989). Most of the larvae found in the Gulf of Mexico were located around the 1,000-fathom (1,828.8 m) curve in the northern Gulf of Mexico, with some sporadic collections off Texas. It appears that larvae are generally retained in the Gulf of Mexico until they grow into juveniles. In the Florida Straits, larvae are primarily collected along the western edge of the Florida Current, suggesting some active transport from the Gulf of Mexico. This could also explain their occasional collection off the southeast United States in some studies.

Muhling et al. (2010) used a time series of larval bluefin tuna data from the Gulf of Mexico to define associations between larval bluefin catch locations and environmental variables. As a result of their analysis, the authors defined favorable habitat for bluefin larvae as moderately warm waters (i.e., they were most commonly collected in 23.5 to 28 °C) outside the Loop Current and Loop Current eddies, and outside of cooler, higher chlorophyll continental shelf waters. The authors noted larval bluefin may be well adapted to nutrient poor waters, since larval tuna have been found to target appendicularians, which are well adapted to oligotrophic open oceans. The authors hypothesized that larvae were likely to be present in the same water mass into which they were spawned. They also proposed that the Loop Current was likely unsuitable for both spawning and larval habitat because the high temperatures would be stressful for adults and larvae would quickly be advected out of the Gulf of Mexico. Although the resolution of sampling locations was low, preventing the authors from correlating larval occurrence with finer habitat features such as fronts and frontal eddies, in 2008 they started collecting more refined habitat station data so future analyses should be able to provide more refined habitat associations.

In June, YOY 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 long. In the summer and further offshore in the winter. They have also 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 Carolina and Cape Cod, Massachusetts (Mather et al. 1995). Mixed-stock analysis indicated that approximately 60 percent of the adolescent bluefin tuna collected from foraging areas in the Atlantic Ocean off the United States originated from the eastern nursery, suggesting that substantial trans-Atlantic movement of adolescents from east to west occurred (Rooker et al. 2008). In addition, natal homing was well developed, with 94 percent of the adult bluefin tuna collected in the Mediterranean Sea derived from the eastern nursery (Rooker et al. 2008). Rooker et al. (2008) suggest that the U. S. fisheries depend upon migrants of Mediterranean origin and that mixing across the 45° W long. management boundary is substantially higher than previously assumed.

Growth and mortality

Bluefin tuna can grow to more than 650 kilograms (kg) in weight and 300 cm in length, with no apparent difference between the growth rates of males and females (Mather et al. 1995). The rapid larval growth rate is estimated as one millimeter (mm) per day up to 15 mm, the size at transformation (McGowan and Richards 1989). Maximum age is estimated to be more than 20 years. ICCAT defines the size and age at sexual maturity as 185 cm CFL and 9 years old. The lengths-at-age are similar between the western Atlantic and Mediterranean Sea bluefin tuna stocks. In 2010, ICCAT used the findings in Restrepo et al. (2009) to adjust the growth (age/length) curve for Western Atlantic bluefin tuna. This change in growth curve calls into question estimated ages reported in previous studies. Heinisch et al. (2014) determined that size at sexual maturity for the Western bluefin stock should be greater than 134 cm CFL, based on a novel analysis of hormones ratios. As of yet, ICCAT has not incorporated these findings into bluefin tuna stock assessments.

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 around approximately 26 °C and 36 ppt, respectively. 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). The analysis by Muhling et al. (2010) which used a time series of larval bluefin tuna data from the Gulf of Mexico to define associations between larval bluefin catch locations and environmental variables was discussed previously under Life History.

Druon et al. (2016) used an ecological niche modelling approach to predict the potential feeding and spawning habitats of two size classes of bluefin tuna, attempting to bridge the ecological traits of bluefin (e.g., temperature tolerance, mobility, feeding and spawning strategies) with patterns of selected environmental variables (chlorophyll a, sea surface current and temperature, sea surface height anomaly). The study was successful in predicting some but not all observed distribution patterns of bluefin tuna in the Mediterranean and North Atlantic.

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 tuna have traditionally been grouped by small schooling, large schooling, and giant size classes.

Essential Fish Habitat for Atlantic Bluefin Tuna

Figure G 5 - Figure G 7

Spawning, eggs, and larvae:	This life stage has been expanded into two areas of the Slope Sea (between North Carolina and Georges Bank, north of the Gulf Stream) due to the presence of extremely young larvae. One area encompasses pelagic habitats on and off the continental shelf, off the coast of North Carolina, and extends to the shoreline between the NC/VA line and Oregon Inlet. The other area includes pelagic waters of the Slope Sea, extending to the outer United States' EEZ south of Georges Bank. From the mid-east coast of Florida in the Atlantic Ocean to the western Gulf of Mexico (seaward of the 100m depth contour in the Gulf of Mexico). EFH for larvae is defined by habitat associations with temperatures ranging from 23.5 to 28 °C.
Juveniles (< 185 cm FL):	Coastal and pelagic habitats of the Mid-Atlantic Bight and the Gulf of Maine, between southern Maine and Cape Lookout,

	from shore (excluding Long Island Sound, Delaware Bay, Chesapeake Bay, and Pamlico Sound) to the continental shelf break. EFH in coastal areas of Cape Cod are located between the Great South Passage and shore. EFH follows the continental shelf from the outer extent of the U.S. EEZ on Georges Bank to Cape Lookout. EFH is associated with certain environmental conditions in the Gulf of Maine (16 to 19 °C; 0 to 40 m deep). EFH in other locations associated with temperatures ranging from 4 to 26 °C, often in depths of less than 20 m (but can be found in waters that are 40-100 m in depth in winter).
Adults (≥ 185 cm FL):	EFH is located in offshore and coastal regions of the Gulf of Maine the mid-coast of Maine to Massachusetts; on Georges Bank; offshore pelagic habitats of southern New England; from southern New England to coastal areas between the mouth of Chesapeake Bay and Onslow Bay, North Carolina; from coastal North Carolina south to the outer extent of the U.S. EEZ, inclusive of pelagic habitats of the Blake Plateau, Charleston Bump, and Blake Ridge. EFH also consists of pelagic waters of the central Gulf of Mexico from the continental shelf break to the seaward extent of the U.S. EEZ between Apalachicola, Florida and Texas.

Habitat Area of Particular Concern (HAPC):

Figure 2.1

Pelagic waters of the Gulf of Mexico seaward of the 100m bathymetric line, extending to the seaward extent of the United States' EEZ and eastward to the 82º W long. line.

Summary of Changes Made to EFH

EFH boundaries that were published in Amendment 1 have been updated in Final Amendment 10. Boundaries of the Spawning, Eggs, and Larval life stage were expanded in the mid-Atlantic and Slope Sea due to the incorporation of new data into the Kernal Density Estimation / 95 Percent Volume Contour models and the availability of new published literature (Richardson et al. 2016). Boundaries of the Juvenile life stage were reduced slightly in accordance with Kernal Density Estimation / 95 Percent Volume Contour model output, but remain similar to those identified in Amendment 1. Boundaries of the Adult life stage were expanded slightly in the Gulf of Mexico in accordance with Kernal Density Estimation / 95 Percent Volume Contour model output, and expanded in offshore pelagic habitats seaward of the continental shelf from the Blake Plateau through the Gulf of Maine in accordance with Kernal Density Estimation / 95 Percent Volume Contour model output. Published literature and PSAT tag data extending from the Blake Plateau and coastal habitats off North Carolina suggest that tagged adult bluefin tuna may spend time in these locations, especially in the springtime (Figure 6.1; Galuardi et al. 2010; Walli et al. 2009). Adult EFH was also expanded seaward of the continental shelf to the outer extent of the United States' EEZ from the Maryland/Delaware line to southern Maine. SEFSC scientists recommended expansion into these areas (Figure 6.1) given the amount of available point data and corroborating PSAT data (Figure 6.1, Galuardi et al. 2010; Walli et al. 2009; Wilson et al. 2005; Wilson et al. 2015).

Final Amendment 10 slightly contracts the EFH boundaries for juvenile bluefin tuna from those in Draft Amendment 10 along the continental shelf from offshore of Rhode Island eastward to the outer extent of the United States' EEZ and in the mid-Atlantic Bight due to the inclusion of new datasets. Boundaries for adult bluefin tuna were expanded in locations seaward of the continental shelf break to the outer extent of the United States' EEZ between the Maryland/Delaware line and southern Maine due to updated data and PSAT data (Figure 6.1; C. Brown pers comm. and G. Diaz pers comm., NOAA SEFSC; Galuardi et al. 2010; Walli et al. 2009; Wilson et al. 2005; Wilson et al. 2015).

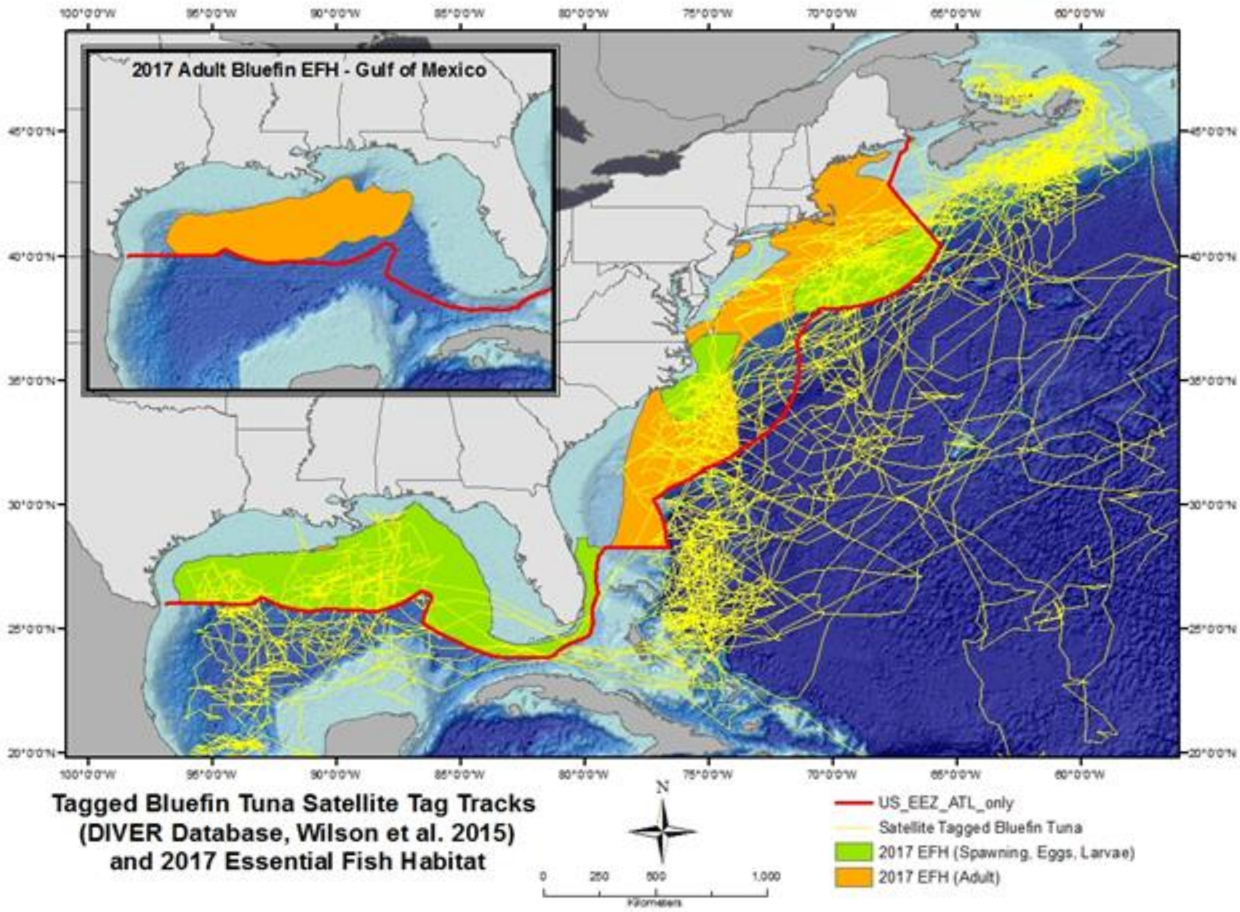

Figure 6.1. Bluefin Tuna EFH Boundaries and PSAT Tag Data. Source: NOAA NRDA Data Integration Visualization Exploration and Reporting (DIVER) database, https://www.diver.orr.noaa.gov/deepwater-horizon-nrda-data

6.2.4 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 tuna 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 and 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 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 and 1979). Skipjack reproductive potential is considered to be high because it reaches sexual maturity around one year and it spawns opportunistically in warm waters above 25 °C throughout the year and in large areas of the ocean (Anon. 2014).

Dueri et al. (2014) used modeling to predict changes in abundance and spatial distribution of skipjack tuna throughout the world's oceans in response to climate change. Models predicted that the current distribution of skipjack tuna would shift from the tropics to warming temperate waters. These changes would be driven by ocean warming and changes in food density. Muhling et al. (2015) used habitat and climate models and determined that habitat suitability for skipjack tuna would increase as temperatures warmed. The models in the latter study were found to contain a degree of misclassification at higher temperatures, resulting in considerable uncertainty around future projections.

Floating objects have been identified to possibly affect migration patterns and cause poor growth rates for skipjack tuna (ICCAT 2008b). Wang et al. (2012) studied the size structure of skipjack schools and hypothesized that the aggregating behavior of skipjack tuna may be changed by the presence of FADs. The authors note that schools in the open water were of similar sized fish, while those that formed around floating objects tended to include fish of mixed size ranges.

Growth and mortality

The maximum size of skipjack tuna 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. Skipjack tuna also associate with birds, drifting objects, whales, sharks and other tuna species (Colette and Nauen, 1983). The optimum temperature for the species is 27 ºC, with a range from 20 to 31° C (ICCAT, 1995). Mugo et al. (2010) used satellite data of environmental characteristics overlaid with fishing data to determine habitat preferences for skipjack in the western North Pacific.

Essential Fish Habitat for Skipjack Tuna

Figure G **8** - Figure G 10

Spawning, eggs, and larvae:	In offshore waters in the Gulf of Mexico to the EEZ and portions of the Florida Straits.
Juveniles (< 45 cm FL):	Offshore pelagic habitats seaward of the continental shelf break between the seaward extent of the U.S. EEZ boundary on Georges Bank (off Massachusetts); coastal and offshore habitats between Massachusetts and South Carolina; localized in areas off Georgia and South Carolina; and from the Blake Plateau through the Florida Straits. Offshore waters in the central Gulf of Mexico from Texas through the Florida Panhandle. In all areas juveniles are found if waters greater than 20 m.
Adults (≥ 45 cm FL):	Coastal and offshore habitats between Massachusetts and Cape Lookout, North Carolina and localized areas in the Atlantic off South Carolina and Georgia, and the northern east coast of Florida. EFH in the Atlantic Ocean also located on the Blake Plateau and in the Florida Straits through the Florida Keys. EFH also includes areas in the central Gulf of Mexico, offshore in pelagic habitats seaward of the southeastern edge of the West Florida Shelf to Texas.

Summary of Changes Made to EFH

EFH boundaries for juvenile and adult life stages published in Amendment 1 have been updated in Final Amendment 10. Juvenile EFH boundaries were expanded further offshore in Atlantic Ocean habitats between Georges Bank and east-central Florida, and in the Gulf of Mexico due to the incorporation of new data into the Kernal Density Estimation / 95 Percent Volume Contour models. Adult EFH boundaries were expanded slightly in the Atlantic Ocean between North Carolina and Massachusetts, modified slightly in the South Atlantic, and expanded in the Gulf of Mexico due to the incorporation of new data into the Kernal Density Estimation / 95 Percent Volume Contour models.

In Final Amendment 10, juvenile EFH boundaries were modified from those in Draft Amendment 10 to exclude inshore habitats less than 20 m of depth in both the Gulf of Mexico and Atlantic. Both juvenile and adult EFH boundaries were modified to adjust the northernmost extent of EFH boundaries. As explained in Section 2.1 under the description of Alternative 2 and in Appendix H (see "Approaches Used to Analyze and Map Data" for a review on how data were adjusted along features), this update was included in response to comments from the SEFSC recommending that these changes be made in order to reflect all available information on distribution and habitat utilization, and thus meets the requirement that these updates be based on the best scientific information.

6.2.5 Atlantic Yellowfin Tuna (*Thunnus albacares*)

Atlantic yellowfin tuna is an epipelagic, oceanic species, found in water temperatures between 18 and 31 °C. The species is circumglobal in tropical and temperate waters, and in the western Atlantic they range from 45° N lat. to 40° S lat. It is a schooling species, with juveniles found at the surface in mixed schools of 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. Atlantic 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 (914.4 m) isobath (Idyll and de Sylva 1963).

Predator-prey relationships

Atlantic yellowfin tuna are opportunistic feeders and are believed to feed primarily in surface waters down to a depth of 100 m. Gut analyses have identified a wide variety of prey items including fish and invertebrates (Dragovich, 1969, 1970b; Dragovich and Potthoff, 1972; Matthews et al., 1977). Morgan et al. (1985) found that gut contents often include *Sargassum* or *Sargassum* associated fauna. Logan et al. (2012) found that cephalopods, fish, and crustaceans are important prey for yellowfin tuna in the North Atlantic Ocean, with diet composition varying spatially and prey size positively correlated with yellowfin size. 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). A stable isotope analysis of yellowfin in the central North Atlantic characterized the species at a lower trophic level relative to other pelagic species (Logan and Lutcavage 2012).

Life history

Sexual maturity is reached at about three years of age, 110 cm FL, and a weight of 25 kg. Spawning occurs throughout the year in the core areas of the species' distribution (between 15° N lat. and 15° S lat.) 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 compared 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). Wexler (2011) found that larval survival was constrained between 21 and 33 °C and DO greater than 2.2 milligrams per liter (mg/L). Larvae have been collected near the Yucatan peninsula and during September in the northern Gulf of Mexico, along the Mississippi Delta (ICCAT 1994).

Growth and mortality

Yellowfin are characteristically large in size, fast growing, and short-lived (Juan-Jorda et al. 2013). The maximum size of yellowfin tuna is over 200 cm FL (Collette and Nauen 1983). 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 generally confined to the upper 100 m of the water column due to their intolerance of oxygen concentrations less than 2 mL/L (Collette and Nauen, 1983). Yellowfin distribution has been associated with thermocline depth (Block et al. 1997; Kuo-We Lan et al. 2011). Weng et al. 2009 described a diel pattern of yellowfin depth distribution in the Gulf of Mexico, with individuals remaining in the thermocline at night and diving to deeper waters during the day, spending most of their time in water shallower than 50 m. Hoolihan et al. (2014) found yellowfin tuna in the Gulf of Mexico made a higher number of vertical movements above the thermocline rather than below. In the Gulf of Mexico, adults usually occur 75 km or more offshore, while in the Caribbean they are found closer to shore. Juveniles are found nearer to shore than are adults (SCRS, 1994). 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 Gulf of Mexico, resulting in greater catches in the northern Gulf of Mexico from July to December. Association with floating objects has been observed, and in the Pacific larger individuals often school with porpoises (Collette and Nauen 1983).

Essential Fish Habitat for Yellowfin Tuna

Figure G 11 - Figure G 13

Spawning, eggs, and larvae:	In offshore waters in the Gulf of Mexico to the EEZ and portions of the Florida Straits, and most the U.S. Caribbean seaward of the 200m bathymetric line.
Juveniles (< 108 cm FL):	Offshore pelagic habitats seaward of the continental shelf break between the seaward extent of the U.S. EEZ boundary on Georges Bank and Cape Cod, Massachusetts. Offshore and coastal habitats from Cape Cod to the mid-east coast of Florida and the Blake Plateau. Locally distributed in the Florida Straits and off the southwestern edge of the West Florida Shelf. In the central Gulf of Mexico from Florida Panhandle to southern Texas. Localized EFH southeast of Puerto Rico.

Adults (≥ 108 cm FL):	Offshore pelagic habitats seaward of the continental shelf break between the seaward extent of the U.S. EEZ boundary on Georges Bank and Cape Cod, Massachusetts. Offshore and coastal habitats from Cape Cod to North Carolina, and offshore pelagic habitats of the Blake Plateau. EFH in the Gulf of Mexico spans throughout much of the offshore pelagic habitat from the West Florida Shelf to the continental shelf off southern Texas.

Summary of Changes Made to EFH

EFH boundaries published in Amendment 1 have been updated in Final Amendment 10. Juvenile EFH boundaries were expanded slightly in the Gulf of Mexico, South Atlantic, and Mid-Atlantic due to the incorporation of new data into the Kernal Density Estimation / 95 Percent Volume Contour models. Juvenile EFH boundaries in one area off South Carolina were contracted slightly, and one small polygon off the West Florida Shelf was removed. Minor updates were made to adult EFH boundaries in the Mid-Atlantic Bight, South Atlantic, and Gulf of Mexico due to the incorporation of new data into the Kernal Density Estimation / 95 Percent Volume Contour models.

In Final Amendment 10, juvenile and adult EFH boundaries were expanded in the Atlantic Ocean north of the Carolinas to include pelagic habitats between the continental shelf break and the seaward extent of the U.S. EEZ. As explained in Section 2.1 under the description of Alternative 2 and in Appendix F (see "Approaches Used to Analyze and Map Data" for a review on how data were adjusted along features such as clipping), this update was included in response to comments from the SEFSC recommending that these changes be made in order to reflect all available information on distribution and habitat utilization, and thus meets the requirement that these updates be based on the best scientific information.

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6.3 Swordfish (*Xiphias gladius*)

Swordfish are circumglobal, ranging through tropical, temperate, and sometimes cold water regions. Their latitudinal range is from 50° to 40° N lat., to 45° S lat. in the western Atlantic, and 60° to 45° N lat., to 50° S lat. 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 are 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 lat. However, genetic investigations by Chow et al. (2007) suggest that the boundary between the populations may be located in the range of 10° to 20° N lat.

Distribution is size and temperature related, with few fish under 90 kg found in waters with temperatures less than 18 °C. 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). The species moves from spawning grounds in warm waters to feeding grounds in colder waters. 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. 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 dives 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). In addition, the species displays diel vertical movements patterns that show periodic daytime basking events and deep diving events during the day, with juvenile swordfish found to make much greater movements during the day than during their lunar movements (Dewar et al. 2011; Fenton, 2012; Abecassis et al. 2012). In addition, Lerner et al. (2009) found that swordfish migration behavior was correlated to lunar illumination, with swordfish depth preference increasing with increasing lunar illumination. Carey (1990) observed different diel migrations in two groups of fish: swordfish in neritic (shallow, near-coastal) waters of the northwestern 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. However, Lerner et al. (2009) found that swordfish can be found at depth of up to 1,448m.

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, swordfish larvae between 9.0 and 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 less than 11 mm preserved standard length eat primarily near-surface copepods, while larvae larger than 11 mm preserved standard length 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).

Growth and mortality

Swordfish have been observed up to a length and weight of 445 cm total length (TL) and 540 kg, respectively. 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 based on the findings of 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.

Reproductive Potential

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 events take place in waters with surface temperatures above 20 to 22 °C, between 15° and 35° N lat. (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 a narrow surface temperature range (between 24 and 29 °C). The Gulf of Mexico is believed to serve as a nursery area (Palko et al. 1981). Spawning in the Gulf of Mexico seems to be focused in the vicinity of the northernmost arc of the Gulf Loop Current (Govoni et al. 2003). Grall et al. (1983) found larvae 10 mm and larger to be abundant in the Caribbean, the Straits of Florida, and the Gulf Stream north of Florida from December to February. Larvae have been found in the Gulf Stream as far north as Cape Hatteras, NC. In the areas off the southeast 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).

Essential Fish Habitat for Atlantic Swordfish

Figure G 14 - Figure G 16

Spawning, eggs, and larvae:	Atlantic Ocean from off Cape Hatteras, North Carolina extending south around through the east coast of Florida continuing to pelagic habitats in the western Gulf of Mexico (off Texas) that are seaward from the 200 m isobath to the EEZ boundary. EFH is strongly associated with the Loop Current boundaries in the Gulf and the western edge of the Gulf Stream in the Atlantic. EFH also includes pelagic habitats in the eastern U.S. Caribbean from the 200 m isobath to the EEZ boundary.
Juveniles (< 180 cm LJFL):	Offshore pelagic habitats, seaward of the continental shelf break, between Georges Bank and the Florida Keys, and from

	the Florida Keys to pelagic habitats off the coast of Texas. EFH in the U.S. Caribbean includes localized areas around Puerto Rico and the Virgin Islands, and in southern portions of the U.S. Caribbean. EFH is in depths greater than 200 m in all areas.
Adults (≥ 180 cm LJFL):	Offshore pelagic habitats, seaward of the continental shelf break, between Georges Bank and the Florida Keys. EFH extends from the continental shelf to the U.S. EEZ boundary off Massachusetts, Virginia, and from South Carolina through the Florida Keys. EFH in the Gulf of Mexico ranges from the Florida Keys to pelagic habitats off the coast of Texas, mostly seaward of the continental shelf break. EFH in the U.S. Caribbean includes localized areas around Puerto Rico and the Virgin Islands, and in southern portions of the U.S. EEZ. EFH is in depths greater than 200 m in all areas of the EEZ.

Summary of Changes Made to EFH

EFH boundaries published in Amendment 1 have been updated in Final Amendment 10. Boundaries were adjusted for all stages of Atlantic swordfish throughout the U.S. EEZ due to the incorporation of new data into the Kernal Density Estimation / 95 Percent Volume Contour models.

Final Amendment 10 updates juvenile and adult EFH boundaries to exclude habitat less than 200 m in depth. As explained in Section 2.1 under the description of Alternative 2 and in Appendix F (see "Approaches Used to Analyze and Map Data" for a review on how data were adjusted along features), this update was included in response to comments from the SEFSC recommending that these changes be made in order to reflect all available information on distribution and habitat utilization, and thus meets the requirement that these updates be based on the best scientific information.

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6.4 Billfishes

6.4.1 Atlantic Blue Marlin (*Makaira nigricans*)

The blue marlin inhabits the tropical and subtropical waters of the Atlantic, Pacific, and Indian Oceans. Based on historical tagging data, their geographic range is from 48° N lat. to 35° S lat. (Orbesen et al. 2011). In the Atlantic two seasonal concentrations occur: January to April in the southwest Atlantic from 5° to 30° S lat. and from June to October in the northwest Atlantic between 10° and 35° N lat. 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 genetic stock structure analysis and tag and recapture data (ICCAT 2001; Graves and McDowell 2001; and Graves and McDowell 2003; Orbesen et al. 2011).

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. As with other billfishes and tunas, the blue marlin exhibits a high-performance physiology that demands large amounts of oxygen. 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. Stramma et al. (2011) examined the expansion of these “oxygen minimum zones,” determining that a decrease in DO between 1960 and 2010 resulted in a 15 percent habitat loss. 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 (Prince et al. 2010).

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 the mixed layer, so that as the depth of the mixed layer increased, the maximum depth of the dives also increased. Goodyear et al. (2008) found that blue marlin spent the majority of their daytime around 40 m depth, with the majority making short term dives to less than 100 m (although one individual made a dive greater than 800 m), and most of their nighttime very near the surface.

Most of the blue marlin tagging and recovery efforts have been restricted to the western North Atlantic Ocean, with particularly intense activities in the northern Gulf of Mexico, the U.S. Caribbean (Puerto Rico and U.S. Virgin Islands), and the north-eastern coast of South America near La Guaira, Venezuela (Ortiz et al. 2003; Orbesen et al. 2011). Tag and recapture data indicate that blue marlin are capable of trans-oceanic and trans-equatorial movements in the Atlantic and Pacific Oceans, and the only documented species to engage in inter-oceanic movements (i.e., one individual moved from the Atlantic to the Indian Ocean) (Orbesen et al.

2011). Kraus et al. (2011), however, found that the Gulf of Mexico provides a spatially dynamic habitat (i.e., seasonal differences in sea surface temperature and chlorophyll) that is often used by blue marlin through seasonal movements year-round. Analysis of $\delta^{13}C$ and $\delta^{18}O$ stable isotopes of blue marlin otoliths indicated that blue marlin migration out of the Gulf of Mexico basin is limited (Wells et al. 2010).

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. (2011) 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 809 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 highest proportion of visits in the Caribbean area.

Predator-prey relationships

Blue marlin are apparent sight feeders that forage near the surface but also are known to feed in deeper waters; more so than the other istiophorids. They feed primarily on tuna-like fishes (Logan et al. 2013), as well as squid, and a wide size range of other organisms, from 38 mm post-larval surgeonfish to 22.7 6 kg (50 pounds (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* spp.) around the Bahamas, Puerto Rico, and Jamaica, and dolphinfishes and scombrids in the Gulf of Mexico. Octopods and copepods (*Farranula* spp. in the Straits of Florida) are also prey items (Rivas 1975; Davies and Bortone 1976; Nakamura 1985; Sponaugle 2014). 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 become sexually mature by 2 to 4 years of age (SCRS 1997). Female blue marlin begin to mature at approximately 47.2 to 107.6 kg (104 to 238 lb) (Salcedo-Bojorquez and Arrenguin-Sanchez 2011), while males mature at smaller weights, generally from 34.9 to 44.0 kg (77 to 97 lb). Estimated size at sexual maturity for females is 183 cm LJFL and for males is 150 cm LJFL (SCRS 2011).

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 approximately 3.6 million to 6.8 million oocytes for five mature females ranging in size from 277 to 290 cm LJFL. Ovaries from a 147 kg (324 lb) female blue marlin from the northwestern Atlantic were estimated to contain 10.9 million eggs, while ovaries of a 124.4 kg (275 lb) female were estimated to contain approximately 7 million eggs. Richardson et al. (2009) estimated that from 2003 to 2004, 449 billion blue marlin eggs were produced annually in the Straits of Florida during the spawning season (144 days surrounding mid-July), with an apparent larval mortality rate of 0.29-0.45 (95 percent confidence interval). Sponaugle (2014) found that blue marlin larvae grew more rapidly in the western Straits than did those in the eastern Straits. These larvae were noted to have a higher percentage of copepods in their diet, and an early ontogenetic shift to piscivory.

Luckhurst et al. (2006) found that the largest female specimen (over 453.6, or 1,000 lb) 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 by the presence of larvae off Punta Cana, Dominican Republic.

One larval blue marlin (5.2 mm standard length) was collected in pelagic waters off Miami, FL (Serafy et al. 2006). Richardson et al. (2009) determined that the Straits of Florida are the spawning location for about 1.6 percent of the Atlantic-wide spawning blue marlin biomass. 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 lat.) of the known spawning area in the northwest Atlantic for blue marlin. Preliminary information on blue marlin reproduction from between 7° N lat. and 20° S lat. 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. Rooker et al. (2012) found blue marlin larvae in pelagic waters across the northern Gulf of Mexico. Akaike information criterion (AIC) values of the environmental variables at the northern Gulf of Mexico sample sites indicated that sea surface salinity, sample year, *Sargassum* biomass, and water depth were the most influential variables toward the presence of blue marlin larvae. 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).

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 29.9 and 44.9 kg (66 and 99 lb) by age one (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. Sponaugle (2014) found that a higher percentage of *Farranula* copepod prey enhanced blue marlin growth rates and relatively early ontogenetic shift to piscivory enhanced survival in the western Florida Straits. 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 (sexually dimorphic growth) 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 99.8 kg (220 lb), while females continue substantial growth throughout their lifetime (Wilson et al. 1991). Male blue marlins do not usually exceed 158.8 kg (350 lb); however, females can exceed 544.3 kg (1,200 lb).

Blue marlin are currently reported to reach the age of 17 years (Salcedo-Bojorquez and Arrengiun-Sanchez 2011), although the SCRS (2011) continues to use the maximum age of 30 years based on Pacific blue marlin hard part aging by Hill et al. (1989). 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. 2008). 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

Physiochemical attributes associated with the prevalence of blue marlin larvae in northern Gulf of Mexico waters include frontal zones, areas proximal to the Loop Current, lower sea surface temperature, and higher salinity. Adults are found primarily in the tropics within the 24 °C isotherm, and make seasonal movements related to changes in sea surface temperatures. Adult blue marlin exhibit seasonal distributions in the Gulf of Mexico that correspond to sea surface temperature and chlorophyll (Kraus et al. 2011). The expanse of oxygen minimum zones has restricted blue marlin habitat to the upper, near-surface portion of these areas, as their physiology requires large amounts of oxygen (Stramma et al. 2011).

Essential Fish Habitat for Blue Marlin

Figure G 17 – Figure G 19

Spawning, eggs, and larvae:	EFH consists of most of the U.S. EEZ off southeastern Florida, through the Straits of Florida, and into the Gulf of Mexico from the Florida Keys to the continental shelf off of southern Texas.

	EFH extends from the 200m bathymetric line to the seaward extent of the U.S. EEZ. EFH also includes a portion of the western U.S. Caribbean between Puerto Rico and the U.S. EEZ.
Juveniles (20-190 cm LJFL):	EFH in the Atlantic Ocean extends from pelagic habitats south of Georges Bank to the Florida Keys, inclusive of the Blake Plateau and Charleston Bump, in depths greater than 200m. EFH in the Atlantic Ocean extends seaward to the U.S. EEZ boundary off Massachusetts, Virginia, Georgia, and Florida. EFH in the Gulf of Mexico extends from the Florida Keys to the continental shelf off southern Texas in depths greater than 200m. EFH also includes pelagic habitats deeper than 200m in the southern U.S. Caribbean and surrounding Puerto Rico the U.S. Virgin Islands.
Adults (≥ 190 cm LJFL):	EFH in the Atlantic Ocean extends from pelagic habitats south of Georges Bank to the Florida Keys, inclusive of portions of the Blake Plateau and Charleston Bump, in depths greater than 200m. EFH in the Atlantic Ocean extends seaward to the U.S. EEZ boundary north of the Carolinas and off the Blake Plateau; otherwise it is constricted somewhat around the continental shelf break. EFH in the Gulf of Mexico extends from the Florida Keys to the continental shelf off southern Texas in depths greater than 200m. EFH also includes pelagic habitats deeper than 200m in the southern U.S. Caribbean and surrounding Puerto Rico the U.S. Virgin Islands.

Summary of Changes Made to EFH

EFH boundaries published in Amendment 1 have been updated in Final Amendment 10. EFH boundaries were expanded for the spawning, eggs, and larval stage in the Gulf of Mexico from the western end of the Florida Straits to pelagic habitats seaward of the continental shelf off southern Texas. EFH boundaries were also expanded for juveniles and adult life stages in the Atlantic Ocean due to the incorporation of new data into the Kernal Density Estimation / 95 Percent Volume Contour models.

In Final Amendment 10, EFH boundaries for juvenile and adult life stages were adjusted to exclude habitats less than 200m in depth. As explained in Section 2.1 under the description of Alternative 2 and in Appendix F (see "Approaches Used to Analyze and Map Data" for a review on how data were adjusted along features), this update was included in response to comments from the SEFSC recommending that these changes be made in order to reflect all available information on distribution and habitat utilization, and thus meets the requirement that these updates be based on the best scientific information.

6.4.2 White Marlin (*Kajikia 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 45° N to 45° S lat. in the western Atlantic and 45° N lat. to 35° S lat. 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 Atlantic blue marlin and sailfish, which 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.

Portions of the following description are excerpted from White Marlin Biological Review Team (2007). Taxonomic investigations occurred prior to Amendment 1 for white marlin and congeners (a "congener" typically refer to organisms belonging in the same taxonomic genus). 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*. The so-called "hatchet marlin" (*Tetrapturus* sp.), another presumed congener, exhibits truncated first dorsal and anal fins. Photographic analysis of confirmed specimens of white marlin and roundscale spearfish reveals this condition can occur in both; thus, the shortened fins suggest a phenotype variable only, not a separate species (Beerkircher et al. 2008). 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 2008, a total of 51,969 white marlin were marked and released along the western North Atlantic, including the Gulf of Mexico, resulting in 1,014 recaptures (1.95 percent; Snodgrass et al. 2011). 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 years). Three individuals made trans-equatorial crossings, and seven made trans-Atlantic crossings, with 41 percent of recaptures occurring throughout the eastern and western Atlantic Ocean. Recaptures also indicate a substantial number of individuals moving between the Mid-Atlantic coast of the United States and the northeast coast of South America, with 59 percent of the recaptures occurring in the Caribbean.

Wells et al. (2010) further determined that there is much movement between the Gulf of Mexico, Straits of Florida, and the U.S. Atlantic. Horodysky et al. (2007) examined vertical movement and habitat use with 47 PSATs that 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 (less than 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. 2010). 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 percent) 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 DO are available. Another is that their susceptibility to capture by surface fishing gears could 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 blue runner (*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, and crabs. Along the central Atlantic coast, food items include round herring (*Etrumerus teres*) and squid *(Loligo pealei*). The mean weight of stomach contents in white marlin sampled in 2001 and 2002 in this region was composed of fishes (~74 percent), followed by cephalopods (~24 percent) consisting primarily of *Teuthoidea* (Logan and Lutcavage 2012). 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). It was found, between 34 and 37 degrees North lat., that white marlin and their larger cephalopod prey occupy similar trophic positions (Logan and Lutcavage 2012). 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 22 kg in weight and 156.2 cm in length at sexual maturity. Reproduction is characterized by Salcedo-Bojorquez and Arrenguin-Sanchez (2011) as rapid with respect to growth to maturity and high spawning duration and frequency, as well as annual and relative fecundity. Spawning activity occurs off southeast Brazil from April to June, the Gulf of Mexico in June, southern Brazil from December to March, and offshore and north of the Antilles between April and July (SCRS 2011). 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° and 22° N lat. 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).

Growth and mortality

Adult white marlin grow to over 280 cm TL and 82 kg. Size at harvest generally ranges from 20 to 30 kg. 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

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 drop-offs, 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 29 °C and over 35 ppt, respectively). 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

Figure G 20 - Figure G 21

Spawning, eggs, and larvae:	Insufficient information available to designate EFH.
Juvenile (< 160 cm LJFL):	In depths greater than 200 m in all areas of the EEZ. Pelagic habitats south of Georges Bank to the outer extent of the U.S. EEZ, and from Cape Cod to the Florida Keys (inclusive of the

	Charleston Bump and the Blake Plateau). EFH also includes pelagic habitats in the central Gulf of Mexico between the Florida Keys (excluding the West Florida Shelf) and the continental shelf break off of southern Texas. EFH also includes the southern portion of the U.S. Caribbean and pelagic habitats deeper than 200m surrounding Puerto Rico and the U.S. Virgin Islands.
Adults (≥ 160 cm LJFL):	In depths greater than 200 m in all areas of the EEZ. Pelagic habitats south of Georges Bank to the outer extent of the U.S. EEZ, from Cape Cod to North Carolina, on the Blake Plateau, and in the Florida Straits between Cape Canaveral and the southwestern edge of the West Florida Shelf. In the central Gulf of Mexico from the Florida Panhandle to pelagic habitats seaward of the continental shelf off southern Texas. EFH also includes the southern portion of the U.S. Caribbean and pelagic habitats deeper than 200m surrounding Puerto Rico and the U.S. Virgin Islands.

Summary of Changes Made to EFH

EFH boundaries published in Amendment 1 have been updated in Final Amendment 10. Boundaries were expanded for juvenile and adult stages of white marlin throughout the Atlantic Ocean, Gulf of Mexico, and U.S. Caribbean due to the incorporation of new data into the Kernal Density Estimation / 95 Percent Volume Contour models and scientific recommendations from the NOAA SEFSC.

In Final Amendment 10, EFH boundaries were adjusted in the Gulf of Mexico and Atlantic to exclude habitats less than 200m in depth and to include the southern U.S. Caribbean. As explained in Section 2.1 under the description of Alternative 2 and in Appendix F (see "Approaches Used to Analyze and Map Data" for a review on how data were adjusted along features), this update was included in response to comments from the SEFSC recommending that these changes be made in order to reflect all available information on distribution and habitat utilization, and thus meets the requirement that these updates be based on the best scientific information.

6.4.3 Roundscale Spearfish (*Tetrapturus georgii*)

Roundscale spearfish was identified as a separate species from white marlin when taxonomic investigations occurred for white marlin and its congeners (similar individuals) prior to Amendment 1. Validity of the roundscale spearfish was reported by Shivji et al. (2006) using genetic and morphometric analyses. Roundscale spearfish are 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:

midlateral scales that have rounded and broadened anterior bases (Beerkircher et al. 2008); 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, although NMFS has been encouraging anglers to distinguish the two species through educational outreach materials and at public events such as fishing tournaments.

The proportion of roundscale spearfish in the white marlin population is unknown, and the historical misidentification of roundscale spearfish as white marlin in historical fishery-dependent and independent studies is recognized as a potential issue (Snodgrass et al. 2011; Beerkircher et al. 2009). Further, it is unknown whether the proportion has changed over time. Bernard et al. (2013) used genetic analysis of 14 individuals to identify the extent of its range.

The world's largest sport fishery for white marlin (ergo roundscale spearfish) occurs in the summer from Cape Hatteras, North Carolina to Cape Cod, Massachusetts especially between Oregon Inlet, North Carolina and Atlantic City, New Jersey. Genetic analysis of specimens identified as white marlin landed in a New Jersey recreational fishing tournament between 1992 and 2011 found an average of 22.6 percent were actually roundscale spearfish (Graves 2012). This has raised the possibility that the abundance of white marlin may be overestimated.

Predator–prey relationships

Information on prey items specific to roundscale spearfish remains unavailable; however, because roundscale spearfish are caught on the same fishing baits used to catch white marlin, it is evident that the two species share some predatory habits.

Reproduction and Early Life History

Female roundscale spearfish are about 22 kg (48.5 lb) in weight and 156.12 cm (61.46 inches) in length at sexual maturity. Spawning activity and environmental associations (e.g. salinity and temperature) are assumed to be similar to those of white marlin until further studies are conducted.

Growth and mortality

Salcedo-Bojorques and Arreguin-Sanchez (2011) found that roundscale spearfish undergo rapid growth, high age at first maturity to maximum age ratios and batch fecundity values, and low spawning duration. Adult roundscale spearfish grow to over 200 cm TL and 24 kg (52.9 lb), with a maximum age of 5 years (Salcedo-Bojorquez and Arrengiun-Sanchez 2011).

Habitat associations

The capture locations of the 14 individuals genetically tested and confirmed to be roundscale spearfish by Bernard et al. (2013) ranged from 37°41' N lat. to 28°52' S lat. and 56°00' W long. to 27°58' W long., which would be considered nominally within the range of this species. At the time of that publication, no specimens had yet been found and verified along the eastern Southern Atlantic Ocean. Pelagic Observer Program (POP) data suggests that roundscale spearfish are widely distributed in the western North Atlantic, and abundant in the Sargasso Sea area during the winter period (Beerkircher et al. 2008). Further, POP observers have reported roundscale spearfish in mid-July off the Grand Banks at 43°42’ N lat. and 47°37’ W long. (L. Beerkircher, SEFSC, Pers. Comm.).

Essential Fish Habitat for Roundscale spearfish

Figure G 22 - Figure G 23

Spawning, eggs, and larvae:	Insufficient information available to designate EFH.
Juvenile (20 - 154 cm LJFL):	Pelagic habitats seaward of the continental shelf (depths greater than 200m) south of Georges Bank to the outer extent of the U.S. EEZ; from Cape Cod to Cape Fear, North Carolina; and from southern South Carolina to the southeastern coast of Florida (close to Jupiter Inlet) .
Adults (≥ 155 cm LJFL):	Pelagic habitats seaward of the continental shelf (depths greater than 200m) south of Georges Bank to the outer extent of the U.S. EEZ and from Cape Cod to the mid-east coast of Florida.

Summary of Changes Made to EFH

EFH boundaries published in Amendment 1 have been updated in Final Amendment 10. In Amendment 1, the EFH boundaries for roundscale spearfish were assumed to be identical to those of white marlin. However, since 2009, NMFS has collected enough new information on roundscale spearfish to run species-specific Kernal Density Estimation / 95 Percent Volume Contour models. EFH boundaries identified in Amendment 1 in the Gulf of Mexico were based primarily on white marlin data; recent model output on verified roundscale spearfish data implied that no areas in the Gulf of Mexico should be included in juvenile and adult EFH boundaries. Boundaries were modified for adult and juvenile stages of roundscale spearfish throughout the Atlantic Ocean due to the incorporation of new data into the Kernal Density Estimation / 95 Percent Volume Contour models.

In Final Amendment 10, EFH boundaries were adjusted from those in Draft Amendment 10 for the Gulf of Mexico and Atlantic to exclude habitats less than 200m in depth. As explained in Section 2.1 under the description of Alternative 2 and in Appendix F (see "Approaches Used to Analyze and Map Data" for a review on how data were adjusted along features), this update was included in response to comments from the SEFSC recommending that these changes be made in order to reflect all available information on distribution and habitat utilization, and thus meets the requirement that these updates be based on the best scientific information.

6.4.4 Atlantic Sailfish (*Istiophorus platypterus*)

Taxonomic investigations have occurred 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.

Sailfish have a circumtropical distribution (Post 1998). They range from 40° N lat. to 40° S lat. in the western Atlantic and 50° N lat. to 32° S lat. 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 28 °C, for approximately 82 percent of the day while foraging, but dive into deeper, colder water and have been found to do so to a maximum of 463.9 m and 8 °C (Hoolihan et al. 2011; Kerstetter et al. 2011). They exhibit a preference for warmer, near-surface depth in comparison to the preferences of other billfishes (Hoolihan et al. 2011), and take short-duration vertical descents to depths of 50 to 150 m (Kerstetter et al. 2011).

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, North Carolina, but there have been reported interactions further north than Cape Hatteras. No transatlantic or transequatorial movements have been documented using tag-recapture methods (Bayley and Prince 1993). This supports the assumption that sailfish have a preference for coastal habitat and minimal mixing with eastern and southern Atlantic populations (Orbesen et al. 2010).

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).

Domenici et al. (2014) described how the sailfish uses its bill to capture prey, inserting it into a school of sardines undetected, and tapping or slashing through the school with one of the highest accelerations of movement recorded in aquatic vertebrates. 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 (~10 m) around Florida, from the Keys to the region off Palm Beach on the east coast. The Florida Straits have been identified by Richardson et al. (2009) as important spawning grounds for sailfish. 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 4- to 24-day-old larvae, in the northern Gulf of Mexico from May to September (Simms et al. 2010).

Richardson et al. (2009) describes the Straits of Florida as the location of about 2.1 percent of Western Atlantic sailfish spawning. 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 to12 mm SL) have been found in pelagic waters off Miami, Florida in August (Serafy et al. 2006).

Sexual maturity occurs at age five, with females at a weight of 28 kg and length of 185.6 cm (Salcedo-Bojorquez and Arreguin-Sanchez 2011) 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).

Growth and mortality

Analysis of daily growth rings in Atlantic sailfish sagittae otoliths estimated ages at 3 to 18 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 weight is 60 kg (132.28 lbs), length is 260 cm (102.36 in), and age can be 13 to15 or more years (Salcedo-Bojorquez and Arrenguin-Sanchez 2011). Growth rate in older individuals is very slow at 0.59 kg/yr (Prince et al. 1986).

Habitat associations

In the winter, 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 28 °C 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). Concerns about hypoxia-induced constraints to habitat availability are presented by Prince and Goodyear (2007), restricting sailfish and other billfishes to shallower waters in which they are more vulnerable to fishing pressures, while also increasing foraging opportunities for sailfish, which could explain the greater size of these fish along the eastern Atlantic shores, where these hypoxic areas are occurring, compared to those of the western Atlantic.

Essential Fish Habitat for Sailfish

Figure G 244 - Figure G 266

Spawning, eggs, and larvae:	Off the southeast 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. EFH in the Gulf of Mexico consists of offshore pelagic habitats from the Florida Keys to the continental shelf off of southern Texas. EFH extends from the 200m bathymetric line to the seaward extent of the U.S. EEZ.
Juveniles (20 - 179 cm LJFL):	Localized distribution of EFH in the Atlantic Ocean from Maryland to Georgia. EFH is also located along the east coast of Florida and on the Blake Plateau through the Florida Straits (south of the Florida Keys) to habitats seaward of the southwestern edge of the West Florida Shelf. Localized EFH in the central and northern Gulf of Mexico, between Apalachicola and southern Texas. Eastern Puerto Rico and Virgin Islands.
Adults (≥ 180 cm LJFL):	Atlantic Ocean at the continental shelf break off the Delmarva Peninsula; along the Outer Banks of North Carolina to Cape Fear, North Carolina; off the central coast of South Carolina; and from northern Florida through the Florida Straits and Florida Keys to the southern edge of the West Florida Shelf. EFH in the Gulf of Mexico spans from coastal habitats off the western Florida panhandle and coastal Louisiana to offshore pelagic habitats associated with the continental shelf westward to the coast of Texas. Also around the Virgin Islands and the northeastern coast of Puerto Rico.

Summary of Changes Made to EFH

EFH boundaries published in Amendment 1 have been updated in Final Amendment 10. Boundaries were expanded for all stages of Atlantic sailfish throughout the U.S. EEZ due to the incorporation of new data into the Kernal Density Estimation / 95 Percent Volume Contour models and scientific recommendations from the NOAA SEFSC.

In Final Amendment 10, EFH boundaries were slightly adjusted from those in the Draft Amendment throughout the U.S. EEZ due to the incorporation of updated data into the Kernal Density Estimation / 95 Percent Volume Contour models. As explained in Section 2.1 under the description of Alternative 2 and in Appendix F (see "Approaches Used to Analyze and Map Data" for a review on how data were adjusted along features), this update was included in response to comments from the SEFSC recommending that these changes be made in order to reflect all available information on distribution and habitat utilization, and thus meets the requirement that these updates be based on the best scientific information.

6.4.5 Longbill Spearfish (*Tetrapturus pfluegeri*)

Longbill spearfish 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 40° N lat. to 35° S lat. 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*. *T. georgii* are not hybrids, but rather a clearly different genetic lineage to sympatric billfish species such as white marlin and longbill spearfish.

Predator-prey relationships

The diet of the longbill spearfish consists of pelagic fishes and squids. Logan and Lutcavage (2012) found Cephalapoda collected from the stomach contents of longbill spearfish included the family Ommastriphidae.

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)

Growth and mortality

The females at first maturity weigh approximately 45 kg (de Sylva and Breder 1997), are a length of 194 cm (194.0 kg, 427.7 lb), and an age of 2 years.

Habitat associations

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

Essential Fish Habitat for Longbill Spearfish:

Figure G 277

Spawning, eggs, larvae, Juveniles, and Adults:

EFH designation for juveniles and adults have been combined and are considered the same. EFH in the Atlantic Ocean extends from pelagic habitats south of Georges Bank to the

Florida Keys, inclusive of the Blake Plateau and Charleston Bump, in depths greater than 200m. EFH in the Gulf of Mexico extends from the Florida Keys to the continental shelf off southern Texas in depths greater than 200m. EFH in the U.S. Caribbean encompasses all pelagic habitats seaward of 200m bathymetric limits.

Summary of Changes Made to EFH

Boundaries published in Amendment 1 have been updated in Final Amendment 10. Boundaries were expanded for all stages of longbill spearfish throughout the U.S. EEZ due to the incorporation of new data into the Kernal Density Estimation / 95 Percent Volume Contour models.

There were no changes to EFH boundaries for longbill spearfish from Draft Amendment 10 to Final Amendment 10.

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6.5 Large Coastal Sharks

6.5.1 Blacktip Shark (C*archarhinus 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 FL, whereas the median size in the Gulf of Mexico region is 117.3 cm FL (Castro, 1996). 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). In addition, tagging studies indicate there is no evidence of blacktip sharks moving from the Gulf of Mexico to the Atlantic or Caribbean Sea or from the western half of the Gulf of Mexico to the eastern half (and vice versa) (Bethea et al. 2012, 2014; Swinsburg et al. 2012). In addition, the 2006 stock assessment for blacktip sharks separated them into an Atlantic and Gulf of Mexico stock (NMFS 2006). Thus, based on the assessment, blacktip sharks are managed as two separate stocks, an Atlantic and Gulf of Mexico stock.

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 Simpfendorfer 2005a). Adult blacktip sharks were primarily found to be distributed within the 200 m depth contour in the Gulf of Mexico, with some sharks moving from U.S. territorial waters to Mexican territorial waters (Swinsburg et al. 2012). Adults are typically found further offshore than juveniles.

Blacktip sharks are associated with warmer temperatures, slightly lowered DO, and mid to deeper water with a salinity of 30 percent or greater (McCallister et al 2013; Ward-Paige et al. 2014) as well as near tidal inlets of moderate salinities that are proximate to deeper waters (Froeschke et al. 2010b). Bethea et al. (2014) conducted the GULFSPAN survey in 2014 to examine the distribution and abundance of juvenile sharks in coastal areas of the Gulf of Mexico. This survey is used to describe and further refine shark EFH and included monthly April to October gillnet sets, and some experimental longline sets, in coastal bays, estuaries, and around barrier islands, covering more than 550 km of coastline in the Gulf of Mexico. This survey showed what YOY blacktip sharks were found in water temperatures ranging from 20.8 to 32.2 °C, salinities ranging from 22.4 to 36.36 ppt, water depth ranging from 0.9 to 7.6 m, and DO ranging from 4.32 to 7.7 mg/L in silt, sand, mud, and seagrass habitats in the Gulf of Mexico. Juvenile blacktip sharks were found in water temperatures ranging from 19.8 to 32.2 °C, salinities ranging from 7.0 to 36.8 ppt, water depth ranging from 0.7 to 9.4 m, and DO ranging from 4.28 to 8.30 mg/L in silt, sand, mud, and seagrass habitats. Adult blacktip sharks were found in water temperatures ranging from 21.5 to 31.1 °C, salinities ranging from 22.3 to 34.7 ppt, water depths ranging from 0.9 to 6.6 m, and DO levels ranging from 5.22 to 7.49 mg/L in silt, sand, mud, and seagrass habitats in the Gulf of Mexico.

Work in the South Atlantic showed juvenile blacktip sharks sampled from North Carolina to Georgia to be in inlets, estuarine, and nearshore waters with water temperatures ranging from 19 to 33 °C, salinities ranging from 13 to 37 ppt, water depth ranging from 2.4 to 12.8 m, and DO ranging from 4.3 to 6.1 mg/L in shell, sand, rocky habitats (McCandless et al. 2002; Able et al. 2007; Gurshin 2007; Ulrich et al. 2007).

Reproductive potential

The 2006 stock assessment for Atlantic blacktip sharks indicated the maximum observed ages were 15.5+ years (female) and 13.5+ years (male) for sharks collected in the South Atlantic Bight (Carlson et al. 2005). In the South Atlantic Bight, median size-at-maturity was 126.6 cm FL for females and 116.7 cm FL for males (Carlson et al. 2005); this corresponded to age-at-maturity of 6.7 years for females and 5.0 years for males (Carlson et al. 2005). SEDAR 11 (NMFS, 2006) updated von Bertalanffy parameters for combined sexes of blacktip sharks: L_4 = 159, K= 0.16, t_0= -3.432. The young are born at 55 to 60 cm TL in late May and early June in shallow coastal nurseries from Georgia to the Carolinas (Castro 1996; Carlson et al. 2005). Mean litter size in the South Atlantic was estimated as 3.2 pups with a biennial reproductive cycle (NMFS 2006). Blacktip sharks 60 - 125 cm FL are considered juveniles in the South Atlantic (Castro 1996; Carlson et al. 2005).

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. The 2012 stock assessment for Gulf of Mexico blacktip sharks indicated the maximum observed ages were 18.5+ years (female) and 23.5+ years (male) (Passerotti and Baremore, 2012). Median size-at-maturity in the Gulf of Mexico was estimated as 119.2 cm FL for females and 105.8 cm FL for males (Baremore and Passerotti, 2013); this corresponded to age-at-maturity of 6.3 years for females and 4.8 years for males (Baremore and Passerotti, 2013). Passerotti and Baremore (2012) gave the von Bertalanffy parameters for combined sexes as: L_4 = 147.18, K= 0.187, t_0= -2.74. YOY are considered less than 61 cm FL (SEDAR, 2012; Baremore and Passerotti 2013; Bethea et al. 2014) and are born in bay systems in the Gulf of Mexico (Carlson 2002; Parsons 2002), and the Texas coast (Jones and Grace 2002). Mean litter size is 4.5 pups per brood with average FL of near term pups to be 38 cm. Females have biennial reproduction cycle and gestation time of 12 months (Baremore and Passerotti 2013). Sharks 62 - 118 cm FL in the Gulf of Mexico are considered juveniles (SEDAR 2012; Baremore and Passerotti 2013; Bethea et al. 2014).

In general, nursery areas are thought to be used for two main reasons: predator avoidance and food abundance (Branstetter 1990; Castro 1993; 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 Simpfendorfer (2002) showed that 61 and 91 percent 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 Simpfendorfer (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.

In the Atlantic, the nurseries are on the seaward side of coastal islands of the Carolinas, at depths of two to four meters (Castro 1993). Castro (1993) found neonates over muddy bottoms off Georgia and the Carolinas, while Hueter found them over seagrass beds off western 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 YOY and small juveniles, suggesting that the estuary system of Sapelo Island, Georgia served as important nursery habitats.

Juvenile blacktip sharks have also been found in Winyah Bay and North Inlet, South Carolina, and this area has been suggested as a 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). The species is also found in the estuary system of Sapelo Island, Georgia. Adams and Paperno (2007) found juvenile blacktip sharks (63 to 88.5 cm TL) along the eastern seaboard from northern Cape Canaveral (28°40' N lat.) south to the Jupiter Island area (27°04' N lat.) in water depths of 3 to 11 m. Blacktip sharks occurred at temperatures between 19 and 31 °C and over a salinity range of 13 to 37 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 YOY blacktip sharks were collected during the study (Abel et al. 2007). With the exception of one individual, neonates and YOY were captured exclusively in estuarine waters between May and early September, indicating the importance of the estuaries as nursery habitat 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 YOY 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 uses both of these areas as nursery habitat (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 were collected in the Gulf of Mexico among 10 geographic areas and were not found to be restricted to any specific nursery area, but rather were abundant in all habitats despite differences in habitats (Bethea et al. 2014). Carlson (2002) found neonates in depths of 2.1 to 6.0 m under a variety of habitat conditions.

On the west coast of Florida, Yankeetown has proven to be the most productive blacktip shark 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).

YOY 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, YOY 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). Juveniles leave the north-central Florida nurseries (e.g., Yankeetown area) in the fall and migrate south as far as the Marquesas Islands west of the Florida. 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). YOY blacktip sharks begin their northward spring migration back to the 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). In the Alabama coast, catch per unit effort for blacktip sharks from inshore and offshore fishery independent surveys carried out in that area was significantly higher at shallow depths, with a significant bias towards females at shallow depths (Drymon et al. 2010). 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 for 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 to 32.4 °C, while salinity ranged from 11.0 to 37.3 ppt over the sampling period, and DO 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. YOY and juvenile blacktip shark collections made in these areas water between 3.1 and 8.2 m in mean depth, 27.1 and 30.6 °C mean temperature, 18 and 20 ppt mean salinity, 5.5 and 7.3 parts per million mean DO, 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 YOY 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).

Essential Fish Habitat for Blacktip Shark (Atlantic Stock)

Figure G 288 - Figure G 299

Neonate/YOY (≤ 59 cm FL): In Atlantic Ocean coastal areas out to 20 m depth contour from northern Florida through areas with muddy bottoms in Georgia and the seaward side of coastal islands of the Carolinas, at depths of 2 to 4 m.

Juvenile (60-125 cm FL) and Adult (≥ 126 cm FL):

EFH is in Atlantic coastal areas from Florida to the Maryland/Virginia line (northern extent of EFH is Chincoteague Island), including the mouth of Chesapeake Bay and adjacent coastal areas along the Delmarva Peninsula. EFH is also in South Carolina Inlets, estuarine, and nearshore waters (including Winyah Bay and North Inlet) associated with water temperatures ranging from 19 to 33 °C, salinities ranging from 13 to 37 ppt, water depth ranging from 2.4 to 12.8 m, and DO ranging from 4.3-6.1 mg/L in shell, sand, and rocky habitats. EFH also ranges from northern Cape Canaveral (~28°40' N lat.) south to the Key Biscayne area (~27°04' N lat.) in water depths of 3 to 11 m.

Summary of Changes Made to EFH

EFH boundaries published in Amendment 1 have been updated in Final Amendment 10. Amendment 1 established EFH for a single stock of blacktip sharks. However, the blacktip shark stock was split into two regional stocks in 2012 due to the results of scientific research presented during the SEDAR 29 stock assessment. NMFS manages each stock separately; therefore, delineation of separate EFH boundaries for Atlantic and Gulf of Mexico stocks would be consistent with current management strategies. EFH boundaries of the neonate/ YOY blacktip shark EFH for the Atlantic stock were expanded between Myrtle Beach (approximately) and northeastern Florida due to the incorporation of new data into the Kernal Density Estimation/ 95 Percent Volume Contour models. The juvenile and adult blacktip shark EFH boundaries for the Atlantic stock were expanded to near-continuous coverage from Chincoteague to the southern boundary to Key Biscayne, Florida due to the incorporation of new data into the Kernal Density Estimation/ 95 Percent Volume Contour models.

In Final Amendment 10, the juvenile and adult EFH boundaries for both the Gulf of Mexico and Atlantic stocks were extended from those in Draft Amendment 10 to the management boundary between the two stocks off southeastern Florida. As explained in Section 2.1 under the description of Alternative 2 and in Appendix H (see "Approaches Used to Analyze and Map Data" for a review on how data were adjusted along features), this update was included in response to public comments and comments from the SEFSC recommending that these changes be made in order to reflect all available information on distribution and habitat utilization, and thus meets the requirement that these updates be based on the best scientific information.

Essential Fish Habitat for Blacktip Shark (Gulf of Mexico Stock)

Figure G 30 – Figure G 31

Neonate/YOY (≤ 61 cm FL):	Coastal areas, including estuaries, out to the 30 m depth contour in the Gulf of Mexico from the Florida Keys to southern Texas. Yankeetown of the west coast of Florida is one of the most productive blacktip shark nurseries, followed by Charlotte Harbor, Tampa Bay, Ten Thousand Islands, and the Florida Keys. Important EFH includes central Louisiana's nearshore coastal waters important pupping and nursery areas, such as habitats 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. . Neonates EFH is associated with water temperatures ranging from 20.8 to 32.2 °C, salinities ranging from 22.4 to 36.4 ppt, water depth ranging from 0.9 to 7.6 m, and DO ranging from 4.32 to 7.7 mg/L in silt, sand, mud, and seagrass habitats.
Juvenile (62 to 118 cm FL) and Adult ((≥ 119 cm FL):	Coastal areas out to 100 m depth contour in the Gulf of Mexico from the Florida Keys to southern Texas. EFH also includes coastal areas of Mississippi and Louisiana, including Mississippi Sound, Mobile Bay, Terrebonne Bay, Timbalier Bay, and Chandeleur Sound. EFH is associated with water temperatures ranging from 19.8 to 32.2 °C, salinities ranging from 7.0 to 36.8 ppt, water depth ranging from 0.7 to 9.4 m, and DO ranging from 4.28 to 8.30 mg/L. EFH includes multiple types of substrate - silt, sand, mud, and seagrass habitats. Found in water temperatures ranging from 21.5 to 31.1 °C, salinities ranging from 22.3 to 34.7 ppt, water depths ranging from 0.9 to 6.6 m, and DO levels ranging from 5.22 to 7.49 mg/L in silt, sand, mud, and seagrass habitats.

Summary of Changes Made to EFH
EFH boundaries published in Amendment 1 have been updated in Final Amendment 10. Amendment 1 established EFH for a single stock of blacktip shark. However, the blacktip shark stock was split into two regional stocks in 2012 due to the results of scientific research presented during the SEDAR 29 stock assessment. NMFS manages each stock separately; therefore, delineation of separate EFH boundaries for Atlantic and Gulf of Mexico stocks would be consistent with current management strategies. The neonate/YOY blacktip shark EFH boundaries as well as the juvenile and adult blacktip shark EFH boundaries for the Gulf of Mexico were adjusted slightly due to the incorporation of new data into the Kernal Density Estimation/ 95 Percent Volume Contour models.

In Final Amendment 10, juvenile and adult EFH boundaries were combined due to similarity in behavior and overlap in model output for these life stages, and were extended from those in Draft Amendment 10 to the stock boundary off southeastern Florida, As explained in Section 2.1 under the description of Alternative 2 and in Appendix H (see "Approaches Used to Analyze and Map Data" for a review on how data were adjusted along features), this update was included in response to comments from the public and the SEFSC recommending that these changes be made in order to reflect all available information on distribution and habitat utilization, and thus meets the requirement that these updates be based on the best scientific information.

6.5.2 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 in the United States (Thorson et al. 1973).

Tagging work by Carlson et al. (2010) in coastal regions of the United States, Gulf of Mexico, and off the southeastern United States, found that of the 15 tags extracted from 18 bull sharks tagged, most bull sharks remained in coastal waters of where they were tagged, with an average movement rate of 5-6 km/day. Some offshore-onshore movement was noted, and may have been due to response to environmental conditions (these movements were noted in areas adjacent to freshwater input; e.g., the Mississippi, Apalachicola, Caloosahatchee Rivers). Adults are usually found in higher salinities than juveniles and neonate/YOY sharks. Adults are also often distributed out to the shelf edge, but are not in slope waters (J Carlson pers comm, NOAA SEFSC; C. McCandless pers comm, NOAA NEFSC). Brunnschweiler et al. (2010) deployed pop-up satellite tags for six bull sharks in the Bahamas and found that for the most part, sharks stayed in shallow waters, except for one shark which moved across the Blake Plateau from the Bahamas to coastal habitat off Florida at the mouth of the Indian River Lagoon, an area considered to be a nursery for bull sharks. In addition, Froeschke et al. (2012) analyzed fishery independent data from 1976-2010 gillnet surveys in Texas coastal waters and found that bull shark abundance has been increasing in those areas.

Recent genetic work by Karl et al. (2011) examined genetic variation of bull sharks in the western Atlantic, and noted that structure exists between the Brazilian and all northern populations at the mtDNA control region. Results were congruent with restricted maternal gene flow between populations caused by female site fidelity to nursery areas. This study also estimated an effective population size for northwest Atlantic bull sharks at 221,000 animals. In addition, Naylor et al. (2012) summarized genetic research completed from 24 specimens collected from around the world. The genetic analysis grouped together three sub-clusters of bull sharks from the western Atlantic (including specimens from Florida and Alabama), South Africa, and Borneo.

Reproductive potential

Males mature at 210 to 220 cm TL or 14 to 15 years of age, while females mature at 225 cm TL or more, or 18 years of age or more (Branstetter and Stiles, 1987). Growth parameters have been estimated by Branstetter and Stiles (1987) as L_∞ = 285 cm TL, K= 0.076, and t_0= -3.0 years. Previous work by Neer et al. (2005) estimated von Bertalanffy growth model parameters as L_∞ = 300.7 cm FL, K= 0.042, and t_0= -6.84 years, 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 FL 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). Recent findings of bull sharks from the Western North Atlantic Ocean (Natanson et al. 2014), estimated size at birth at 60.8 cm FL for males and 62.2 cm FL for females (overall mean size at birth was estimated at 61.5 cm FL). Age at maturity was estimated at 15-17 years for males and 15 years for females (Natanson et al. 2014). Maximum age for males and females was 25 and 27 years of age, respectively (Natanson et al. 2014). The study noted that bull sharks in the western North Atlantic and the Gulf of Mexico have similar growth and maturation rates, but that there were sex-related differences in growth rates (Natanson et al. 2014).

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. Many of the nursery areas in United States waters include 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).

Curtis et al. (2011) reported shallow freshwater creeks, power plant outfalls, ocean inlets, and seagrass habitats with temperatures greater than 20 °C, salinities of 10 to 30 ppt, and DO concentrations between 4 and 7 mg/L most influenced the distribution of juvenile bull shark. On the east coast of Florida, juvenile bull sharks ranging from 75.4 to 146 cm TL were collected from northern Cape Canaveral (28°40’ N lat.) south to the Jupiter Island area (27°04’ N lat.) 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 Center for Shark Research (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). Important 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). YOY bull sharks are found in these same areas throughout the warm months and remain in these 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 nurseries for the bull shark (Hueter and Tyminski 2007), with bull shark abundance in the Florida Keys being higher in winter months (December- January) based on tagging work by Hammershlag et al. (2012).

Streich and Peterson (2011) found that the Altamaha River Estuary in Georgia also served as a bull shark nursery area. Froeschke et al. (2010a) found that both the Matagorda Bay and San Antonio Bays off Texas met the criteria for potential bull shark nursery habitat for YOY bull sharks and juvenile bull sharks, respectively. 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 use estuarine nursery areas (1.7 to 41.1 ppt), they do not appear to venture as far into freshwater as the neonates and YOY (Hueter and Tyminski 2007). Additionally, YOY 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). Using long-term fisheries independent gill net surveys conducted in Texas estuaries from 1975 to 2006 habitat use models for bull shark found that the central region along the Texas coast contains the most important estuarine bull shark habitat characterized by warm temperatures, moderate salinities, and abundant tidal inlets. Bull sharks also extended into low salinity estuaries (Froeschke et al. 2010b).

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 Simpfendorfer et al. (2005) found neonate and YOY 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. Different size classes were also shown to prefer different salinity and temperature regimes where year one individuals were most common in salinities between 7 and 17.5 ppt and were found in the highest temperatures (Simpfendorfer et al. 2005). Work by Wiley and Simpfendorfer (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 less than 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 Simpfendorfer 2007). In the Everglades National Park, bull sharks were found in salinities lower than 25 ppt, but seemed to avoid salinities higher than 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 Simpfendorfer 2007).

Louisiana's coastal and inland estuarine waters are also important 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 to 37 °C, and turbidity ranging from 10 to 200 cm in mud, and mud/shell habitats (Blackburn et al. 2007; Neer 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).

Bethea et al. (2014) surveyed shark nursery areas in the Gulf of Mexico in 2014 under GULFSPAN. The survey showed what YOY bull sharks were found in water temperatures around 28.8 °C, lower salinities around 16.9 ppt, water depths around 2.2 m, and DO levels around 4.5 mg/L in silt habitats. Juvenile bull sharks were found in water temperatures ranging from 24.2 to 30.9 °C, salinities ranging from 10.6 to 30.8 ppt, water depth ranging from 1.4 to 5.8 m, and DO ranging from 5.97 to 7.6 mg/L in sand, mud, and seagrass habitats. However, this survey did not encounter many bulls sharks compared to other shark species; adult bull sharks were not encountered during the surveys.

Essential Fish Habitat for Bull Shark

Figure G 32 – Figure G

Neonate/YOY (≤ 77 cm FL):	Atlantic Ocean in the Cape Canaveral area. Gulf of Mexico EFH includes localized areas off the west coast of Florida, including Caloosahatchee River area, Yankeetown, Tampa Bay, Charlotte Harbor, Ten Thousand Islands, and the Keys; the Florida Panhandle; coastal habitats between Mobile Bay and Lake Borgne. Coastal areas along Texas to the mouth of the Mississippi River, particularly the inland bay and bayou systems of Louisiana (i.e., 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). EFH for neonates/YOY includes areas of shallow depth (less than 9 m) in lower salinity estuaries and river mouths (as low as 0.9 ppt) until water temperatures reach 21 °C.

Juveniles (78-188 cm FL) and Adults (≥ 189 cm FL):

Atlantic coastal areas between South Carolina and the Florida Keys. Altamaha River Estuary in Georgia. From the mid-east coast of Florida, including northern Cape Canaveral (28°40’ N) south to the Jupiter Island area (27°04’ N lat.) in water depths of 3 to 11 m, EFH includes freshwater creeks, ocean inlets, and seagrass habitats; temperatures ranging as low as 16.4 °C; salinities ranging between 1.7 to 41.1 ppt; and DO concentrations ranging between 4 and 7 mg/L. EFH is located in shallow depths less than 9 m.

EFH in the Gulf of Mexico includes the Florida Keys, Ten Thousand Islands, Charlotte Harbor, Tampa Bay, Yankeetown, Pine Island Sound, the Florida panhandle, Mississippi Sound and Mobile Bay off the coasts of Mississippi and Alabama, interior of Lake Pontchartrain, the Pearl River system, around the Chandeluer Sound on the east side of the Mississippi River Delta, 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, the west side of Mississippi River Delta and, and coastal areas along the Texas coast, especially Matagorda Bay and San Antonio Bays.

Summary of Changes Made to EFH

EFH boundaries published in Amendment 1 have been updated in Final Amendment 10. Boundaries of the neonate/YOY bull shark EFH were modified to exclude areas offshore of Texas in the western Gulf of Mexico, but include new areas in Vermillion Bay, Caillou Bay, Terrebonne Bay, West Bay, and East Bay as well as areas along the Florida Keys. Juvenile and adult EFH boundaries were considered similar enough to warrant combining them, based on scientific recommendations from the SEFSC and NEFSC. Boundaries of the juvenile and adult bull shark EFH were expanded to include the mid-Gulf of Mexico coastal regions and mid-coastal areas of South Carolina in the Atlantic. These areas were added due to the incorporation of new data into the Kernal Density Estimation/ 95 Percent Volume Contour models for all maps.

There were no changes to EFH boundaries for bull shark from Draft Amendment 10 to Final Amendment 10.

6.5.3 Great Hammerhead Shark (*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). 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 encountering prey, and enhanced maneuverability, which may aid in prey capture (Kajiura and Holland 2002). Great hammerhead sharks have been observed using their laterally expanded head in prey-handling (Strong et al. 1990; Chapman and Gruber 2002). It is usually a solitary fish, unlike the more common scalloped hammerhead, which often forms very large schools.

Hammerschlag et al. (2011) tracked a satellite tagged great hammerhead in 2010. It travelled 1,200 km, from the Florida Keys to approximately 500 km off New Jersey, which represented northeasterly range extension for the species. Great hammerheads were tracked in the northern Gulf of Mexico and the Florida Keys using satellite tags with high point densities found in the northern Florida Keys (Calich 2014, unpublished data).

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). Piercy et al. (2010) estimated maximum length for males at 264.2 cm FL and 307.8 cm FL for females in the Gulf of Mexico and northwest Atlantic. Passerotti et al. (2010) estimated maximum age for females and males at 44 and 42 years, respectively, using bomb radiocarbon analysis.

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 uses 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 CSR (Hueter and Tyminski 2007). The presence of YOY 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). YOY 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, DO 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). McCandless et al. (2002) showed that great hammerhead sharks utilize shallow coastal waters (9.8 m depth) along North Carolina during the warm months. 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 from march through October (Hueter and Tyminski 2007). Longline surveys of Texas coastal waters also have revealed offshore secondary nurseries for this species (Hueter and Tyminski 2007). Bethea et al. (2014) showed nursery habitat characteristics from George Sound to Ancolete Kes, Florida consisted of temperatures between 26.3 and 30.1 °C, salinities of 30.0 to 32.7 ppt, DO of 5.6 to 7.2 mg/L, and depths of 1.3 to 5.8 m in sandy and seagrass areas for juvenile great hammerhead sharks.

Essential Fish Habitat for Great Hammerhead Shark

Figure G 34

Neonate/YOY, Juveniles (< 224 cm FL), and Adults (≥ 224 cm FL):

> Atlantic Ocean coastal areas on the central east coast of Florida, from just north of Biscayne Bay through the Florida Straits to the Dry Tortugas, and extending from the north side of the Florida Keys to Anclote Key (north of the mouth of Tampa Bay). EFH includes important habitats near Yankeetown, Tampa Bay, and Charlotte Harbor in temperatures ranging from 23.9 to 31.5 °C, salinities ranging from 20.8 to 34.2 ppt, DO ranging from 5.3 to 7.6 mg/L, and depths ranging from 1.8 to 5.5 m.

Summary of Changes Made to EFH

EFH boundaries published in Amendment 1 have been updated in Final Amendment 10. Boundaries of the EFH for all life stages were modified to reduce EFH in offshore areas. Miller et al. 2014 reported a preference for warmer water temperatures above 20°C and noted that occurrences in cooler, deeper water temperatures in offshore coastal areas may be due to great hammerhead sharks' seasonal southward migration. Great hammerhead shark occurring far offshore are most likely transient; therefore habitats occupied by these individuals may not constitute EFH (J. Carlson, personal communication). As such EFH boundaries for all life stages of great hammerhead shark were refined to just include the most important areas as EFH, and to exclude migratory corridors.

There were no changes to EFH boundaries for North Atlantic albacore tuna from Draft Amendment 10 to Final Amendment 10.

6.5.4 Lemon Shark (*Negaprion brevirostris*)

The lemon shark is common in the American tropics, inhabiting shallow coastal areas, especially around coral reefs. The lemon shark is widely distributed throughout the western Atlantic from North Carolina to Brazil, the Gulf of Mexico, Caribbean Sea, and tropical eastern Atlantic and eastern Pacific and is a top predator in nearshore habitats and coral reefs (Snelson and Williams, 1981; Morrissey and Gruber, 1993).

The primary population in continental U.S. waters is found off south Florida, although adults travel north to the Carolinas and Virginia in the summer. Kessel et al. (2014) used passive acoustic tags to show that lemon sharks are distributed across a wide geographical area in the summer months and migrate south concentrating off southeast Florida in the winter, with this temperature driven pattern repeated each year. Reyier et al. (2014) tracked juvenile lemon sharks off the east coast of Florida using passive acoustic telemetry to assess factors that influence site fidelity. Tagged sharks showed a high degree of wintertime site fidelity to the Cape Canaveral region except under extreme decreases in water temperature (when sharks would be displaced to the south). Tagged lemon sharks moved northward to summer habitats off northeastern Florida, Georgia, and the Carolinas. Reyier et al. (2008 2014) also identified the overwintering area as nursery grounds. Davis (2010) and McKenzie (2014) identified another nursery area near the Chandeleur Islands off of Louisiana, and genetic analysis showed seven of 15 mothers returning across years. YOY and juvenile lemon sharks in this area are typically sampled in seagrass beds and waters less than 2 m deep. Additional life history information can be found in Sundström et al. (2001) and Barker et al. (2005). Stump (2013) found evidence that two separate populations exist within the western Atlantic Ocean: one in the Caribbean and one in the Gulf of Mexico. In addition, Ashe et al. (2015) found genetic diversity of the lemon shark from eight sites in the western Atlantic with higher diversity at lower latitudes, and determined five distinct groups (Brazil, Louisiana, Cape Canaveral, Gullivan Bay and the Florida Keys/Bahamas/Virgin Islands).

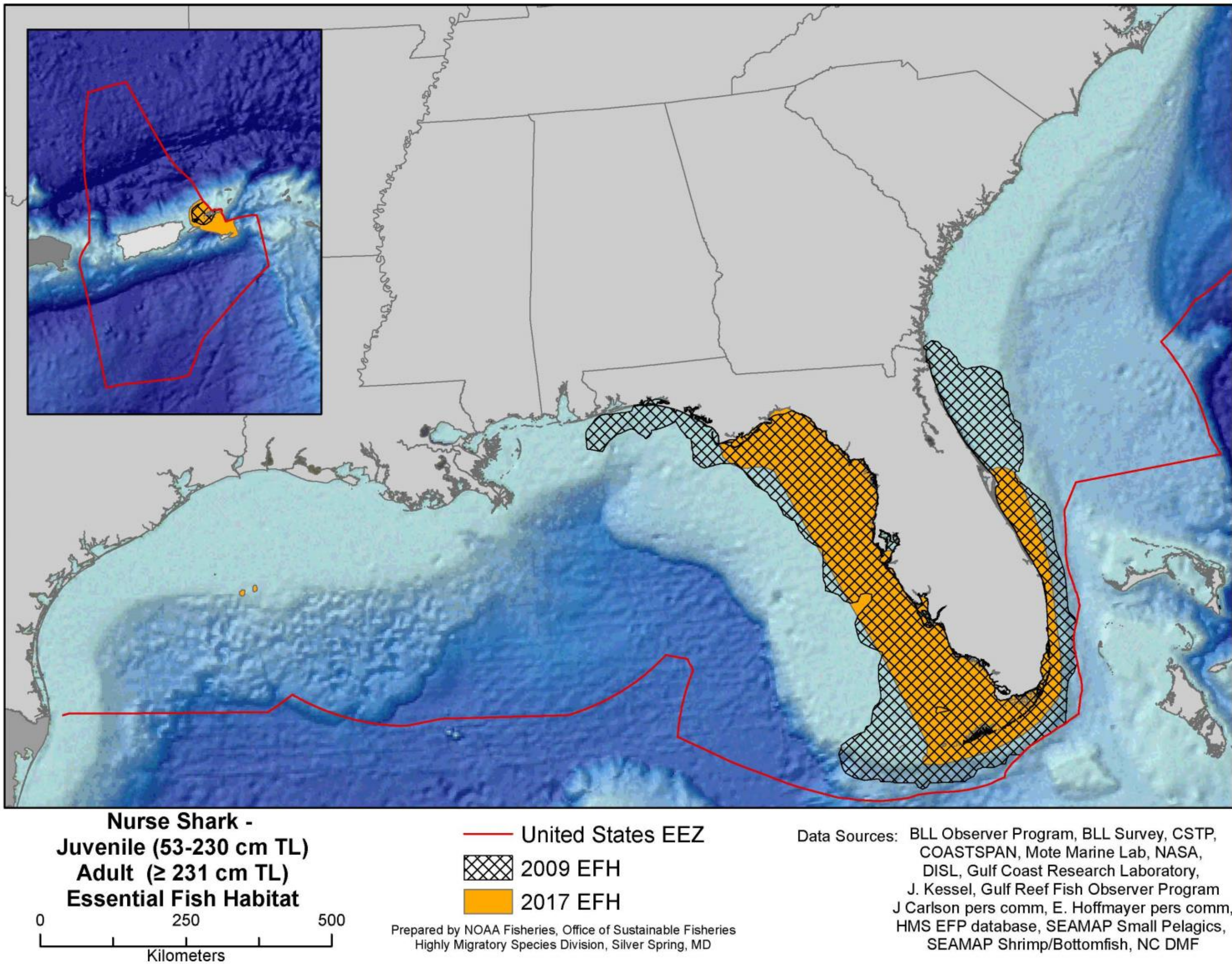
Reproductive potential

Lemon sharks typically mature around 228 cm TL (Springer, 1950a), 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 old) with the von Bertalanffy parameters: L_∞ =317.65, K= .057, and t_0 = -2.302 (Brown and Gruber, 1988). Lemon shark reproductive cycles are biennial (Castro 1993; Morrissey and Grube, 1993) and gestation lasts 10 (Springer 1950a) to 12 months (Clark and von Schmidt, 1965; Morrissey and Gruber, 1993). Litters typically consist of 5 to 17 pups, which measure about 64 cm TL at birth (Springer, 1950a; Clark and von Schmidt, 1965). The shallow waters around mangrove islands (Springer 1950a) off tropical Florida and the Bahamas have been shown to serve as nursery areas for this species. Morrissey and Gruber (1993) found juvenile lemon sharks selected shallower, warmer water with an underlying rocky or sandy substrate perhaps for predator avoidance. 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). McCandless et al (2002) indicated that lemon shark neonates may be using South Carolina waters as a nursery ground. Betheat et al. (2014) found lemon shark juveniles from St. George Sound to Anclote Key where temperatures ranged between 26.4 to 31.3 °C, salinities of 23.2 to 31.2 ppt, depth of 0.9 to 5.4 m and DO of 5.2 to 6.7 mL/L in mud and seagrass areas. Newman et al. (2010) found high overlap between juvenile lemon shark diet and mangrove communities, revealing the importance of mangroves to lemon sharks and their prey. Newman et al. (2012) presented an analysis of ontogenetic variation in prey preference and size selection in lemon sharks, indicating flexible foraging tactics. Stump (2013) found that habitat degradation in nursery areas caused declines in juvenile lemon shark annual growth rates and survival. Betheat et al. (2014) found lemon shark adults from St. George Sound to Anclote Key where temperatures ranged between 29.3 to 29.9 °C, salinities of 25.7 to 29.8 ppt, depth of 2.1-4.3 m and DO of 5.2 to 6.7 mL/L in mud and seagrass areas.

The lemon shark is managed as one overall stock in the Atlantic Ocean, Gulf of Mexico, and U.S. Caribbean Sea in the aggregated large coastal shark complex.

Essential Fish Habitat for Lemon Shark:

Figure G 35



Neonate/YOY (≤ 75 cm FL):	Found inshore of the 15 m bathymetric line (~50 ft) in the Atlantic. Atlantic coastal areas of eastern Florida between the Florida/Georgia border and the Florida Keys. Eastern Puerto Rico and the U.S. Virgin Islands. In the Gulf of Mexico, EFH includes the north side of the Florida Keys and Florida Bay to Naples, and coastal areas along Texas between Galveston Island and the Texas/Mexico border. Nursery areas are also immediately adjacent to the Chandeleur Islands off Louisiana, and include seagrass beds in shallow water (less than 2 m deep). EFH is also located in the eastern U.S. Caribbean.
Juveniles (76 to 200 cm FL):	Bathymetric depth limit of 200m in all locations, unless otherwise noted/described. Atlantic coastal areas from South Carolina through the Florida Keys. Gulf of Mexico EFH includes habitats on the north side of the Florida Keys and Florida Bay to Naples especially areas where temperatures ranged between 26.4 to 31.3 °C, salinities of 23.2 to 31.2 ppt, depth of 0.9-5.4 m and DO of 5.2 to 6.7 mL/L in mud and seagrass areas (Bethea et al. 2014). EFH also includes coastal areas along Texas, and the Chandeleur Islands off Louisiana. EFH in the U.S. Caribbean includes coastal waters off Puerto Rico and the U.S. Virgin Islands.
Adults (≥ 201 cm TL):	Bathymetric depth limit of 200m in all locations, unless otherwise noted/described. Atlantic coastal areas extending from Charleston, South Carolina (during the summer months (Kessel et al. 2014)) to the Florida Keys. Gulf of Mexico EFH includes the west coast of Florida through the Florida Keys, especially in areas where temperatures ranged between 29.3 to 29.9 °C, salinities of 25.7 to 29.8 ppt, depth of 2.1 to 4.3 m and DO of 5.2 to 6.7 mL/L in mud and seagrass areas (Bethea et al. 2014). EFH in the Gulf of Mexico also includes coastal areas along the east coast of Louisiana (i.e., Breton Sound to the Chandeleur Islands). EFH is also located in the eastern U.S. Caribbean waters surrounding the U.S. Virgin Islands.

Habitat Area of Particular Concern (HAPC):

Figure 2.3	East central coast of Florida from areas encompassing Cape Canaveral to areas just south of Jupiter Inlet (approximately 26º50’ N lat.), Florida. The HAPC specifically includes sheltered longshore troughs and the shallow open surf zone adjacent to Cape Canaveral used by juveniles, reef and wreck structure off Jupiter Inlet in 20-35 m of water used by adults, and the migratory corridor in between due to genetic and

behavioral linkages between the groups of sharks. The HAPC extends 12 km from shore.

Summary of Changes Made to EFH

EFH boundaries published in Amendment 1 have been updated in Final Amendment 10. Boundaries of neonate/YOY lemon shark EFH were slightly adjusted based on the incorporation of new data into the Kernal Density Estimation/ 95 Percent Volume Contour models and recommendations from SEFSC to include Chandeleur Sound based on new literature (Davis 2010; McKenzie 2014). The juvenile and adult lemon shark EFH boundaries were modified to exclude areas in Louisiana and the eastern Gulf of Mexico, and to add areas along the eastern coastal waters off Georgia and South Carolina in the Atlantic. These changes were based on the incorporation of new data into the Kernal Density Estimation/ 95 Percent Volume Contour models and recommendations from the SEFSC based on new tagging literature (Reyier et al. 2014).

There were no changes to EFH boundaries for lemon shark from Draft Amendment 10 to Final Amendment 10.

6.5.5 Nurse Sharks (*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 (Bigelow and Schroeder, 1948). It is also found in the eastern 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). Hendon et al. (2013) documented the first occurrence of a nurse shark in the Mississippi Sound. Hannan et al. (2012) investigated nurse shark distribution in the Gulf of Mexico and found that nurse sharks are broadly distributed along the Gulf continental shelf from the Florida Keys to Louisiana, but are rarely observed in the western Gulf of Mexico. This difference is hypothesized to show an association with hard bottom substrate (Hannan et al. 2012). Karl et al. (2012) conducted a population genetics study for nurse sharks in the Western Atlantic. Mitochondrial DNA suggested three populations offshore of Brazil and geographically proximate populations off Florida and in the Bahamas; however, microsatellite data indicated that sharks from Brazil, the Bahamas, and Florida constitute a single group.

Reproductive potential

Males reach maturity at about 214 cm TL and females at about 214 cm TL (Castro, 2011). Litters consist of 20 to 30 pups, the young measuring about 30 cm TL at birth. The gestation period is about five to six months and reproduction is biennial (Castro 2000; Pratt and Carrier 2007). 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. Shallow waters of the Florida Keys are important nursery grounds (Pratt and Carrier 2007). 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 YOY 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). Bethea et al. (2014) found one juvenile nurse shark in nearshore waters of St George Sound to Ancolte Keys, Florida in seagrass areas with a temperature of 31.3 °C, salinity of 32.7 ppt, DO of 6.9 mg/L, and depth of 2.6 m. In the same area, adult nurse sharks where observed in sandy and seagrass areas with temperatures ranging between 26.3 to 30.1 °C, salinities of 30.0 to 32.7 ppt, DO of 5.9 to 7.2 mg/L, and depths of 1.3 to 5.8 m (Bethea et al. 2014). In addition, juvenile nurse sharks (62.0–121.9 cm TL) were collected in Northern Cape Canaveral (28°40' N lat.) to south of the Jupiter Island area (27°04' N lat.) 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 and 2007), and this area is used as nursery grounds (Pratt and Carrier 2007). 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 Carrier 2001).

Work by Wiley and Simpfendorfer (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 lower than 30 ppt and were found in salinities higher than 30 ppt. Most nurse sharks were caught in waters between 25 to 29 °C and in depths greater than 2.25 m (Wiley and Simpfendorfer 2007).

Essential Fish Habitat for Nurse Shark

Figure G 38

Neonate/YOY (≤ 40 cm FL):	At this time, there is insufficient information to delineate EFH for this lifestage.

Juvenile (41 to 178 cm FL) and Adult (≥ 179 cm FL):

Juvenile and adult EFH in the Atlantic Ocean includes coastal areas from Cape Canaveral, Florida to the Florida Keys.

Juvenile and adult EFH in the Gulf of Mexico extends from the north side of the Florida Keys and Florida Bay to the Florida panhandle. Important juvenile EFH also includes Tampa Bay, Charlotte Harbor, Ten Thousand Islands, and the Florida Keys (including the Dry Tortugas), where temperatures range between 17.5 to 32.9 °C, salinities range between 21.8 to 38.9 ppt, DO ranges between 1.7 to 11.5 mg/l, and depths range between 0.3 to 12.2 m (Hueter and Tyminski 2007; Bethea et al. 2014; Adams and Paperno 2007). Juvenile EFH is also in the eastern U.S. Caribbean, specifically in areas surrounding the U.S. Virgin Islands. Adult EFH occurs in areas where temperatures ranges between 26.3 to 30.1 °C, salinity ranges between 30.0 and 32.7 ppt, DO ranges between 5.9 and 7.2 mg/l, and depth ranges between 1.3 and 5.8 m in sandy and seagrass areas (Bethea et al. 2014).

Summary of Changes Made to EFH

EFH boundaries published in Amendment 1 have been updated in Final Amendment 10. The juvenile and adult nurse shark EFH boundaries were slightly adjusted due to the incorporation of new data into the Kernal Density Estimation/ 95 Percent Volume Contour models and enlarged to include areas such as the Flower Garden Banks. In addition, the juvenile and adult nurse shark EFH boundaries were combined due to strong overlap in behavior and habitat utilization of sharks at these different life stages between the two maps (i.e., EFH was identified by the model in similar areas).

There were no changes to EFH boundaries for North Atlantic albacore tuna from Draft Amendment 10 to Final Amendment 10.

6.5.6 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 2008). It is a bottom-dwelling species most common in 20 to 55 m of water, but occasionally found at depths of about 200 m. The sandbar shark is managed as one overall stock in the Atlantic Ocean, Gulf of Mexico, and U.S. Caribbean Sea.

Reproductive potential

The sandbar shark is a slow growing species. Both sexes reach maturity at about 147 cm TL 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. Baremore and Hale (2012a, b) determined the size and age at 50 percent maturity was 151.6 cm FL (12.1 yr) for males and 154.9 cm FL (13.1 yr) for females. Based on these more recent estimates of size-at-maturity, landings data indicate the average sandbar shark caught in the commercial sandbar shark fishery is at the cusp of maturity. The von Bertalanffy growth parameters were proposed for combined sexes are L_{max}= 186 cm FL (224 cm TL; 168 cm PCL), K= 0.046, t_0= -6.45 by Casey and Natanson (1992); and re-evaluated by Sminkey and Musick (1995) as L_{max}= 164 cm PCL (219 cm TL; 182 cm FL), K= 0.089, and t_0= -3.8.

Andrews et al. (2011) also utilized bomb radiocarbon dating and tag-recapture techniques to indicate that ages of sandbar sharks based on vertebral counts are only accurate to about 12 years of age. Both techniques gave ages of 20-26 years for three adult sharks and support the hypothesis that longevity in this species can exceed 30 years. Hale and Baremore (2013) aged over 1,000 sandbar sharks from the Gulf of Mexico and western Atlantic Ocean using vertebral rings counts, finding a female maximum age of 27 years and a male maximum age of 22 years.

Males and females showed distinct seasonal reproduction patterns, with peak mating and parturition occurring from April through July (Baremore and Hale, 2012a, b). The majority of near-term pregnant and postpartum females were observed in the Florida Keys, which is an extension of the previously reported nursery grounds for sandbar sharks in the western North Atlantic Ocean (Baremore and Hale, 2012a, b). Female fecundity averaged 8.0 pups, and there was a significant increase in fecundity with length and age (Baremore and Hale, 2012a, b). Spring (1960) found litters that consisted of one to 14 pups, with nine being the average. Young are born at about 60 cm TL (smaller in the northern parts of the North American range) from March to July (Springer, 1960). The ovarian cycle is at least biennial, although there is evidence that some females have triennial cycles (Baremore and Hale, 2012a, b). Past work has shown that 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 (McCandless et al. 2002; Skomal 2007). 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 Musick 2008) are important nurseries. Juvenile sandbar sharks were found in water temperatures ranging from 15 to 30 °C, salinities at least from 15 to 35 ppt, and water depth ranging from 0.8 to 23 m in sand, mud, shell and rocky habitats from Massachusetts to North Carolina (Grubbs and Musick 2007, Grubbs et al. 2007; McCandless et al. 2002, 2007; Merson and Pratt 2007;

Skomal 2007). Shiffman et al. (2014) found an ontogenetic shift in diet occurs when benthic feeding YOY become juveniles and switch to a more pelagic, fish based diet.

Size and sex data from surveys in waters of Nantucket Sound, Massachusetts indicate that this region also provides 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. YOY were present in Delaware Bay until early October when the temperature fell below 21 °C. Grubbs and Musick (2007) reported that the nursery in Chesapeake Bay is limited to the southeastern portion of the estuary, where salinity is greater 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. Sandbar neonates were found off Yankeetown, Florida from April to July, in temperatures of 17.0 to 29.0 °C and salinities of 20.4 to 34 ppt (Hueter and Tyminski 2002, 2007; McCandless et al. 2002, Steiner et al. 2007). Neonate sandbar sharks were found in an area between Indian Pass and St. Andrew Sound, Florida in June in water temperatures from 20 to 31 °C at salinities from 19 to 39 ppt and depths of 2.1 to 5.2 m in silt/clay habitats (McCandless et al 2002; Carlson 2002, 2007). Pupping grounds were identified in Winyah Bay to Port Royal sound off South Carolina at water temperatures of 15 to 30 °C and salinities of 13 to 37 ppt (McCandless et al., 2002; Abel et al. 2007; Ulrich et al. 2007).

Bethea et al. (2014) found juvenile sandbar sharks on the gulf-side of St. Vincent Island from West Pass to Indian Pass located in the western portion of the Apalachicola Bay system off the panhandle in Florida that has a benthic habitat of a mix of sand, clay, and mud over a limestone bottom. McCandless et al (2002) and Parsons and Holffmayer (2007) a potential nursery area in the north central Gulf Mexico in Mississippi Sound where a few neonates were present in the summer in water temperatures ranging from 23 to 24 °C, salinities from 13to 15 ppt, a depth of 2.1 m and DO of 8.0 to 8.3 mg/L.

Essential Fish Habitat for Sandbar Shark

Figure G 39 – Figure G 41

Neonate/YOY (< 66 cm FL):	Atlantic coastal areas from Long Island, New York to Cape Lookout, North Carolina, and from Charleston, South Carolina to Amelia Island, Florida. Important neonate/YOY EFH includes: Delaware Bay (Delaware and New Jersey) and Chesapeake Bay (Virginia and Maryland), where the nursery habitat is limited to the southeastern portion of the estuaries (salinity is greater than 20.5 ppt and depth is greater than 5.5 m); Great Bay, New Jersey; and the waters off Cape Hatteras, North Carolina. In all nursery areas between New York and North Carolina, unless otherwise noted, EFH is associated with water temperatures that range from 15 to 30 °C; salinities that vary from 15 to 35 ppt; water depths that range from 0.8 to 23 m; and sand, mud, shell, and rocky sediments/benthic habitat.

EFH in the Gulf of Mexico includes localized coastal areas on the Florida panhandle (Indian Pass and St. Andrew Sound, Florida) in water temperatures from 20 to 31 °C at salinities from 19 to 39 ppt and depths of 2.1 to 5.2 m in silt/clay habitats.

Juvenile (67 to 154 cm FL): EFH includes coastal portions of the Atlantic Ocean between southern New England (Nantucket Sound, Massachusetts) and Georgia in water temperatures ranging from 20 to 24 °C and depths from 2.4 to 6.4 m. Important nurseries include Delaware Bay, Delaware and New Jersey; Chesapeake Bay, Virginia; Great Bay, New Jersey; and the waters off Cape Hatteras, North Carolina. For all EFH, water temperatures range from 15 to 30 °C, salinities range from 15 to 35 ppt, water depth ranges from 0.8 to 23 m, and substrate includes sand, mud, shell, and rocky habitats. EFH in the Gulf of Mexico includes localized areas off Apalachicola Bay, Florida.

Adult (> 154 cm FL): EFH in the Atlantic Ocean includes coastal areas from southern New England to the Florida Keys, ranging from inland waters of Delaware Bay and the mouth of Chesapeake Bay to the continental shelf break. EFH in the Gulf of Mexico includes coastal areas between the Florida Keys and Anclote Key, Florida; areas offshore of the Big Bend region; coastal areas of the Florida panhandle and Gulf coast between Apalachicola and the Mississippi River; and habitats surrounding the continental shelf between Louisiana and south Texas. Adults commonly use habitats in the West Florida Shelf, off Cape San Blas, and cool, deep, clear water offshore of Texas and Louisiana.

Habitat Areas of Particular Concern (HAPC)

Figure 2.2

HAPC constitutes important nursery and pupping grounds which have been identified in shallow areas and at the mouth of Great Bay, New Jersey, in lower and middle Delaware Bay, Delaware, lower Chesapeake Bay, Maryland, and offshore of the Outer Banks of North Carolina in water temperatures ranging from 15 to 30 °C; salinities at least from 15 to 35 ppt; water depth ranging from 0.8 to 23 m; and in sand and mud habitats.

Summary of Changes Made to EFH

EFH boundaries published in Amendment 1 have been updated in Final Amendment 10. Boundaries of the neonate/ YOY sandbar shark EFH were adjusted slightly due to the incorporation of new data into the Kernal Density Estimation/ 95 Percent Volume Contour models and the need to incorporate important nursery habitats such as Delaware Bay, Delaware; Chesapeake Bay, Maryland; and an area between Indian Pass and St. Andrew Sound, Florida (JCarlson, personal communication). Juvenile sandbar shark EFH boundaries were adjusted to include areas off Cape San Blas, Florida and to remove areas off the east coast of Florida due to scientific recommendations from the SEFSC. Adult sandbar shark EFH was expanded into coastal and offshore waters adjacent to Texas, Louisiana, Alabama, and Mississippi due to the incorporation of new data into the Kernal Density Estimation/ 95 Percent Volume Contour models and scientific recommendations from the SEFSC.

In Final Amendment 10, neonate/YOY sandbar shark EFH boundaries in the northern Gulf of Mexico were modified slightly to reflect the best scientific information available. As explained in Section 2.1 under the description of Alternative 2 and in Appendix F (see "Approaches Used to Analyze and Map Data" for a review on how data were adjusted along features), this update was included in response to comments from the SEFSC recommending that these changes be made in order to reflect all available information on distribution and habitat utilization, and thus meets the requirement that these updates be based on the best scientific information.

6.5.7 Scalloped Hammerhead Shark (*Sphyrna lewini*)

The scalloped hammerhead is a large, schooling hammerhead of warm waters. Compagno (1984) noted that at that time it was 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. 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). McCallister et al. (2013) collected samples in estuarine areas on the northeast coast of Florida using bottom longline and captured 22 scalloped hammerheads, which made up 5.8 percent of the sharks caught in this survey. The majority of the scalloped hammerheads caught were considered to be juveniles and likely using the estuarine areas as a nursery. 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) and undergo diurnal deep dives. Hoffmayer et al. (2013) tracked a female scalloped hammerhead in the northern Gulf of Mexico using a satellite tag and showed that this individual performed numerous dives at night to deep depths (up to 964 m) over a 27 day period of time, but also showed that the shark spent almost 72 percent of its time at or near the surface of the water. 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 northwestern 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, 1987a; 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, 1987a; 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 (1987a) 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, 1987a; Hazin et al. 2001; Piercy et al. 2007), with a maximum size of 305 to 310 cm, corresponding to 35 yrs of age (Branstetter, 1987a). Peircy et al. (2007) found that the northwestern 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 (1987a) reported growth through the first winter around 15 cm, and an annual growth rate of 10 to15 cm 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 (more than 30 pups) with pups ranging in size from 38 and 56.2 cm TL (Clarke 1971; Castro, 1983; Compagno 1984; Branstetter, 1987a; Chen et al. 1988). 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, 1987a). Clarke (1971) reported a 39.5 cm TL scalloped hammerhead from Hawaiian waters. Castro (1993) 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, 1993), and the gestation period is nine to ten months (Stevens and Lyle, 1989) but may be as long as 12 months (Branstetter, 1987a). Castro (1993) found nurseries in the shallow coastal waters of South Carolina. Subsequent studies have identified the importance of coastal South Carolina waters as 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 nursery area for this species. In the northern Gulf of Mexico, temperature and salinity have been found to be the two most influential factors determining juvenile scalloped hammerhead shark occurrence. In the northern Gulf of Mexico, occurrence of juvenile scalloped hammerheads was found to increase with both temperature (greater than 30 °C) and salinity (greater than 35 PSU) (Ward-Paige et al. 2014). Bethea et al. (2014) in a comprehensive study of 10 geographic areas in the northeastern Gulf of Mexico also found juvenile scalloped hammerheads were restricted to specific nursery area based primarily on salinity and water clarity. 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 to 37 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.

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 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). Bethea et al. (2014) confirmed that neonates prefer these ranges of temperature, salinity, and DO ranges. They are typically found in depths in the 5 to 6 meter range and prefer mud and seagrass bottoms. YOY 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 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).

Essential Fish Habitat for Scalloped Hammerhead

Figure G 42 – Figure G 43

Neonate/YOY (≤ 45 cm TL): Atlantic east coast from North Inlet/Winyah Bay, South Carolina to the mid-east coast of Florida, including estuarine habitats. Coastal areas in the Gulf of Mexico including those adjacent to Charlotte Harbor and Tampa Bay, coastal areas of Florida around Apalachicola and Cape San Blas, and coastal Texas. EFH is located in temperatures of 23.2 to 30.2 °C, salinities of 27.6 to 36.3 ppt, DO of 5.1 to 5.5 mL/L, depths in the 5 to 6 m, and mud and seagrass substrate.

Juveniles and Adults (> 45 cm FL): EFH in the Atlantic Ocean ranges from North Carolina to the Florida Keys, including Florida Bay and the Dry Tortugas. EFH is also located in the northern Gulf of Mexico from eastern Louisiana to Pensacola Florida, (Mississippi Delta to DeSoto Canyon).

Summary of Changes Made to EFH

EFH boundaries published in Amendment 1 have been updated in Final Amendment 10. Boundaries of the neonate/ YOY scalloped hammerhead shark EFH were modified to remove EFH from the big bend region of Florida, and to include coastal waters off Texas and Apalachicola, Florida, due to the incorporation of new data into the Kernal Density Estimation/ 95 Percent Volume Contour models and recommendations from the SEFSC. Juvenile and adult life stage EFH boundaries were combined due to similar utilization of habitats. The juvenile and adult scalloped hammerhead shark EFH boundaries were adjusted to exclude coastal waters off Texas and western Louisiana, due to the incorporation of new data into the Kernal Density Estimation/ 95 Percent Volume Contour models.

Since publication of Draft Amendment 10, EFH boundaries were slightly modified to exclude inshore and riverine habitats that did not contain data points. As explained in Section 2.1 under the description of Alternative 2 and in Appendix F (see "Approaches Used to Analyze and Map Data" for a review on how data were adjusted along features), this update was included in response to comments from the SEFSC recommending that these changes be made in order to reflect all available information on distribution and habitat utilization, and thus meets the requirement that these updates be based on the best scientific information..

6.5.8 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 (Bigelow and Schroeder, 1948). Tagging data indicate movement of silky sharks between the Gulf of Mexico and the U.S. Atlantic coast (Kohler et al. 1998). Hoffmayer and Franks (2010) used pop up satellite archival tags to quantify the short-term movements of silky sharks in the northern Gulf of Mexico. The silky sharks were all tagged along the continental shelf edge and remained within 150 km of the initial tagging locations. Clarke et al. (2015) sequenced the complete mitochondrial DNA of silky sharks from the western Atlantic, the Indo-Pacific and the Red Sea, finding strong phylogenetic partitioning between ocean basins and defining at least five populations worldwide.

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 (older than 12 years of age). The von Bertalanffy parameters estimated by Bonfil et al. (1993) are: $L_\infty = 311$ cm TL, $K= 0.101$, and $t_o= -2.718$ yr. Maximum ages were 20 years or older for males and 22 years or older 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)

Essential Fish Habitat for Silky Shark:

Figure G 44

Neonate/YOY, Juvenile, and Adult:

EFH includes offshore, pelagic waters of the U.S. EEZ. Atlantic east coast from Florida to Massachusetts. In pelagic Gulf of Mexico habitats from the Florida Keys, across the central Gulf of Mexico, to southern coastal waters of Texas (deeper than 50m).

Summary of Changes Made to EFH
EFH boundaries published in Amendment 1 have been updated in Final Amendment 10. EFH boundaries for all life stages of silky shark were adjusted slightly due to the incorporation of new data into the Kernal Density Estimation/ 95 Percent Volume Contour models and recommendations from the SEFSC and NEFSC.

There were no changes to EFH boundaries for silky shark from Draft Amendment 10 to Final Amendment 10.

6.5.9 Smooth Hammerhead Shark (*Sphyrna zygaena*)

This hammerhead shark is located in temperate waters worldwide. This large, active swimming coastal-pelagic and semi-oceanic hammerhead is found close inshore and in shallow water over continental and insular shelves to well offshore, at depths from the surface down to at least 200 m along the edge of the continental shelf (Ebert and Stehmann 2013). It has been recorded from Nova Scotia to the Florida Keys in the northwestern Atlantic. Identification issues between smooth hammerhead and scalloped hammerhead have led to all hammerhead species being managed as a hammerhead complex in one overall stock in the Atlantic Ocean, Gulf of Mexico, and U.S. Caribbean Sea.

Reproductive potential

Maximum total length is estimated to be about 370 to 400 cm with adults maturing at about 210 to 240 cm (Ebert and Stehmann 2013). An age and growth study on smooth hammerhead from the equatorial Atlantic produced von Bertalanffy growth parameters of L_∞ = 272 cm FL, k = 0.06 year for males and L_∞ = 285 cm FL, k = 0.07 year for females and are described in Coelho et al. (2011). The reproductive cycle of smooth hammerheads is estimated to be biennial with a 10-11 month gestation, and litter size ranges from 20-50 young ranging in size from 50-65 cm (Castro, 2011; Ebert and Stehman 2013). Neonates and juveniles have been reported from Delaware Bay to the Bay of Fundy (Castro, 2011). Juvenile smooth hammerheads have been found in the Delaware Bay in water temperatures 26 °C, salinities of 30 ppt, and water depths of 3.6 m in sand and mud habitats (McCandless et al. 2002). In North Carolina from Cape Hatteras to Holden Beach, McCandless et al. (2002) found juvenile smooth hammerheads in water temperatures ranging from 18 to 20 °C, salinities of 31.5 ppt, and water depths ranging from 5-16 m.

Essential Fish Habitat for Smooth Hammerhead

At this time, insufficient information is available to describe and identify EFH for this species.

6.5.10 Spinner Shark (*Carcharhinus brevipinna*)

The spinner shark is a coastal-pelagic, warm-temperate, and tropical shark of the continental and insular shelves (Compagno, 1984). It inhabits inshore waters less than 30 m deep, but ranges offshore to at least 150 m deep (Aubrey and Snelson 2007). The spinner shark often swims 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 the species ranges from Virginia to Florida and in the Gulf of Mexico. Juveniles tend to stay inshore of the 20m bathymetric line, whereas adults are found inshore and in offshore habitats to the 90m bathymetric line. Adults are generally not found in inland bays or bayous.

Predator-prey Relationships

A study on shark foraging ecology conducted by Bethea et al. (2004) in Apalachicola Bay, Florida, showed that neonate/YOY 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, 1987b). According to Branstetter (1987b), 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 (1987b) gave von Bertalanffy parameters for both sexes were: L_∞ = 214 cm, K= 0.212, t_o = -1.94 years. The ages have not been validated. According to Garrick (1982), the species reaches a maximum size of 278 cm TL. Jong et al. (2005) found both male and female spinner sharks to reach maturity at about 210-220 cm. The spinner shark has a biennial reproductive cycle (Castro 1993), 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). However, Jong et al. (2005) found litters ranging from three to 14 pups.

In the Carolinas, the nursery areas are in shallow coastal waters (Castro, 1993); 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. 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. YOY 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. During an independent gillnet survey in the Gulf of Mexico, large abundance of juvenile spinner sharks were found in general areas off northwest of Florida (Bethea et al. 2014), with larger juveniles have been captured off Sarasota and Tampa Bay (Hueter and Tyminski 2007).

Essential Fish Habitat for Spinner Shark:

Figure G 45 – Figure G 46

Neonate/YOY (≤ 57 cm FL):	In the Atlantic Ocean EFH includes coastal areas between Cape Hatteras, North Carolina and the Florida Keys. EFH in the Gulf of Mexico includes coastal areas surrounding the Florida Keys and from the Big Bend Region to southern Texas. Gulf of Mexico EFH consists of sandy bottom areas where sea surface temperatures range from 24.5 to 30.5 °C and mean salinity is around 36 ppt.
Juveniles and Adults (> 57 cm FL):	EFH in the Atlantic Ocean includes coastal areas between North Carolina and Florida. Juvenile spinner shark EFH is associated with 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. Juvenile and adult EFH in the Gulf of Mexico includes coastal areas from Apalachicola, Florida to southern Texas. In all locations, juveniles EFH extends from shore to depths to 20m, whereas adult EFH extends from shore to 90m in depth.

Summary of Changes Made to EFH

EFH boundaries published in Amendment 1 have been updated in Final Amendment 10. Boundaries of the neonate/YOY spinner shark EFH were enlarged slightly to include coastal areas in eastern Louisiana, and areas from Mississippi to northern Florida due to the incorporation of new data into the Kernal Density Estimation/95 Percent Volume Contour models. Juvenile and adult spinner shark EFH is considered similar and was combined in Amendment 10 based on scientific recommendations from the NEFSC and SEFSC. The juvenile and adult spinner shark EFH were adjusted slightly to include more offshore areas in the existing EFH, and remove areas from Cedar Key, Florida to the Florida Keys, due to incorporation of new data into the Kernal Density Estimation/95 Percent Volume Contour models and based on scientific recommendations from the SEFSC.

There were no changes to EFH boundaries for spinner shark from Draft Amendment 10 to Final Amendment 10.

6.5.11 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 lat., and have been documented to make transoceanic migrations (Driggers et al. 2008). Tiger sharks have also been observed to have a great deal of intraspecific variability in vertical habitat use. Vaudo et al. (2014) tagged 14 tiger sharks with PSATs in the Caribbean and Western North Atlantic and observed a high frequency of yo-yo diving within the isothermal layer, with sharks typically remaining in the upper 50 m of the water column, but making multiple dives to depths more than 200 m, and also spending a notably large amount of time at shallow depths (upper 5 m). Hoffmayer et al. (unpublished data) found tiger sharks to undertake long distance movements to the open waters of the Gulf Stream, which seemed to overlap with the distribution of their prey along the dynamic Gulf Stream current system. 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. Juvenile tiger sharks were shown to prefer seagrass flats in the Gulf of Mexico on the west coast of Florida (Bethea et al. 2014). 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. This species is believed to be one of those most 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. 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_∞ = 440 cm TL, K= 0.107, and t_o= -1.13 years, and for a Gulf of Mexico sample as L_∞ = 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 appears to be about one year (Castro, 2011).

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 occur at approximately 35° N and from 33°45’ to 29°20’ N lat. 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 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 lat., larger than previously reported by Natanson et al. (1998), with the region from 31° to 33° N lat. 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 long. and 93° and 95° W long. Hueter and Tyminski (2007) report YOY collected during surveys in water depths 20 to 50 m in July and August along the Louisiana, Mississippi, Alabama, and Florida coasts, and older juveniles occasionally along the central Florida Gulf coast.

Essential Fish Habitat for Tiger Shark

Figure G 47 – Figure G 48

Neonate/YOY (≤ 101 cm FL): EFH in the Atlantic Ocean includes coastal areas from the North Carolina/Virginia border to the Florida Keys. EFH in the Gulf of Mexico includes coastal and offshore areas, between the Florida Keys and Alabama.

Juveniles (102 - 266 cm TL) and Adults (> 266 cm TL):

EFH in the Atlantic Ocean extends from offshore pelagic habitats associated with the continental shelf break at the seaward extent of the U.S. EEZ boundary (south of Georges Bank, off Massachusetts) to the Florida Keys, inclusive of offshore portions of the Blake Plateau. EFH in the Gulf of Mexico includes pelagic and coastal habitats between Tampa Bay, Florida BayandFlorida Keys, and the edge of the West Florida Shelf; and an area extending from off eastern Louisiana, Mississippi, and Alabama to offshore pelagic habitats in the central Gulf of Mexico. Grass flats in the Gulf of Mexico are considered feeding areas, and are included as EFH. EFH also includes coastal and pelagic habitats surrounding Puerto Rico (except on the northwest side of the island) and the U.S. Virgin Islands.

Summary of Changes Made to EFH

EFH boundaries published in Amendment 1 have been updated in Final Amendment 10. Boundaries of the neonate/ YOY tiger shark EFH were adjusted to include coastal areas from the Florida Panhandle to the Florida Keys due to the new data incorporated into the Kernal Density Estimation/ 95 Percent Volume Contour models and scientific recommendations from the SEFSC. The juvenile and adult tiger shark EFH were combined due to similarity in habitat utilization, expanded in the U.S. Caribbean, and enlarged to include offshore areas from eastern Louisiana to Mobile, Alabama and coastal waters from Palm Harbor, Florida to the Florida Keys. These edits were made based on new data incorporated into the Kernal Density Estimation/ 95 Percent Volume Contour models and scientific recommendations from the SEFSC and NEFSC.

There were no changes to EFH boundaries for tiger sharks from Draft Amendment 10 to Final Amendment 10.

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6.6 Small Coastal Sharks

6.6.1 Blacknose Shark (*Carcharhinus acronotus*)

The blacknose shark is a coastal species that inhabits the western North Atlantic from North Carolina to southeast Brazil (Bigelow and Schroeder, 1948). Schwartz (1984) hypothesized that there are two separate populations in the western Atlantic. Potnoy et al. (2014) found significant heterogeneity within blacknose sharks in the U.S. Atlantic and Gulf of Mexico and genetic testing suggested that there are five genetic groups in the region (western Gulf, eastern Gulf, Atlantic, Mexico, and the Bahamas). Blacknose shark were last assessed during the 2010 SEDAR 21 stock assessment, where it was determined that a split assessment on separate Gulf of Mexico and Atlantic stocks was appropriate. Thus, based on the assessment, blacknose sharks are managed as two separate stocks. EFH was previously only designated for a single stock. Therefore, where available, life history information is presented for both Atlantic and Gulf of Mexico stocks, and EFH for each stock is presented in separate text descriptions and maps.

McCandless et al. (2002) identified neonate and YOY blacknose sharks in coastal nearshore waters of South Carolina and Georgia, and noted a nursery and pupping area off Holden Beach, North Carolina. Blacknose sharks are abundant in coastal and nearshore waters off South Carolina from May to October with mating taking place in the late spring and early summer (Driggers 2001; Ulrich et al. 2007). In addition, Castro (1993) noted that Bulls Bay, South Carolina and nearshore areas adjacent nearshore areas were nursery grounds for nine shark species, including blacknose. There has been no indication of habitat partitioning between adults and juveniles (Ulrich et al. 2007).

Tag recapture data for this species show a strong philopatric behavior and an annual homing cycle in the Gulf of Mexico (Heuter et al. 2005; Heuter and Tyminski 2007). Parsons and Hoffmeyer (2007) stated 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 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. However, Carlson (2002) used gillnet surveys from 1993-2000 and reported blacknose juveniles and neonates present in northwest Florida (from St. Andrews Bay to Apalachee Bay) from May through October ranging in size from 39.5 to 135 cm TL. The 2014 GULFSPAN report reviewed habitat associations in the northern Gulf of Mexico and further confirmed the presence of blacknose shark nursery areas in the Big Bend Region (St. George Sound to Anclote Keys). Hueter and Tyminski (2007) provide a description of blacknose behavior and distribution in central and south Florida. Neonate blacknose sharks are found along gulf beaches in the Tampa Bay area in June, and YOY are found in nearshore waters off beaches in the Tampa Bay area and in Charlotte Harbor. Older juveniles were found between Yankeetown FL and the Florida Keys in the summer, and in the Florida Keys in winter.

Habitat Associations

Carlson (2002) found blacknose shark in water temperatures ranging from 20.8 to 33.6 °C, in salinities averaging 32.1 ppt, and in water depths averaging 3.7 m in the Gulf of Mexico. Fishery-independent gillnet survey data in the Gulf of Mexico and found that blacknose sharks seemed to be restricted to specific areas generally with areas of higher salinity and seagrass coverage (Bethea et al. 2014). Blacknose sharks are found over a variety of bottom types in northwest Florida and tolerate DO levels to 2.0 mg/L (Carlson 2002). Drymon et al. (2010 2013) showed a discrete depth preference of 10–30 m for blacknose shark.

Ulrich et al. (2007) found juvenile and adult blacknose shark in water temperatures ranging from 17.2 to 30.0 °C (mean temperature 24.97 ± 2.99 °C) and in salinities of 31 to 35 ppt (mean salinity 32.12 ± 1.05 °C). The majority of sharks were caught in salinities ranging between 34 to 35 ppt. Ulrich et al. (2007) noted that the distribution of blacknose in coastal South Carolina waters was largely temperature related. The first occurrence of blacknose sharks generally corresponded to water temperatures reaching 24 °C in the spring, and abundance rapidly declined in the fall after temperatures decreased to 19 °C.

The 2014 GULFSPAN reported noted habitat associations for YOY blacknose in the big Bend region of northern Florida (St. George Sound to Anclote Keys water temperatures of 29 to 30.5 °C, with salinities of approximately 28.5 ppt); individuals were also captured in Pine Island Sound (southwestern FL). Neonate/YOY, juvenile, and adult blacknose were typically captured in sandy seagrass habitats, while adults were also captured on the edges of muddy channels adjacent to seagrass habitat. Hueter and Tyminski (2007) broadly defined blacknose associations with environmental conditions (but not specific bottom type) for areas of the Gulf coast of peninsular Florida as salinity ranging from 25 to 37 ppt, temperatures ranging from 17 to 34 °C, DO ranging from 3.3 to 8.7 mg/L, and depth ranging from 0.6 to 60 m based on data collected from gillnet studies completed between 1991 and 2004. Habitat associations for neonates, YOY, and juveniles were more specifically described for the Tampa Bay region. Blacknose neonates/YOY were found in salinities ranging from 28 to 37 ppt, temperatures ranging from 28 to 30 °C, and depth ranging from 0.6-7 m. Juveniles were noted in salinities ranging from 28 to 37 ppt, temperatures ranging from 17 to 30 °C, and depths ranging from 0.9-7 m. Habitat associations were also noted in Charlotte Harbor for YOY and juveniles. Smaller numbers of YOY blacknose were associated with salinities of 26 to 27 ppt, temperature of 34 °C, and depths of 1.2 to1.8 m.

Life History and Reproductive potential

Males have a higher maximum age in the South Atlantic compared to the Gulf of Mexico (10.5 years vs. 9.5 years; Driggers et al. 2007). Maximum estimated longevity of blacknose sharks in the western North Atlantic Ocean was determined by Frazier et al. (2014) to be 22.8 years through tag-recapture data and 20.5 years through direct age estimates. The observed maximum age was 15.5 and 19.5 for males and females, respectively in the Gulf of Mexico (Hendon et al. 2014).

The length at 50 percent maturity for males was found to be 79.5 cm FL and 84.8 cm FL for females in the northern Gulf of Mexico (Driggers et al. 2010). Hendon et al. (2014) reported the size at 50 percent maturity for blacknose sharks in the Gulf of Mexico to be 800 and 822 mm FL for males and females, respectively. Litters consist of one to six pups, which measure 50 cm TL at birth (Castro 1983; Driggers et al. 2010; Hendon et al.2014). In the 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 maximum observed age of 12.5 years (Driggers et al. 2007). In the Gulf of Mexico, female blacknose sharks mature at 6.6 years, a maximum observed age of 11.5 years, and give birth to 3.13 pups/year (Driggers et al. 2007; Sulikowski et al. 2007). Sulikowski et al. (2007) determined that reproductive activity peaks in May through July in the northern Gulf of Mexico. In addition, Sulikowski et al. (2007) 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 (Driggers et al. 2004), whereas Hazin et al. (2002) suggested annual reproduction off northeastern Brazil. The species is found 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.

Essential Fish Habitat for Blacknose Shark (Gulf of Mexico Stock)

Figure G 49 - Figure G 50

Neonate/YOY (≤ 45 cm FL): In the Gulf of Mexico coastal areas of the west coast of Florida in higher salinity areas between East Cape and Micmac Lagoon (Everglades National Park) and Sea Grove Beach (roughly consistent with the southeastern extent of Choctawhatchee Bay). Nearshore areas off beaches in the Tampa Bay area and Charlotte Harbor region. EFH is specifically associated with certain habitat conditions in Charlotte Harbor for YOY and juveniles (salinity 26 to 27 ppt, temperatures up to 34 °C, and depths of 1.2 to 1.8 m). Tampa Bay region (nearshore, off beaches): salinity 28 to 37 ppt, temperature 28 to 30 °C, and depth 0.6 to 7 m. Gulf coast of peninsular Florida: salinity from 25 to 37 ppt, temperature from 17 to 34 °C, DO from 3.3 to 8.7 mg/L, and depth from 0.6 to 60 m. EFH in the big bend region of Florida (St. George Sound to Anclote Keys) is considered nursery habitat (sand/seagrass, 29-30.5 °C, salinity ~28.5-28.6 ppt). Florida panhandle EFH: temperature 29 to 30 °C, average salinity of 28.5 ppt, depth 2.5 to 3.7 m, and sand or seagrass bottom type.

Juveniles (46 to 84 cm FL) and Adults (> 84 cm FL):

EFH is specifically associated with certain habitat conditions in Tampa Bay region (nearshore, off beaches): salinity from 28 to 37 ppt, temperature from 17 to 30 °C, and depth from 0.9 to 7.0 m. Gulf coast of peninsular Florida EFH: salinity from 29 to 36 ppt, temperature from 23 to 31 °C, DO from 3.3 to 8.7 mg/L, and depth from 1.3 to 60 m. Coastal areas of the Big bend region of Florida EFH includes habitats with higher salinities (St. George Sound to Anclote Key): sand/seagrass, 29 to 30.5 °C, average salinity of 28.5 ppt, 1.3 to 7 m depth. EFH also includes northern coastal Florida from approximately the border of Walton and Bay counties on the Florida panhandle through the Florida Keys in the Gulf of Mexico. EFH in northwest Florida is also associated with DO levels to 2.0 mg/L and depths of 10 to 30 m. EFH also includes coastal areas of Mississippi (east of the Chandeleur Islands and south of Cat, Horn and Petit Bois Islands) to Pensacola Inlet. EFH in other areas of the Gulf of Mexico (from southeastern coastal Texas to Galveston Bay and then offshore to southern Louisiana (roughly to areas offshore of Terrebonne Bay)) is defined by water temperatures ranging from 20.8 to 33.6 °C , average salinity of 32.1 ppt, and average water depth 3.7 m.

Summary of Changes Made to EFH

EFH boundaries published in Amendment 1 have been updated in Final Amendment 10. Amendment 1 previously designated EFH boundaries for a single blacknose shark stock. The blacknose shark stock was split into two regional stocks in 2010 due to the results of scientific research presented during the SEDAR 21 stock assessment. NMFS manages each stock separately; therefore, delineation of separate EFH boundaries for Atlantic and Gulf of Mexico stocks would be consistent with current management strategies. EFH boundaries of juvenile and adult Gulf of Mexico stock blacknose shark were combined due to similarity in life history and model output, and adjusted to include more areas in the western Gulf of Mexico and expanded slightly in the eastern Gulf of Mexico, due to the new data incorporated into the Kernal Density Estimation/ 95 Percent Volume Contour models and scientific recommendations from the SEFSC.

In Final Amendment 10, the neonate/YOY EFH boundaries of Gulf of Mexico stock blacknose shark were adjusted to be identical to those finalized in Amendment 1. In Draft Amendment 10, EFH was derived from a model using 35 data points for neonate/YOY blacknose. EFH boundary model output spanned much of the Gulf of Mexico, but available empirical scientific data was not available for several of these areas. Given the small number of available data points, and the stated intent to avoid designating EFH across the entire known range of a species' distribution, NMFS scientists from the SEFSC (W. Driggers and J. Carlson pers comm, NOAA SEFSC) recommended that the EFH boundaries be adjusted to match Amendment 1. These boundaries are considered to reflect best available scientific information.

Essential Fish Habitat for Blacknose Shark (Atlantic Stock)

Figure G 51

Neonate/YOY (< 43 cm TL):	At this time insufficient information is available to describe and identify EFH for this life stage in the Atlantic.

Juveniles (43 - 90 cm FL) and Adults (> 90 cm FL):

Coastal areas within 90 m from shore along the Atlantic east coast from Cape Hattaras to the mid-coast of Florida. Coastal waters from Cape Lookout to Holden Beach NC and SC nearshore waters - seasonal distribution correlated with temperatures of 17 to 30 °C. EFH includes higher salinity nearshore habitats (34-35 ppt) off South Carolina.

Summary of Changes Made to EFH

EFH boundaries published in Amendment 1 have been updated in Final Amendment 10. Amendment 1 previously designated EFH boundaries for a single blacknose shark stock. The blacknose shark stock was split into two regional stocks in 2010 due to the results of scientific research presented during the SEDAR 21 stock assessment. NMFS manages each stock separately; therefore, delineation of separate EFH boundaries for Atlantic and Gulf of Mexico stocks would be consistent with current management strategies. In comparison to Amendment 1, neonate/YOY blacknose sharks EFH is not designated in Amendment 10 based on scientific recommendations from the NEFSC. EFH boundaries for juvenile and adult blacknose sharks were reduced slightly off northeastern South Carolina and in Raleigh Bay, North Carolina due to the incorporation of new data into the Kernal Density Estimation / 95 Percent Volume Contour models. The seaward extent of EFH boundaries were also restricted to habitats less than 90 m in depth due to scientific recommendations from the NEFSC.

In Final Amendment 10, boundaries were slightly reduced off South Carolina due to the incorporation of updated data into the Kernal Density Estimation / 95 Percent Volume Contour models and concerns about data transcription errors in the COASTSPAN dataset (C. McCandless pers comm, NOAA NEFSC). As explained in Section 2.1 under the description of Alternative 2 and in Appendix F (see "Approaches Used to Analyze and Map Data" for a review on how data were adjusted along features), this update was included in response to comments from the SEFSC recommending that these changes be made in order to reflect all available information on distribution and habitat utilization, and thus meets the requirement that these updates be based on the best scientific information.

6.6.2 Bonnethead Shark (*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). Bonnethead shark were last assessed during the 2014 SEDAR 34 stock assessment. Although the stock assessment was conducted on a single unit stock, scientific review of the stock assessment strongly implied the presence of separate Gulf of Mexico and Atlantic stocks. Thus, based on the assessment and its reviews, bonnethead sharks are managed as two separate stocks. EFH was previously only designated for a single stock. Therefore, where available, life history information is presented for both Atlantic and Gulf of Mexico stocks, and EFH for each stock is presented in separate text descriptions and maps.

Habitat Associations

Ward-Paige et al. (2014) characterized preferred habitats for bonnethead shark in the northern Gulf of Mexico showing a bias toward higher temperature (higher than 30 °C) and mid-salinity (30–35 PSU) areas. Tagging studies have shown that bonnetheads exhibit strong site fidelity and do not travel far from the area where they were tagged (Driggers et al. 2014; McCallister et al. 2013; Kohler et al. 2013). McCandless et al. (2002), Hueter and Tyminski (2007), Steiner et al. (2007) and others (see McCandless et al. (eds) 2007) summarized important summer nursery areas for bonnethead in the Gulf of Mexico: northeastern estuarine and shallow coastal waters (Apalachee Bay, Apalachicola Bay, St. Joseph Bay, Crooked Island Sound, St. Andrews Bay) (temperature 16-32.5 °C, salinity range of 19-38 ppt, depth 0.7-6.4 m), coastal areas offshore of Yankeetown (YOY: salinity range of 20.9-30.6 ppt, temperature 27.6-30 °C, depth 2.4-3.7 m), Tampa Bay region (YOY: salinity range of 22.3-35.3 ppt, 16.1-31.0 °C, depth 0.6-6.1 m), Charlotte Harbor (NEO/YOY: salinity range of 15.4-37.5 ppt, temperature 15.9-33.3 °C, depth 0.6-3.7 m), the Florida Keys (temperature 16.1-31.7 °C, salinity range of 15.4-35.6 ppt, depth 1.8-2.1 m), the 10,000 Islands estuary (YOY: salinity range of 23.3-36.1 ppt, temperature 26.0-31.0 °C, depth 0.9-3.4 m), and other areas (salinity range of 15.4-37 ppt, temperature 15.9-33.3 °C, depth 0.6-6.1 m) of Florida; Bay St. Louis, Mississippi to Perdido Bay, Alabama (average measurements for environmental variables include 28-29 °C temperatures, salinity range of 17.2-26.2 ppt, and approximately depth of 4.6 m); the Terrebone and Timbalier Bay system, Louisiana; and all major bay systems along the Gulf coast of Texas from Sabine Lake to Lower Laguna Madre (temperature 18-33.5 °C).

McCandless et al. (2002), Hueter and Tyminski (2007), Steiner et al. (2007), and others also summarized juvenile habitat (nursery) for Gulf of Mexico bonnethead as the northeastern Gulf of Mexico (Apalachee Bay, Apalachicola Bay, St. Joseph Bay, Crooked Island Sound, St. Andrews Bay) (temperature range of 16-32.5 °C, salinity range of 1.9-8.3 ppt, depth 0.7-6.4 m) and from Yankeetown to Charlotte Harbor and the Florida Keys (temperature range of 15.9-33 °C, salinity range of 16.5-36.9 ppt, depth 0.6-4.9 m), the 10,000 Islands estuary (temperature range of 20-33.6 °C, salinity range of 14-41.8 ppt, depth 0.8-4 m), Florida; Bay St. Louis Mississippi to Perdido Bay Alabama (28-31.1 °C, 15.5-24 ppt, depth 3-3.4 m); the Terrebone and Timbalier Bay system, Louisiana (temperature range of 28.4-31.4 °C, salinity range of 25.3-34.3 ppt, depth 1.8-2.4 m); and all major bay systems along the Gulf coast of Texas from Sabine Lake to Lower Laguna Madre. Steiner et al. (2007) noted mature bonnethead in the 10,000 Islands estuary region associating with temperatures between 20.0-33.6 °C, salinity between 14.4-41.7 ppt, and depth ranging between 7.6-40 m.

McCandless et al. (2002) identified seasonal nursery habitat for neonate/YOY Atlantic bonnethead as coastal waters from the tip of Georgia to Cape Canaveral, Florida. Neonate/YOY Atlantic bonnethead habitat was identified as inshore and nearshore waters from Cape Hatteras to Holden Beach, North Carolina (temperature 19-33 °C, depth 0.6-11.6 m); coastal and estuarine waters of South Carolina (no data) and Georgia (temperature 23-31 °C, salinity 22-36.6 ppt, depth 0.5-13.1m); and coastal waters from the tip of Georgia to Cape Canaveral, Florida (no data). McCandless et al. (2002) summarized seasonal nursery habitat for juvenile Atlantic bonnethead as coastal waters from the tip of Georgia to Cape Canaveral, Florida. Juvenile Atlantic bonnethead habitat was identified as inshore and nearshore waters from Cape Hatteras to Holden Beach, North Carolina (temperature 19-33 °C, depth 0.6-11.6 m); coastal and estuarine waters of South Carolina (no data) and Georgia (temperature 23-31 °C, salinity 22-36.6 ppt, depth 0.5-13.1 m); and coastal waters from the tip of Georgia to Cape Canaveral, Florida (no data).

Life History and Reproductive potential

Frazier et al. (2014) presented von Bertalanffy parameters for bonnethead sharks of $L_\infty = 1{,}036$ mm L_F, $k = 0{\cdot}18$, $t_0 = -1{\cdot}64$ and $L_0 = 272$ mm LF for females and $L_\infty = 782$ mm L_F, $k = 0{\cdot}29$, $t_0 = -1{\cdot}43$ and $L_0 = 266$ mm L_F for males. Maximum observed age was 17.9 years for females and 16.0 years for males. Frazier et al. (2014) also found significant differences in multiple life history characteristics between bonnethead sharks in the western North Atlantic and the Gulf of Mexico, which combined with evidence from tagging and genetic studies (Escatel-Luna et al. 2015) suggest that the stocks should be considered separate.

There is latitudinal variation in pupping season in the eastern Gulf of Mexico (Parsons 1993; Manire et al. 1995). YOY remain in shallow estuaries through the fall before migrating south in October when water temperatures reach 20 °C (Hueter and Tyminski 2007). Along with other sharks, bonnetheads are occasionally found in warm water effluents of Tampa Bay power plants. Juveniles are found year-round in the Florida Keys (Hueter and Tyminski 2007) and the 10,000 Islands estuary (Steiner et al. 2007). 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). Frazier et al. (2014) found that length and age at 50 percent maturity were 819 mm and 6.7 years for females, and 618 mm and 3.9 years for males. The reproductive cycle is annual, with some seasonal variation in mating, ovulation, and fecundity between the Gulf of Mexico and Atlantic stocks (Gonzalez De Acevedo 2014). 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. Litters consist of 8 to12 pups, with the young measuring 27 to 35 cm TL at birth (Castro, 1983; Parsons, 1993). Heuter and Tyminski (2007) found YOY and juveniles in the west coast of Florida at temperatures of 16.1° to 31.5° C, salinities of 16.5 to 36.1, and DO of 2.9 to 9.4 mL/L. Parthenogenesis (development of an embryo from an egg without male genetic contribution) in a bonnethead shark was reported to have occurred in a U.S. aquarium, whereby an adult female that had been held captive in the absence of males for three years gave birth to a normally developed live female pup; the validity of this birth occurring through parthenogenesis was later confirmed by DNA analysis (Chapman et al. 2007)

Essential Fish Habitat for Bonnethead Shark (Gulf of Mexico Stock):

Figure G 52 - Figure G 54

Neonate/YOY (≤ 45 cm FL):	EFH includes coastal areas from the Florida Keys through eastern Mississippi and from western Louisiana to Texas EFH includes important summer nursery areas for Gulf of Mexico bonnethead: the 10,000 Islands estuary (YOY: salinity range of 23.3-36.1 ppt, 26.0-31.0 °C temperature, 0.9-3.4 m depth); the Florida Keys (16.1-31.7 °C, salinity range of 15.4-35.6 ppt, 1.8-2.1 m depth); Charlotte Harbor (NEO/YOY: salinity range of 15.4-37.5 ppt, 15.9-33.3 °C temperature, 0.6-3.7 m depth); Tampa Bay region (YOY: salinity range of 22.3-35.3 ppt, 16.1-31.0 °C temperature, 0.6-6.1 m depth); coastal areas offshore of Yankeetown (YOY: salinity range of 20.9-30.6 ppt, 27.6-30 °C temperature, 2.4-3.7 m depth); estuarine and shallow coastal waters in the northeastern Gulf of Mexico (Apalachee Bay, Apalachicola Bay, St. Jospeh Bay, Crooked Island Sound, St. Andrew Bay) (temperature 16-32.5 °C, salinity 19-38 ppt, depth 0.7-6.4 m), and other areas (salinity range of 15.4-37 ppt, 15.9-33.3 °C temperature, 0.6-6.1 m depth) of Florida; Bay St. Louis Mississippi to Perdido Bay Alabama (average measurements for environmental variables include 28-29 °C temperature, salinity range of 17.2-26.2 ppt, approximately 4.6 m depth) ; the Terrebone and Timbalier Bay system, Louisiana; and all major bay systems along the Gulf coast of Texas from Sabine Lake to Lower Laguna Madre (temperature 18-33.5 °C).
Juveniles (46 to 65 cm FL):	EFH includes coastal areas in the Gulf of Mexico from the Florida Keys to Chandeleur Sound and along Texas. Known habitat associations are identified for: Yankeetown to Charlotte Harbor and the Florida Keys (15.9-33 °C, 16.5-36.9 ppt, 0.6-4.9 m); the 10,000 Islands estuary (20-33.6 °C, 14-41.8 ppt, 0.8-4 m), Florida; the northeastern Gulf of Mexico (Apalachee Bay, Apalachicola Bay, St. Jospeh Bay, Crooked Island Sound, St. Andrew Bay) (temperature 16-32.5 °C, salinity 1.9-8.3 ppt, depth 0.7-6.4 m) Bay St. Louis Mississippi to Perdido Bay Alabama (28-31.1 °C, 15.5-24 ppt, depth 3-3.4 m); the Terrebone and Timbalier Bay system, Louisiana (28.4-31.4 °C, 25.3-34.3 ppt, 1.8-2.4 m); and all major bay systems along the Gulf coast of Texas from Sabine Lake to Lower Laguna Madre.
Adults (≥ 66 cm FL):	EFH includes coastal areas from the Florida Keys to Chandeleur Sound, and along Texas, and from Chandeleur

Sound, Louisiana and eastern Mississippi. Habitat associations are noted in the 10,000 Islands estuary system (20.0-33.6 °C, 14.4-41.7 ppt, and 7.6-40 m).

Summary of Changes Made to EFH

EFH boundaries published in Amendment 1 have been updated in Final Amendment 10. Amendment 1 established EFH for a single stock of bonnethead shark. However, the bonnethead shark stock was split into two regional stocks in 2014 due to the results of scientific research presented during the SEDAR 34 stock assessment. NMFS manages each stock separately; therefore, delineation of separate EFH boundaries for Atlantic and Gulf of Mexico stocks would be consistent with current management strategies. EFH boundaries of Gulf of Mexico stock neonate/ YOY, juvenile, and adult life stages were modified between Cape San Blas and the Mississippi River delta and in the western Gulf of Mexico due to the incorporation of new data into the Kernal Density Estimation/ 95 Percent Volume Contour models and recommendations from SEFSC scientists.

There were no changes to EFH boundaries for Gulf of Mexico stock bonnethead shark from Draft Amendment 10 to Final Amendment 10.

Essential Fish Habitat for Bonnethead Shark (Atlantic Stock):

Figure G 55 – Figure G 56

Neonate/YOY (≤ 31 cm FL): Atlantic east coast inshore and nearshore waters from Cape Hatteras to Holden Beach, North Carolina (temperature 19-33 °C, depth 0.6-11.6 m); coastal and estuarine waters of South Carolina (no data) and Georgia (temperature 23-31 °C, salinity 22-36.6 ppt, depth 0.5-13.1 m); and coastal waters from the tip of Georgia to Cape Canaveral, Florida.

Juveniles (32 to 81 cm FL)
and Adults (> 81 cm FL): Atlantic east coast inshore and nearshore waters from Holden Beach, North Carolina (temperature 19-33 °C, depth 0.6-11.6 m) to coastal and estuarine waters of South Carolina (no data) and Georgia (temperature 23-31 °C, salinity 22-36.6 ppt, depth 0.5-13.1 m); and coastal waters from Georgia to Cape Canaveral, Florida.

Summary of Changes Made to EFH

EFH boundaries published in Amendment 1 have been updated in Final Amendment 10. Amendment 1 established EFH for a single stock of bonnethead shark. However, the bonnethead shark stock was split into two regional stocks in 2014 due to the results of scientific research presented during the SEDAR 34 stock assessment. NMFS manages each stock separately; therefore, delineation of separate EFH boundaries for Atlantic and Gulf of Mexico stocks would be consistent with current management strategies. EFH boundaries of the Atlantic stock neonate/ YOY were extended slightly further south and reduced such that they did not go as far offshore between South Carolina and central Florida due to scientific recommendations from the NEFSC. Due to similarity in behavior and a high degree of model output similarity, juvenile and adult life stages EFH boundaries were combined per scientific recommendations from the NEFSC. Additional EFH boundary modifications for the juvenile and adult life stages included contraction of the northern extent from Raleigh Bay to Cape Fear, North Carolina due to recommendations from NEFSC scientists.

Since the publication of Draft Amendment 10, EFH boundaries were slightly reduced in coastal areas off South Carolina NEFSC recognized data transcription errors in a dataset and NEFSC recommended that the change be made as a result. As explained in Section 2.1 under the description of Alternative 2 and in Appendix F (see "Approaches Used to Analyze and Map Data" for a review on how data were adjusted along features), this update was included in response to comments from the SEFSC recommending that these changes be made in order to reflect all available information on distribution and habitat utilization, and thus meets the requirement that these updates be based on the best scientific information.

6.6.3 Finetooth Shark (*Carcharhinus isodon*)

The finetooth shark is an inshore species of the western Atlantic. Its range is from North Carolina to Brazil. It is found 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 (Castro 1993b; 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 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 YOY finetooth sharks seek different types of habitat than their older conspecifics in the eastern portion of the Mississippi sound region. Ward-Paige et al. (2014) described juvenile finetooth sharks to be associated with low salinity habitats (lower than 20 ppt) and moderate depths (~ 4 m) in the northern Gulf of Mexico. Bethea et al. (2014) also found finetooth sharks to be consistently captured in lower salinity areas, and restricted to a select group of bays in the northern Gulf of Mexico.

Hendon et al. (2014) noted the observed maximum male and female age to be 5.5 years, and 8.5 years, respectively, in the northern Gulf of Mexico.

Reproductive potential

Males mature at about 130 cm total length and females mature at about 135 cm TL. The size at 50 percent maturity for finetooth sharks was 956 and 1035 mm FL for males and females, respectively, in the northern Gulf of Mexico' with male sperm production peaking in April to coincide with female ovulation in May (Hendon et al. 2014). The young measure 48 to 58 cm TL at birth. Litters range from two to six embryos, with an average of four, and in the northern Gulf of Mexico litter sizes range from one to nine pups (Hendon et al. 2014). The gestation period lasts about a year, and the reproductive cycle is biennial (Castro 1993). Driggers and Hoffmayer (2009) and Hendon et al. (2014) describe individuals from the northern Gulf of Mexico showing reproductive condition representative of an annual cycle. This annual cycle was not observed in finetooth sharks from the northwestern Atlantic (Brown 2015). 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 nursery area for this species (Ulrich et al. 2007). Hueter and Tyminski (2007) collected a 63 cm (TL) YOY 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 ppt. 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 and 26 ppt. Peak abundance occurred at the end of June and first half of July. Hendon and Hoffmeyer (2007) found that YOY 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 long., and from near Sabine Pass, Texas at 94.2° W long. to Laguna Madre, Texas at 26° N lat.; also, coastal waters out to the 25 m isobath from South Carolina north to Cape Hatteras, North Carolina at 35.5° N lat. 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 Louisiana. 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 YOY 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.

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 long., and from near Sabine Pass, Texas at 94.2° W long. to Laguna Madre, Texas at 26° N lat. 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.

Essential Fish Habitat for Finetooth Shark

Figure G 57

Neonate/YOY, Juvenile, and Adult:

EFH in the Atlantic Ocean includes coastal areas between Cape Hatteras and the Florida Keys. Important nursery habitats include coastal areas between Cape Hatteras to Holden Beach, North Carolina (3.1-10.7 m depth, 22-30.6 °C); South Carolina estuarine and coastal waters (including Wynah Bay and North Inlet) (20-28 °C, salinity 23.5 ppt or higher); Georgia estuarine waters, specifically the lower Duplin River and Doboy Sound (25-28.2 °C, salinity range of 23-32.1 ppt, 0.5-4.3 m depth).

EFH in the Gulf of Mexico includes shallow coastal waters of the northeastern Gulf of Mexico with muddy bottom (19.5-31.4 °C, 19-38 ppt, 2.3-5.3 m depth) the seaward side of coastal islands, especially around the mouth of the Apalachicola River and the gulf side of St. Vincent Island to just southeast of St. Andrews Bay Inlet, Florida. Also includes St. Vincent Sound, Saint Andrew Sound, Saint Joseph Bay, and Apalachicola Bay. Hyper-saline environmental conditions may spatially or temporally restrict neonate/YOY EFH in the western Gulf of Mexico, and should not be included in EFH. EFH also includes Bay St. Louis; Perdido Sound; Bon Secour Bay and lower Mobile Bay, Alabama; Terrebonne and Timbalier bay system, Louisiana (25.3-32.1 °C, 0.6 - 4.9 m depth); the Mississippi Sound, specifically north of and off western Horn, Sound, and Round Islands (YOY), between the islands and the coast of Louisiana; coastal areas of Texas, including portions of Corpus Cristi Bay, Aransas and Copano Bays, San Antonio Bay, Espiritu Santo Bay, Matagorda Bay, Galveston Bay, and Trinity Bay) (19.2-30.6 °C, 16-36 m depth) ; and beaches of the southeastern Texas coast (2.1-5.5 m depth).

Summary of Changes Made to EFH

EFH boundaries published in Amendment 1 have been updated in Final Amendment 10. Amendment 1 finalized EFH for neonate/YOY and juvenile/adult finetooth sharks, however all life stages were combined for Amendment 10 analyses based on scientific recommendations from the NEFSC and SEFSC (due to similarity in behavior, distribution, and model output of each life stage). EFH boundaries were constricted in the Gulf of Mexico due to the incorporation of new data into the Kernal Density Estimation / 95 Percent Volume Contour models and scientific recommendations intended to refine EFH to those areas most important for feeding, breeding, spawning or growth to maturity (J. Carlson pers comm, NOAA SEFSC). EFH boundaries were reduced in the Atlantic Ocean to a core area between Myrtle Beach, SC and Cape Canaveral, FL, due to incorporation of new data into the Kernal Density Estimation / 95 Percent Volume Contour models and scientific recommendations from NOAA NEFSC staff intended to refine EFH (C. McCandless pers comm, NOAA NEFSC).

There were no changes to EFH boundaries for finetooth shark from Draft Amendment 10 to Final Amendment 10.

6.6.4 Atlantic Sharpnose Shark (*Rhizoprionodon terraenovae*)

The Atlantic sharpnose shark is a small coastal carcharhinid, inhabiting the waters of the northeast coast of North America. Atlantic sharpnose were last assessed during the 2014 SEDAR 34 stock assessment, where it was determined that a split assessment on separate Gulf of Mexico and Atlantic stocks was appropriate. Based on the assessment, Atlantic sharpnose sharks are managed as two separate stocks. EFH was previously only designated for a single stock. Therefore, where available, life history information is presented for both Atlantic and Gulf of Mexico stocks, and EFH for each stock is presented in separate text descriptions and maps. Tagging studies suggest little to no movement between the Gulf of Mexico and the Atlantic (Bethea and Grace 2013; Hendon et al. 2013; Kohler et al. 2013; Tyminski et al. 2013). Bethea and Grace (2013) noted that most tag recaptures occurred in the same bodies of water from which tagged sharpnose sharks were released. Cortes (2002) noted that at that time, the Atlantic sharpnose shark was the most abundant small coastal shark in U.S. Atlantic and Gulf of Mexico waters.

Habitat Associations

Atlantic sharpnose are a year-round resident along the coasts of South Carolina, Florida, and in the Gulf of Mexico and an abundant summer migrant off coastal Virginia and the Chesapeake Bay (Latour et al. 2013). Important nursery habitats for juveniles, neonates and YOY are summarized by McCandless et al. (2002) and include inshore and nearshore waters from Cape Hatteras to Holden Beach, North Carolina (juveniles: 17.3 – 33 °C, 1.4 – 16.5 m depth); and estuarine and nearshore waters of South Carolina (21-29 °C, salinity range of 24-37 ppt, pupping activity May-June, nursery occupation through October); estuarine and coastal waters of Georgia (26.4 – 30.8 °C, salinity range of 21.6 – 36.4 ppt, 2.7 – 13.1 m depth).

Atlantic sharpnose sharks are known to occur in a variety of coastal habitats and bottom types (silt, sand, mud, seagrass) in the Gulf of Mexico, some of which are proposed nursery areas (McCandless et al. 2002). Habitat utilization reflects seasonal onshore-offshore migrations. Overwintering grounds are in the Florida Keys. 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). Habitat associations for Atlantic sharpnose are reviewed in McCandless et al. (2002) and in chapters of McCandless et al. (eds)(2007). Bethea et al. (2015) noted that Atlantic sharpnose sharks in the Gulf of Mexico are found across a broad range of substrate types. 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 °C, 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, 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). YOY and juveniles were found in temperatures of

21.8 to 31.7 °C, salinities of 29.0 to 37.2 ppt, and DO of 2.7 to 6.9 mL/L. Coastal nursery habitats of Atlantic sharpnose shark have been identified in northeastern Florida (McCallister et al. 2013). Mature sharks were found in these nursery areas between May and June. Age-0 individuals were found throughout the summer (primarily in July and August. 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 (tendency to return to a specific location in order to breed or feed), but likely use a series of coastal bays and estuaries throughout the juvenile stage (Carlson et al. 2008).

Ward-Paige et al. (2014) developed habitat suitability models from coastal sites in the Northeastern Gulf of Mexico, and found that increasing temperature and depth most influenced the occurrence of juvenile Atlantic sharpnose shark. Bethea et al. (2014) analyzed fishery-independent gillnet survey data in the Gulf of Mexico and found that Atlantic sharpnose was the most commonly caught shark species and were caught consistently across all sampling areas.

In both the Atlantic and Gulf of Mexico, EFH reflects sex-specific distribution and behavioral differences - females pup offshore and thus may be located in deeper waters, whereas males tend to be closer to shore. For example, sampling in Delaware Bay suggests that these habitats are heavily used by adult males. Adult male and juvenile Atlantic sharpnose sharks do not appear to be restricted to any specific areas throughout the northeastern Gulf of Mexico. However, adult females are generally only found offshore.

Life History and Reproductive potential

Maximum estimated longevity of Atlantic sharpnose sharks in the western North Atlantic Ocean was determined, by Frazier et al. (2014), to be 19.8 years through tag-recapture data and 18.5 years through direct age estimates. 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. Hoffmayer et al. (2013) identified mature spermatozoa in male sharks from March to November, and postpartum females from April to September showing variability in this species reproductive cycle, but did confirm an annual reproductive cycle. 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 $L_\infty = 110$, $K = 0.39$, and $t_o = -0.86$ y (Carlson and Baremore 2003). Cortés (1995) calculated the populations 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).

Driggers et al. (2012) determined that Atlantic sharpnose sharks showed no distinct feeding patterns during the diel cycle. Atlantic sharpnose sharks across all size classes eat primarily teleost fishes (Drymon et al. 2012).

Essential Fish Habitat for Atlantic Sharpnose (Gulf of Mexico Stock):

Figure G 58 – Figure G 59

Neonate/YOY:	EFH includes Gulf of Mexico coastal areas including offshore of Naples, Florida; localized areas between Panama City, Florida to Apalachicola; and between Mobile Bay, Alabama and southern Texas. EFH is recognized in important summer nursery habitats for neonates and includes certain habitat associations: peninsular Florida near Charlotte Harbor and Naples (18.4 – 30.7 °C, salinity range of 22.8-33.7 ppt, 0.9-4 m depth); northeastern Gulf of Mexico, including Apalachee Bay, Crooked Island Sound, St. Joseph Bay, St. Andrew Bay, and the Apalachicola Bay systems (e.g., St. Vincent Island) (21.8 to 31.7 °C, salinities of 29.0 to 37.2, and DO of 2.7 to 6.9 mL/L); mouth of St. Louis Bay to the tip of Ft. Morgan, Alabama; coastal areas of the Mississippi delta and Mississippi Sound (28.6 °C, salinity range of 22.4-26.4 ppt, 2.3-26.4m depth); Terrebonne/Timbalier bay systems of Louisiana; and all major bay systems along the Gulf coast of TX from Galveston Bay to lower Laguna Madre and coastal Texas waters (16.7 – 32 °C, salinity range of 10-38 ppt).
Juvenile (50 - 61 cm FL) and Adults (≥ 62 cm FL):	EFH for juveniles includes Gulf of Mexico coastal areas from the Florida Keys to Texas, out to a depth of 200m. EFH is recognized in important nursery areas in concert with specific habitat associations, including Yankeetown, Florida to the 10,000 Islands estuary system and coastal areas surrounding the Florida Keys (17.2-33.3 °C, salinity range of 22.8-37.4 ppt, 2.9-8.71 mg/L DO, 0.6-43.9 m depth); Yankeetown and Anclote Key during the months of May to July (17.2° to 33.3° C, salinities of 22.8 to 35.5, and DO of 4.5 to 8.6 mL/L); northeastern Gulf of Mexico, including Apalachee Bay, Crooked Island Sound, St. Joseph Bay, St. Andrew Bay, and the Apalachicola Bay systems (e.g., St. Vincent Island) (16° to 32.4° C, salinities of 19.0 to 38 ppt, and DO of 4.5 to 8.3 mL/L); coastal Alabama off Dauphin Island and Mobile Point (24.5-31.5 °C, 0.3-7.2 mg/L DO, salinity range of 28.6-36.3 ppt, depth of 2.7-14 m); mouth of St. Louis Bay to the tip of Ft. Morgan, Alabama; Terrebonne/Timbalier bay systems of Louisiana (22.6-32.4 °C, salinity range of 23-37.3 ppt, depth 1.5-4.9 m); and all major bay systems along the Gulf coast of Texas from Galveston Bay to lower Laguna Madre and coastal Texas waters (16.- 32 °C, salinity range of 10-38 ppt). Notable EFH associations in specific habitats for adults are available for coastal areas of western Florida from St. George

Sound to Anclote Keys Florida (19.1-31.8 °C, salinity range of 19.7-37.3 ppt, depth of 0.4-7.0 m); northwest Florida (St. Andrew Bay, Crooked Island Sound, St. Joseph Bay, gulf side of St. Vincent island) (20.4-30.9 °C, salinity range of 25.1-32.7 ppt, depth of 2.5-8.3 m); and Mississippi Sound (27.3-29.3 °C, salinity range of 19.9-30.3 ppt, 3.1-5.1 m depth).

Summary of Changes Made to EFH

EFH boundaries published in Amendment 1 have been updated in Final Amendment 10. Amendment 1 established EFH for a single stock of Atlantic sharpnose. However, the Atlantic sharpnose shark stock was split into two regional stocks in 2014 due to the results of scientific research presented during the SEDAR 34 stock assessment. NMFS manages each stock separately; therefore, delineation of separate EFH boundaries for Atlantic and Gulf of Mexico stocks would be consistent with current management strategies. In addition, EFH boundaries of the neonate/ YOY Atlantic sharpnose EFH for the Gulf of Mexico stock were modified to include offshore areas in the western Gulf of Mexico (where pupping is suspected to occur) and to remove areas from mid-coastal Florida to the Florida Keys due to scientific recommendations from the SEFSC. Due to similarities in behavior, distribution, and model output, juvenile and adult EFH boundaries were combined; minor modifications were made due to the incorporation of new data into the Kernal Density Estimation/ 95 Percent Volume Contour models.

In Final Amendment 10, EFH boundaries for the neonate/YOY life stage for Gulf of Mexico stock Atlantic sharpnose sharks were reduced from those in Draft Amendment 10 in the Big Bend region of Florida, off Tampa, and in the Florida Keys due to comments from the SEFSC reflecting the best available scientific information. As explained in Section 2.1 under the description of Alternative 2 and in Appendix F (see "Approaches Used to Analyze and Map Data" for a review on how data were adjusted along features), this update was included in response scientific literature indicating that neonate/YOY do not use this area, and off Tampa and in the Florida Keys, and to comments from the SEFSC recommending that these changes be made in order to reflect all available information on distribution and habitat utilization, and thus meets the requirement that these updates be based on the best scientific information.

Essential Fish Habitat for Atlantic Sharpnose (Atlantic Stock)

Figure G 60 - Figure G 62

Neonate/YOY (≤ 51 cm FL): Atlantic Ocean EFH includes areas between the mid-coast of Florida and Cape Hattaras, with seasonal summer distribution in the northern part of the range. Most EFH includes important nursery habitats include inshore and nearshore waters from Cape Hatteras to Holden Beach, North Carolina; estuarine and nearshore waters of South Carolina (21-29 °C, salinity range of 24-37 ppt, , nursery occupation through October); and estuarine and coastal waters of Georgia (26.4-30.8 °C, salinity range of 21.6-36.4 ppt, 2.7-13.1 m depth). The northeastern coast of Florida to Cape Canaveral is an important nursery area (18.4-

	30.7 °C, salinity range of 22.8-33.7 ppt, 0.9-4 m depth). Offshore depth extent of EFH is 20m for this life stage.
Juvenile (52 - 59 cm FL):	EFH for this life stage extends from portions of the lower Chesapeake Bay (Virginia) to the mid-coast of Florida, with seasonal summer distribution in the northern part of the range. Important nursery areas for juveniles include: inshore and nearshore waters from Cape Hatteras to Holden Beach, North Carolina (17.3-33 °C, 1.4-16.5m depth); estuarine and nearshore waters of South Carolina (21-29 °C, salinity range of 24-37 ppt, nursery occupation through October); and estuarine and coastal waters of Georgia (26.4-30.8 °C, salinity range of 21.6-36.4 ppt, 2.7-13.1 m depth). Offshore depth extent of EFH for this life stage is 180m.
Adult (≥ 60 cm FL):	EFH for this life stage extends from portions of Delaware Bay and Cape May, NJ to the mid-coast of Florida, including portions of Chesapeake Bay, with seasonal summer distribution in the northern part of the range. Offshore depth extent for this life stage is 180m.

Summary of Changes Made to EFH

EFH boundaries published in Amendment 1 have been updated in Final Amendment 10. Amendment 1 established EFH for a single stock of Atlantic sharpnose. However, the Atlantic sharpnose stock was split into two regional stocks in 2014. NMFS manages each stock separately; therefore, delineation of separate EFH boundaries for Atlantic and Gulf of Mexico stocks would be consistent with current management strategies. Boundaries of the neonate/ YOY Atlantic sharpnose EFH for the Atlantic stock were slightly modified to include portions of Pamlico Sound near Hatteras and Ocracoke Inlets due to inclusion of new data into the Kernal Density Estimation/ 95 Percent Volume Contour models. The juvenile and adult Atlantic sharpnose EFH for the Atlantic stock were expanded from North Carolina to Chesapeake Bay and Delaware Bay, respectively, due to the incorporation of new data into the Kernal Density Estimation/ 95 Percent Volume Contour models and scientific recommendations from the NEFSC. An area previously identified in Amendment 1 off Delaware was removed for the juvenile life stage based on recommendations from the NEFSC.

There were no changes to EFH boundaries for the Atlantic stock of Atlantic sharpnose shark from Draft Amendment 10 to Final Amendment 10.

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6.7 Pelagic Sharks

6.7.1 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. Queiroz et al. (2012) showed that blue sharks occupy productive marine zones for extended periods and structure diel activity patterns across multiple spatio-temporal scales in response to particular habitat types, including diving to depths of 1,160 m. Howey (2010) and Campana et al. (2011) found that blue sharks in the northwest Atlantic showed restricted movements over the continental shelf during the summer months, and moved offshore in the fall. This offshore movement coincided with a greater usage of the water column and diel depth patterns, possibly to follow the vertical migrations of prey species. 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 40° and 50° N lat.

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 that the number of embryos ranged between one and 62 embryos in 669 pregnant females in the North Pacific (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° to 40° N lat. 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° to 40° N lat. of the Pacific Ocean. Vandeperre et al. (2014) showed that small juvenile blue sharks of both sexes used a relatively limited area, between 25° and 45° N lat. and 22° and 56° W long. For extended periods of time, with water temperature ranging between 17 to 25 °C, suggesting an oceanic nursery area.

Essential Fish Habitat for Blue Shark

Figure G 63 - Figure G 64

Neonate/YOY (≤ 76 cm FL):	In the Atlantic in areas offshore of Cape Cod through New Jersey, seaward of the 30m bathymetric line (and excluding inshore waters such as Long Island Sound). EFH follows the continental shelf south of Georges Bank to the outer extent of the U.S. EEZ in the Gulf of Maine.
Juvenile (77 to 184 cm FL) and Adult (≥ 185 cm FL):	Localized areas in the Atlantic Ocean in the Gulf of Maine, from Georges Bank to North Carolina, South Carolina, Georgia, and off Florida.

Summary of Changes Made to EFH

EFH boundaries published in Amendment 1 have been updated in Final Amendment 10. Boundaries of the neonate/ YOY blue shark EFH were modified due to the incorporation of new data into the Kernal Density Estimation/ 95 Percent Volume Contour models and scientific recommendations from the NEFSC. The juvenile and adult blue shark EFH were adjusted to include areas inshore of the 200 m isobath along Florida to South Carolina and areas south of Georges Bank. EFH was adjusted to exclude pelagic habitats offshore of the Mid-Atlantic, on Georges Bank and in the central Gulf of Maine due to the incorporation of new data into the Kernal Density Estimation/ 95 Percent Volume Contour models and recommendations from the NEFSC.

There were no changes to EFH boundaries for blue shark from Draft Amendment 10 to Final Amendment 10.

6.7.2 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. Tagging data from an individual in the Gulf of Mexico indicate that the oceanic whitetip is an epipelagic species spending the majority of its time at or near the surface (0-50 m). Little time was spent below 75 m, and only one deep dive of 256 m was recorded. Temperatures primarily occupied were between 24.05 and 26 °C (Carlson and Gulak, 2012). A tagging study in Hawaiian waters found that oceanic whitetip spend more than 95 percent of their time at temperatures within 2 °C of sea surface temperature (Musyl et al. 2011). Howey-Jordan et al. (2013) and Madigan et al. (2015) found that tagged sharks showed seasonal site fidelity to an area in the Bahamas, but also tended to range along the outer continental shelf north of the Antilles islands of the eastern Caribbean northward to Cape Hatteras, North Carolina. These tagged sharks tended to remain in the epipelagic zone with short dives into the mesopelagic zone. Their rapid descent, slow ascent behavior suggests that these sharks might be foraging.

Reproductive potential

Both males and females appear to mature at about 190 cm TL (Bass et al., 1973). Coelho et al. (2009) suggest that size at first maturity is occurring from 160 to 196cm in males and from 181 to 203cm in females in the southwestern equatorial Atlantic. 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).

Essential Fish Habitat for Oceanic Whitetip Shark

Figure G 65

Neonate/YOY, Juveniles (< 180 cm FL), and Adults (≥ 180 cm FL):

> At this time, insufficient data is available to differentiate EFH between the neonate/YOY, juvenile, and adult size classes; therefore, EFH is the same for those life stages. EFH in the Atlantic Ocean includes localized areas in depths greater than 200 m from offshore of the North Carolina/Virginia border to the Blake Plateau. EFH in the Gulf of Mexico includes offshore habitats of the northern Gulf of Mexico at the Alabama/Florida border (i.e., the Mississippi plume seems particularly important for juveniles and adults) to offshore habitats of the western Gulf of Mexico south of eastern Texas. The entire U.S. Caribbean is considered to be EFH.

Summary of Changes Made to EFH:

EFH boundaries published in Amendment 1 have been updated in Final Amendment 10. Boundaries of EFH areas for all life stages of oceanic whitetip shark were reduced from a continuous designation spanning the U.S. EEZ between Georges Bank and the western Gulf of Mexico to more refined and localized EFH designation in both Atlantic and Gulf of Mexico. EFH was expanded in the Caribbean. These updates are based on the incorporation of new data into the Kernal Density Estimation/ 95 Percent Volume Contour models and scientific recommendations from the NEFSC and SEFSC.

In Final Amendment 10, EFH boundaries on the maps are updated to combine all life stages into a single designation. NMFS had intended to identify EFH for all life stages in this way in Draft Amendment 10, consistent with Amendment 1 EFH boundary designations, and EFH text descriptions in the Draft Amendment reflect this intent. However the EFH maps were mistakenly split between the neonate/YOY and juvenile/adult life stages; the final amendment corrects this error in the map.

6.7.3 Porbeagle Shark (*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 that is valued as food. Francis et al. (2008) stated that separate porbeagle stocks occur in the northwestern and northeastern Atlantic with little transatlantic crossover. Semba et al. (2013) found a wide porbeagle distribution across the southern hemisphere, finding that juveniles and adults prefer cooler areas than neonates. 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. 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. Campana and Joyce (2004) suggested that porbeagle sharks have evolved to take advantage of their thermorgulating capability by allowing them to seek out and feed on abundant coldwater prey in the absence of non-thermoregulating competitors. Skomal et al. (2009) showed that porbeagle exhibited broad seasonally dependent horizontal and vertical movements ranging from 77 to 870 km and from the surface to 1300 m depth, respectively. Study showed that while sharks moved through temperatures ranging from 2 to 26 °C, they spent 76 percent of the time in water ranging from 8 to 16 °C. In the spring and summer months, the sharks were epipelagic, swimming in the upper 200 m of the water column while in the late autumn and winter, some of the porbeagle moved to depths between 200 and 1,000 m.

Reproductive potential

Aasen (1963) estimated that maturity was reached at 150 to 200 cm TL for males and 200 to 250 cm TL for females. Jensen et al. (2002) found that males matured between 162 and 185 cm FL, and 50 percent were mature at 174 cm FL. Females matured between 210 and 230 cm FL, and 50 percent were mature at 218 cm FL. Francis et al. (2008) reported that age at 50 percent maturity for North Atlantic males and females were 8 and 13 years, respectively. Porbeagles have a protracted fall mating period from September to November (Jensen et al. 2002). Campana et al. (2010a and 2013) identified two mating grounds: 1) on the Grand Banks, off southern Newfoundland, and at the entrance to the Gulf of St. Lawrence, and 2) Georges Bank. 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) and Jensen et al. (2002) found the average number of young born to a female was 3.7 and 4.0, respectively, and the young are nourished through oophagy (Jensen et al. 2002). Porbeagles have a one-year reproductive cycle (Jensen et al 2002; Aasen, 1963) and a gestation period lasting 8-9 months (Jensen et al. 2002). Female PAT-tagged porbeagle sharks (n = 7) were noted to exit Canadian and northern U.S. coastal regions and make extensive migrations to deep, cold-water thermal refugia of the Sargasso Sea (Campana et al. 2010b). Given that the majority of mature females are gravid after November (Jensen et al. 2002). Campana et al. (2010b) hypothesize that pupping may occur in the Sargasso Sea and that pups and mature females follow the Gulf Stream back to northern feeding habitats.

Essential Fish Habitat for Porbeagle Shark

Figure G 66

Neonate/YOY (≤ 106 cm TL), Juvenile (106 to 196 cm TL), and Adult (≥ 196 cm TL):

At this time, available information is insufficient for the identification of EFH by life stage, therefore all life stages are combined in the EFH designation. EFH in the Atlantic Ocean includes offshore and coastal waters of the Gulf of Maine (not including Cape Cod Bay and Massachusetts Bay) and offshore waters of the Mid-Atlantic Bight from Georges Bank to New Jersey.

Summary of Changes Made to EFH

EFH boundaries published in Amendment 1 have been updated in Final Amendment 10. Boundaries of the porbeagle shark EFH were adjusted slightly to remove several nearshore areas near Long Island, Virginia, and North Carolina, and expanded in the Gulf of Maine between Georges Bank and Maine, due to the incorporation of new data into the Kernal Density Estimation/ 95 Percent Volume Contour models and scientific recommendations from the NEFSC.

There were no changes to EFH boundaries for porbeagle shark from Draft Amendment 10 to Final Amendment 10.

6.7.4 Shortfin Mako Shark (*Isurus oxyrinchus*)

The shortfin mako shark is an oceanic species found in warm and warm-temperate waters throughout all oceans. Heist et al. (1996) found considerable intraspecific genetic variation and significant partitioning of haplotypes between the North Atlantic and other regions; however, there was no evidence of multiple subspecies of shortfin mako, nor of any past genetic isolation between shortfin mako populations. 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). MacNeil et al. (2005) found evidence of a cephalopod to bluefish diet switch in the spring.

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, Campana et al. (2002) using radiocarbon assays found that the estimate may be incorrect. Bishop et al. (2006) considered Campana et al. (2002) when estimating 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: $L = 3210$ mm, $K = .072$, and $t_0 = -3.75$. Litter size ranges from 4 to 25, and size at birth is approximately 70 cm TL (Mollet et al. 2000). Gestation period was estimated at 15-18 months and the reproductive cycle at 3 years. Semba et al. (2011) estimated gestation period being between 9 and 13 months, with fecundity increasing as the female grows. 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 (Bishop et al. 2006).

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 lat. (Gilmore 1993); however, there is no information about the area where mating occurs.

Essential Fish Habitat for Shortfin Mako Shark

Figure G 67

Neonate/YOY (≤ 128 cm FL), Juvenile (129 to 274 cm FL), and Adult (≥ 275 cm FL):

At this time, available information is insufficient for the identification of EFH by life stage, therefore all life stages are combined in the EFH designation. EFH in the Atlantic Ocean includes pelagic habitats seaward of the continental shelf break between the seaward extent of the U.S. EEZ boundary on Georges Bank (off Massachusetts) to Cape Cod (seaward of the 200m bathymetric line); coastal and offshore habitats between Cape Cod and Cape Lookout, North Carolina; and localized habitats off South Carolina and Georgia. EFH in the Gulf of Mexico is seaward of the 200 m isobaths in the Gulf of Mexico, although in some areas (e.g., northern Gulf of Mexico by the Mississippi delta) EFH extends closer to shore. EFH in the Gulf of Mexico is located along the edge of the continental shelf off Fort Meyers to Key West (southern West Florida Shelf), and also extends from the northern central Gulf of Mexico around Desoto Canyon and the Mississippi Delta to pelagic habitats of the western Gulf of Mexico that are roughly in line with the Texas/Louisiana border.

Summary of Changes Made to EFH

EFH boundaries published in Amendment 1 have been updated in Final Amendment 10. EFH boundaries for all life stages of shortfin mako shark were adjusted off southern Maine and off South Carolina, and expanded in the Gulf of Mexico and west of the Florida Keys, due to the incorporation of new data into the Kernal Density Estimation/ 95 Percent Volume Contour models (both regions) and recommendations from the SEFSC (Gulf of Mexico only).

There were no changes to EFH boundaries for shortfin mako from Draft Amendment 10 to Final Amendment 10.

6.7.5 Common 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, with some seasonal abundance and north-south migrations along the U.S. East Coast (Castro, 2011), particularly in the offshore and cold inshore waters during the summer months (Gervelis and Natanson 2013). McCandless *et al.* (2002) showed nursery area characteristics in nearshore waters of North Carolina consisted of temperatures from 18.2 to 20.9 °C and at depths from 4.6 to 13.7 m.

In the Atlantic, mark recapture data (number tagged = 203 and recaptures = 4) from the NMFS Cooperative Shark Tagging Program (CSTP) between 1963 and 2013 provide supporting evidence that common thresher sharks do not make transatlantic movements (Kohler et al. 1998, NMFS unpublished data).

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). Studies have found that the species reaches upwards of 573 to 760 cm in size, with males reaching at least 22 years of age and females 24 years of age (Gervelis and Natanson 2013). In addition, growth of both sexes has been found to be similar until ages 8 and 12, when male and female growth slows down, respectively (Gervelis and Natanson 2013).

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. Mating is suspected to occur in the late fall (Gervelis and Natanson 2013). Gervelis and Natanson (2013) found mature pregnant females in the northwest Atlantic Ocean between 221 and 251 cm FL in size. Cailliet and Bedford (1983) stated that the age at maturity ranges from three to seven years. Castro (2009) notes that Alopias spp. exhibit an annual reproductive cycle with concurrent vitellogenesis and gestation and have continuous ovulation. This allows the female to conceive shortly after parturition. Natanson and Gervelis (2013) conclude that the common thresher shark has at least a biennial cycle, due to the capture of resting stage females, with evidence for a triennial cycle. Litters consist of four to six pups, which measure 137 to 155 cm TL at birth (Castro, 1983;

Mancini and Amorim 2006). But, they may vary depending on geographic location, with the average litter size ranging from 3 to 7 pups per litter (Goldman, 2009; Gervelis and Natanson 2013). According to Bedford (1985), gestation lasts nine months and female threshers give birth annually every spring (March to June). Gervelis and Natanson (2013) reported the life history characteristics of thresher sharks in the northwest Atlantic Ocean. The study found threshers in the area to have a life span between 15-50 years, 15 to 25 years for males and 28 to 46 years for females; size at birth at 81 cm FL; and size at maturity for males 314 to 420 cm TL and 315 to 400 cm TL for females.

Essential Fish Habitat for CommonThresher Shark

Figure G 68

Neonate/YOY, Juveniles, and Adults:

> 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. EFH is located in the Atlantic Ocean, from Georges Bank (at the offshore extent of the U.S. EEZ boundary) to Cape Lookout, North Carolina; and from Maine to locations offshore of Cape Ann, Massachusetts. EFH occurs with certain habitat associations in nearshore waters of North Carolina, especially in areas with temperatures from 18.2 to 20.9 °C and at depths from 4.6 to 13.7 m (McCandless et al. 2002).

Summary of Changes Made to EFH

EFH boundaries published in Amendment 1 have been updated in Final Amendment 10. Boundaries for the common thresher shark EFH were adjusted to remove some of the localized areas in the central Gulf of Mexico, Florida Keys, areas off Puerto Rico, the mid-east coast of Florida, Georgia and South Carolina due to the incorporation of new data into the Kernal Density Estimation/ 95 Percent Volume Contour models and scientific recommendations from the NEFSC and SEFSC.

There were no changes to EFH boundaries for common thresher shark from Draft Amendment 10 to Final Amendment 10.

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6.8 Smoothhound Shark Complex: Smooth Dogfish (*Mustelus canis*); Florida Smoothhound (*Mustelus norrisi*); Gulf Smoothhound (*Mustelus sinusmexicanus*)

The smoothhound shark complex consists of three species, smooth dogfish, Florida smoothhound, and Gulf smoothhound. These three species are difficult to differentiate, complicating separate EFH determination for each species. SEDAR 39 found that smooth dogfish is the only smoothhound shark complex species found in the Atlantic so all EFH identified in the Atlantic is exclusively for smooth dogfish. All three species, however, occur in the Gulf of Mexico, thus, separate EFH for each species cannot be identified in that region. This section examines life history of each species separately but combines EFH where appropriate for each stock.

6.8.1 Smooth dogfish (*Mustelus canis*)

Smooth dogfish is a common coastal shark species found in the Atlantic Ocean from Massachusetts to northern Argentina. They are primarily demersal sharks that inhabit continental shelves and are typically found in inshore waters down to 200m depth (Compagno, 1984). Smooth dogfish is a migratory species that responds to changes in water temperature. They primarily congregate between southern North Carolina and the Chesapeake Bay in the winter. In the spring, smooth dogfish move along the coast when bottom water warms up to at least 6 to 7 °C. As temperatures get colder, smooth dogfish move offshore to their wintering areas (Compagno, 1984). Smooth dogfish can tolerate a range of temperatures from 6 to 27 °C. Able et al. (2014) used acoustic telemetry to track the seasonal use of New Jersey estuaries by smooth dogfish, with tagged individuals leaving by September. The NMFS Cooperative Shark Tagging Program reported a maximum displacement distance of 460 nm, distance traveled increased with increasing FL, and none of the tagged smooth dogfish moved between the Atlantic and the Gulf of Mexico (Kohler et al. 2014). Smooth dogfish have diets that are dominated by invertebrates (Scharf et al. 2000). They primarily feed on large crustaceans, consisting mostly of crabs (Gelsleichter et al. 1999), but also rely heavily on American lobsters. In the New England waters during the spring, smooth dogfish feed on small bony fish, including menhaden, stickleback, wrasses, porgies, sculpins, and puffers (Compagno 1984). In Delaware Bay, smooth dogfish fed on invertebrates with larger sharks shifting to large crabs and teleosts (McElroy 2009).

Smooth dogfish reproductive potential

The maximum size limit for smooth dogfish is 150 cm TL. Males mature at 2-3 years old (about 82 cm TL) and females mature between 4-7 years old, which is about 90 cm TL (Compagno 1984; Conrath et al. 2002). The length at 50 percent maturity for females is 102 cm TL, while males reach 50 percent maturity at 86 cm TL. Female smooth dogfish have an 11–12 month gestation period with mating occurring between May and September. The fecundity of smooth dogfish ranges between 3 and 18 pups per litter (Conrath and Musick 2002). The size range at birth is between 28 and 39 cm (Rountree and Able, 1996). Marsh creeks may be particularly important to newborn smooth dogfish during June and July. YOY pups grow rapidly in these areas to a size of 55-70 cm TL, prior to migration from the estuaries by the end of October. The abundance of YOY within estuaries strongly suggests that estuaries are critically important nursery habitats for smooth dogfish within the Mid-Atlantic Bight (Rountree and Able, 1996).

6.8.2 Florida smoothhound (*Mustelus norrisi*):

Florida smoothhound is not as well studied, but like smooth dogfish, is most often found in depths ranging from 50 m to 200 m. The species is not as abundant as smooth dogfish and Gulf smoothhound in the Gulf of Mexico and its highest abundance occurs in the eastern Gulf of Mexico, east of the Mississippi River (Jones 2014).

Florida smoothhound reproductive potential:

Male Florida smoothhounds mature around age 3 and females around age 4. The length at 50 percent maturity for females is 75 cm FL, while males reach 50 percent maturity at 69 cm FL. The fecundity of Florida smoothhound ranges between 8 and 14 pups per litter (Jones 2014).

6.8.3 Gulf smoothhound (*Mustelus sinusmexicanus*):

Gulf smoothhound is most often found in depths ranging from 50 m to 200 m. The species is widely distributed in the Gulf of Mexico from Florida Keys to Southern Texas, but abundance is highest in the northwest Gulf of Mexico (Jones 2014).

Gulf smoothhound reproductive potential:

Male Gulf smoothhounds mature around age 3 and females around age 4. The length at 50 percent maturity for females is 59 cm FL, while males reach 50 percent maturity at 54 cm FL. The fecundity of Florida smoothhound ranges between 3 and 10 pups per litter. Based on observations of newborn pups, Gulf smoothhound likely have summer parturition (Jones 2014).

Essential Fish Habitat for the Smoothhound Shark Complex (Gulf of Mexico stock):

Figure G 69

Neonate/YOY, Juvenile, and Adult:

At this time, available information is insufficient for the identification of EFH for this life stage, therefore all life stages are combined in the EFH designation. The smoothhound shark EFH identified in the Gulf of Mexico is for smooth dogfish, Florida smoothhound, and Gulf smoothhound. EFH in the Gulf of Mexico includes offshore areas from Florida to Texas, roughly following the continental shelf break in habitats ranging from 50 to 200m in depth.

Summary of Changes Made to EFH

EFH boundaries published in Amendment 1 have been updated in Final Amendment 10. Amendment 3 (2010) established EFH for a single stock of smooth dogfish. However, the smoothhound shark stock complex was recognized and split into two regional stocks in 2015 due to the results of scientific research presented during the SEDAR 39 stock assessment. NMFS manages each stock complex separately; therefore, delineation of separate EFH boundaries for Atlantic and Gulf of Mexico stock complexes would be consistent with current management strategies. Due to the incorporation of new data into the Kernal Density Estimation/ 95 Percent Volume Contour models and scientific recommendations from the SEFSC and NEFSC EFH boundaries of the Gulf of Mexico and Atlantic smoothhound shark complexes were expanded off the West Florida Shelf and Texas and reduced in the northern Mid-Atlantic Bight, respectively.

There were no changes to EFH boundaries for the Gulf of Mexico and Atlantic smoothhound shark complexes from Draft Amendment 10 to Final Amendment 10.

Essential Fish Habitat for the Smoothhound Shark Complex (Atlantic stock):

Figure G 70

Neonate/YOY, Juvenile, and Adult:

At this time, available information is insufficient for the identification of EFH for this life stage, therefore all life stages are combined in the EFH designation. Smoothhound shark EFH identified in the Atlantic is exclusively for smooth dogfish. EFH in Atlantic coastal areas ranges from Cape Cod Bay, Massachusetts to South Carolina, inclusive of inshore bays and estuaries (e.g., Pamlico Sound, Core Sound, Delaware Bay, Long Island Sound, Narragansett Bay, etc.). EFH also includes continental shelf habitats between southern New Jersey and Cape Hatteras, North Carolina.

Summary of Changes Made to EFH

EFH boundaries published in Amendment 1 have been updated in Final Amendment 10. Amendment 3 (2010) established EFH for a single stock of smooth dogfish. However, the smoothhound shark stock complex was recognized and split into two regional stocks in 2015 due to the results of scientific research presented during the SEDAR 39 stock assessment. NMFS manages each stock complex separately; therefore, delineation of separate EFH boundaries for Atlantic and Gulf of Mexico stock complexes would be consistent with current management strategies. Boundaries of EFH for all the life stages of smoothhound shark complex in the Atlantic were reduced due to the incorporation of new data into the Kernal Density Estimation/ 95 Percent Volume Contour models and scientific recommendations from the NEFSC.

There were no changes to EFH boundaries for the Atlantic smoothhound stock complex from Draft Amendment 10 to Final Amendment 10.

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6.9 Prohibited Sharks

6.9.1 Angel Sharks (*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). The angel shark migrates seasonally from shallow to deep water (Castro, 2011). Baremore et al. (2008) found that teleost fishes dominated the diet of angel sharks of all sizes in the Gulf of Mexico. Squid, crustaceans, and portunid crabs were also eaten by angel sharks of all sizes and in all seasons sampled (Baremore et al. 2010). Accurate age and growth models have not yet been developed (Baremore et al. 2009). NMFS has prohibited the possession of this species in the U.S. Atlantic Ocean, Gulf of Mexico, and Caribbean Sea.

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), but the average litter size is seven (Baremore 2010). The species has a biennial reproductive cycle with a gestation period of approximately 10 to 12 months (Baremore and Carlson 2004 and Baremore 2010). Ebert and Stehman (2013) present a 12 month gestation period followed by a 12 month resting phase after giving birth. Baremore and Carlson (2004) report median length at maturity for males to be 89 cm and for females 83 cm. Birth occurs at depths of 18-27 m during the spring or early summer months (Castro 2011).

Essential Fish Habitat for Atlantic Angel Shark:

Figure G 71

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

Neonate/YOY, Juvenile, and Adult:	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. EFH in the Atlantic Ocean includes continental shelf habitats from Cape May, New Jersey to Cape Lookout, North Carolina. EFH in the Gulf of Mexico ranges from Florida to Mississippi, and from offshore habitats south of eastern Louisiana to the Texas/Mexico border.

Summary of Changes Made to EFH

EFH boundaries published in Amendment 1 have been updated in Final Amendment 10. Boundaries of all life stages for the Atlantic angel shark EFH were expanded in the Gulf of

Mexico and Atlantic due to the incorporation of updated data into the Kernal Density Estimation/ 95 Percent Volume Contour models.

In Final Amendment 10, EFH boundaries are slightly expanded in the northern Gulf of Mexico from those in Draft Amendment 10 due to the incorporation of updated data into the Kernal Density Estimation / 95 Percent Volume Contour models that became available after the publication of Draft Amendment 10.

6.9.2 Basking Sharks (*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 swimming forward 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, 1999; Sims and Quayle, 1998; Sims et al. 2003) and follow annual changes in zooplankton distribution (Sims and Reid 2002). Basking sharks are hypothesized to structure movement patterns in order to maximize utilization of prey resources in preferred habitats (Sims et al*.*, 2006). 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). NMFS has prohibited the possession of whale sharks in the U.S. Atlantic Ocean, Gulf of Mexico, and Caribbean Sea.

In the northwestern and eastern 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, Witt et al. 2012). The temporal and spatial distribution of basking sharks in both the northwestern and eastern 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, Witt et al. 2012). Recent tagging and metabolic studies have shown that basking sharks do not hibernate during the winter; rather they make extensive migrations, often to deeper waters, utilizing productive continental-shelf and shelf-edge habitats. Recent studies have shown for the first time that basking sharks migrated from the Northern to the Southern Hemisphere through satellite tagging and geolocation techniques (Skomal et al. 2009); this considerably extends the known distribution of basking sharks. Skomal et al. (2009) showed that basking sharks moved from southern New England into tropical latitudes of the Bahamas, the Caribbean Sea, and onward to the coast of South America and into the Southern Hemisphere. When in these areas, the basking sharks descended to mesopelagic depths and in some cases remained there for weeks to months at a time (Skomal et al. 2009). Some correlations have been made between numbers of basking shark observations in coastal regions of the Northeast Atlantic and major climactic phenomena, such as the North Atlantic Oscillation (Witt et al. 2012). Distribution data for the basking shark is incomplete largely because the species is not commonly taken by fisheries. In addition, a stock assessment has not been conducted on basking sharks to date; 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). Basking sharks are known to move across the equator (northern hemisphere to southern hemisphere, Skomal et al. 2009) and across the Atlantic Ocean basin (eastern Atlantic to western Atlantic, Gore et al. 2008). Four separate sightings of basking sharks were documented in the northern Gulf of Mexico in March of 2010 and 2011, raising the possibility that basking sharks exhibit seasonal migrations through the Gulf of Mexico (Hoffmayer et al. 2011). Witt et al. (2012) indicate that populations off the coasts of England and Scotland may be increasing based on changes in observed body sizes.

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); however, the age at maturation is not known at this time. 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). Skomal et al. (2009) suggest that extensive migrations may be linked to the reproductive biology of basking sharks. It is believed that female basking sharks give birth to young measuring about 180 cm 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.

Essential Fish Habitat for Basking Shark

Figure G 72

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

Neonate/YOY (≤ 210 cm FL), Juveniles (211 to 887 cm FL) and Adults (> 888 cm FL):

At this time, insufficient data is available to differentiate EFH between size classes; therefore, EFH designations for all life stages have been combined and are considered the same. Atlantic east coast from the Gulf of Maine to the northern Outer Banks of North Carolina, and from mid-South Carolina to coastal areas of northeast Florida. Aggregations of basking sharks were observed from the south and southeast of Long Island, east of Cape Cod, and along the coast of Maine, in the Gulf of Maine and near the Great South Channel, approximately 95 km southeast of Cape Cod, Massachusetts as well as approximately 75 km south of Martha's Vineyard and 90 km south of Moriche's Inlet, Long Island. These aggregations tend to be associated with persistent thermal fronts within areas of high prey density.

Summary of Changes Made to EFH

EFH boundaries published in Amendment 1 have been updated in Final Amendment 10. Boundaries of EFH for all the life stages of basking sharks were added off northern Florida to mid-South Carolina, and adjusted between the Outer Banks, North Carolina and the Gulf of Maine, due to the incorporation of updated data into the Kernal Density Estimation/95 Percent Volume Contour models.

There were no changes to EFH boundaries for basking shark from Draft Amendment 10 to Final Amendment 10.

6.9.3 Bigeye Sand Tiger Shark (*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 lat.; 35° W long.) 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.

Essential Fish Habitat for Bigeye Sand Tiger Shark:

At this time insufficient information is available to describe and identify EFH for this species.

6.9.4 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). Barnett et al. (2012) report a predominately teleost diet for this species. A deep water elasmobranch survey in the Bahamas expanded the depth range for this species to 701 m (Brooks et al. 2015). 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.

Reproductive potential

Females mature at 123–157 cm TL and produce 13–26 pups per reproductive cycle, although the duration of the cycle is unknown. The largest specimen on record is a 178 cm female taken in Indonesia (White and Dharmadi 2010).

NMFS prohibited the possession of bigeye sixgill sharks in the U.S. Atlantic Ocean, Gulf of Mexico, and Caribbean Sea.

Essential Fish Habitat for Bigeye Sixgill Shark:

At this time insufficient information is available to describe and identify EFH for this species.

6.9.5 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), and catch rates were estimated to be significantly higher under El Niño climate conditions than under neutral conditions around the Marshall Islands (Bromhead et al. 2012). 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 that 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). Around the Marshall Islands, Cao et al. (2011) found the optimum water temperature, salinity, and DO range for bigeye threshers to be 10-16 °C, 34.5-34.7 ppt, and 3.0-4.0 mL/L, respectively, during the daytime. The bigeye thresher shark was widely distributed in areas where the DO was higher than 0.5 mL/L (Cao et al. 2011).

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). Carlson and Gulak (2012) describe the movements of a bigeye thresher shark that was tagged in the Gulf of Mexico, which remained around the Mississippi delta offshore during the 120 day tag event. It was found most frequently between 25.5 and 50 m, and 20.05 and 22 °C. 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).

In the Pacific, catch per unit effort (CPUE) was highest beetween 10° and 15° N lat. and 5° and 10° S lat. Juveniles smaller than 150 cm were also distributed in this area. Matsunaga and Yokawa (2013) observed seasonal changes in the distribution of abundance are thought to represent seasonal migrations in latitude. They also observed an increase in the ratio of large individuals at high latitude, likely a result of their increased thermal capacity allowing them to migrate further. Males were captured more often than females, suggesting that there is segregation by sex. Pregnant females were observed from 0° to 36° N lat. in the north Pacific. Neonates were observed between 10° and 15° N lat. and 150° and 180° W long., overlapping with the area in which large numbers of juveniles were captured. Thus, Matsunaga and Yokawa (2013) hypothesized that this area represents the parturition and nursery grounds for bigeye thresher in this region.

Reproductive potential

Males mature at about 270 cm TL and females at about 340 cm TL (Moreno and Morón, 1992; Chen et al. 1997). Fernandez et al. (2015) estimated median size at maturity at 208.6 cm FL for females and 159.2 cm FL for males for bigeye thresher sampled throughout the Atlantic Ocean. Ages at maturity were estimated by Liu et al. (1998) to be 12.3 to 13.4 years for females and 9 to 10 years for males. Pregnant females were recorded in the tropical northeast and southwest Atlantic, with these regions possibly serving as nursery areas (Fernandez et al. 2015). In Indonesian and northwestern Pacific waters, litters consisted of two embryos (Chen et al. 1997; White 2007). The length of the reproductive cycle and the location of nursery areas are unknown.

Fernandez-Carvalho et al. (2011) estimated age and growth of bigeye thresher sharks in the northeast Atlantic using the von Bertalanffy growth model and found the model fit best with the following parameters: the asymptotic maximum FL (L_{inf}) for females to be 293 cm FL and 206 cm FL for males; the growth coefficient (k) to be 0.06 y^{-1} for females and 0.18 y^{-1} for males; and the FL at birth (L_0) to be 111 cm FL for females and 93 cm FL for males.

Essential Fish Habitat for Bigeye Thresher Shark

Figure G 73

Neonate/YOY (≤ 88 cm FL), Juveniles (89 to 295 cm FL), and Adults (≥ 296 cm FL):

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. EFH in the Atlantic Ocean includes offshore pelagic habitats seaward of the continental shelf break between the seaward extent of the U.S. EEZ boundary on Georges Bank (off Massachusetts) to Georgia; and from the Blake Plateau to Biscayne Bay. EFH is association with known habitat conditions including depth (frequently found between 25.5 and 50 m), and temperature (20.05 and 22 °C). EFH in the Gulf of Mexico occurs off the southwestern edge of the West Florida Shelf to Key West, Florida; and between Desoto Canyon and pelagic habitats south of Galveston, Texas.

Summary of Changes Made to EFH

EFH boundaries published in Amendment 1 have been updated in Final Amendment 10. EFH boundaries for bigeye thresher shark were removed in the U.S. Caribbean and expanded in other areas of the Gulf of Mexico and Atlantic due to the incorporation of new data into the Kernal Density Estimation/ 95 Percent Volume Contour models.

There were no changes to EFH boundaries for bigeye thresher shark from Draft Amendment 10 to Final Amendment 10.

6.9.6 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 (Anderson and Stevens, 1996). Bignose sharks have been documented near the bottom at depths of 90-500 m during the 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 (1950) 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 (L. Natanson, NEFSC, unpubl. data). The lengths of the gestation period and of the breeding cycle have not been reported. The location of the nurseries is unknown.

NMFS has prohibited the possession of this species in the U.S. Atlantic Ocean, Gulf of Mexico, and Caribbean Sea.

Essential Fish Habitat for Bignose Shark

At this time insufficient information is available to describe and identify EFH for this species.

6.9.7 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; Driggers et al. 2011). This is a poorly known, bottom-dwelling species that inhabits shallow coastal waters, usually around coral reefs (Castro 1983). Tavares (2009) describes the diet of Caribbean reef sharks as mainly teleosts. Brooks et al. (2013) conducted a tagging study of Caribbean reef sharks in the Bahamas that showed seasonal and demographic habitat use patterns. Bond et al. (2012) also showed strong site fidelity in Caribbean reef sharks in a marine reserve in Belize.

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). 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 EFH for Caribbean reef sharks (Childs 2000).

NMFS has prohibited the possession of this species in the U.S. Atlantic Ocean, Gulf of Mexico, and Caribbean Sea.

Essential Fish Habitat for Caribbean Reef Shark

Figure G 74

Neonate/YOY (≤ 73 cm FL), Juveniles (74 to 163 cm FL), Adults (≥ 164 cm FL):

EFH designation for all life stages have been combined and are considered the same. Atlantic coastal areas along the southern Florida coast. Gulf of Mexico coastal areas along the Florida Keys and the Flower Garden Banks National Marine Sanctuary. The entirety of the U.S. Caribbean, including coastal areas of Puerto Rico and the Virgin Islands.

Summary of Changes Made to EFH

EFH boundaries published in Amendment 1 have been updated in Final Amendment 10. EFH boundaries for Caribbean reef shark were removed in the Florida Straits, the U.S. Caribbean, and in Flower Garden Banks National Marine Sanctuary due to the incorporation of new data into the Kernal Density Estimation/ 95 Percent Volume Contour models, new literature (Driggers et al. 2011), and scientific recommendations from the SEFSC.

There were no changes to EFH boundaries for Caribbean reef shark from Draft Amendment 10 to Final Amendment 10.

6.9.8 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 lat. to 35° S lat., while the Atlantic sharpnose is found at latitudes higher than 24° N lat. Their biology is very similar.

NMFS has prohibited the possession of this species in the U.S. Atlantic Ocean, Gulf of Mexico, and Caribbean Sea; therefore it cannot be retained in commercial or recreational fisheries.

Essential Fish Habitat for Caribbean Sharpnose:

At this time insufficient information is available to describe and identify EFH for this species.

6.9.9 Dusky Shark (*Carcharhinus obscurus*)

The dusky shark inhabits 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 legally caught as a commercial species and a game fish, but is currently prohibited. Benavides et al. (2011) assessed global genetic stock structure in dusky sharks, whereby clearly distinct genetic stocks were identified for three major management units in the U.S. Atlantic, South Africa, and off Australia. This analysis included samples from both U.S. Atlantic (n= 76) and U.S. Gulf of Mexico (n = 26) dusky sharks, and results indicated that sharks from these two regions are genetically similar (i.e., are part of the same genetic stock). Under the most recent SEDAR assessment and its update, dusky sharks are considered a single unit stock and assessed as such (SEDAR 2011, 2016).

Recent tagging work has given insight on the movement of this species. A tagging study by Carlson and Gulak (2012) yielded three PSAT tags with usable data for dusky shark movements One shark made a lengthy migration from southern Florida to the NC/VA border. These sharks spent over half their time in water temperatures between 20.05 and 24 °C and in depths of 0-40 m the majority of the time, although dives up to 400 m were recorded. Hoffmayer et al. (2014) used PSAT tags on 10 dusky sharks in the Gulf of Mexico. The tags showed movements in excess of 200 km, the sharks spending 87 percent of their time between 20 and 125 m depth and 83 percent of their time between 23 and 30 °C. McCandless et al. (2002) showed nursery area characteristics in nearshore waters of North Carolina consisted of temperatures from 18.1 to 22.2 °C, salinities of 25 to 35 ppt at depths of 4.3 to 15.5 m. In cooperation with recreational anglers and NMFS scientists, approximately 7,832 dusky sharks were tagged between 1963 and 2009; of these, 161 dusky sharks were recaptured between 1967 and 2009 (2.1 percent recapture rate) (Kohler and Turner 2010).

In addition, Naylor et al. (2012) completed DNA sequencing suggesting that dusky sharks (*C. obscurus*) and Galapagos sharks (*C. galapagensis*) are likely the same species, and suggest that *C. galapagensis* may represent the oceanic form of *C. obscurus*. G. Naylor (personal communication, College of Charleston, as cited in McCandless et al. (2014)).

Reproductive potential

Males mature at 290 cm TL and reach at least 340 cm TL, while females mature at about 300 cm TL and reach up to 365 cm TL. Dusky sharks are one of the slowest growing requiem sharks. This species matures at approximately age 19 to 21 and may live up to 45 years (Natanson et al. 1995). Natanson et al. (2013) utilized vertebral centra and bomb radiocarbon dating to age dusky sharks, and determined a maximum validated age of 42 years with revised estimates of age at maturity of 17.4 years for males and 17.6 years for females. Litters consist of six to 14 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. For stock assessment purposes, dusky sharks are assumed to have a 3-year reproductive cycle (2 year gestation and 1 year resting) (SEDAR 2011). Natanson (1990) gave the following parameters for males: L_{max}= 351 cm FL (420 cm TL), K= .047, t_o = -5.83; and for females: L_{max}= 316 cm TL (378 cm TL), 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 shark neonates often inhabit nursery areas in coastal waters. For example, Castro (1993) 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. The neritic waters of Massachusetts provide a nursery habitat for dusky sharks, with eastern and southern waters of Martha's Vineyard Island potentially providing suitable secondary habitat to juvenile dusky sharks (MacCandless *et al.* 2002).

NMFS has prohibited the possession of this species in the U.S. Atlantic Ocean, Gulf of Mexico, and Caribbean Sea since 1999. NMFS recently determined that the Northwest Atlantic and Gulf of Mexico population constitutes a distinct population segment (DPS) under the ESA, but does not warrant listing as endangered or threatened under the ESA at this time (79 FR 74684).

Essential Fish Habitat for Dusky Shark:

Figure G 75 – Figure G 76

Neonate/YOY (≤ 98 cm FL): EFH in the Atlantic Ocean includes offshore areas of southern New England to Cape Lookout, North Carolina. Specifically, EFH is associated with habitat conditions including temperatures from 18.1 to 22.2 °C, salinities of 25 to 35 ppt and depths at 4.3 to 15.5 m. Seaward extent of EFH for this life stage in the Atlantic is 60 m in depth.

Juvenile and Adult (> 98 cm FL):

Coastal and pelagic waters inshore of the continental shelf break (< 200 meters in depth) along the Atlantic east coast from habitats offshore of southern Cape Cod to Georgia, including the Charleston Bump and adjacent pelagic habitats. Inshore extent for these life stages is the 20 meter bathymetric line, except in habitats of southern New England, where EFH is extended seaward of Martha's Vineyard, Block Island, and Long Island. Pelagic habitats of southern Georges Bank and the adjacent continental shelf break from Nantucket Shoals and the Great South Channel to the eastern boundary of the United States EEZ. Adults are generally found deeper (to 2000 meters) than juveniles, however there is overlap in the habitats utilized by both life stages.

Offshore waters of the western and north Gulf of Mexico, at and seaward of the continental shelf break (a buffer is included ~10 nautical miles north of the 200 meter bathymetric line), and in proximity to numerous banks along the continental shelf edge (e.g., Ewing and Sackett Bank). The continental shelf edge habitat from Desoto Canyon west to the Mexican border is important habitat for adult dusky sharks.

Summary of Changes Made to EFH
In concert with the stated intent of the EFH provisions in the MSA that EFH only reflect important habitats and not the entire range of a species' distribution, EFH boundaries for neonates/YOY were reduced in the Atlantic to reflect core habitat and distribution areas between Cape Lookout, NC and Cape Cod, Massachusetts based on comments from the NOAA NEFSC (C. McCandless pers comm).EFH boundaries for juvenile and adults were expanded in the western and northern Gulf of Mexico due to scientific recommendations from the SEFSC (E. Hoffmayer and J. Carlson pers. comm, NOAA SEFSC) based on NOAA survey and observer program data. EFH was removed from localized sites along the Florida Panhandle, off Tampa Florida, and from the west Florida Shelf through the Florida Keys to the Florida/Georgia line based on scientific recommendations from the NOAA SEFSC and NEFSC (J. Carlson and C. McCandless pers comm, respectively). EFH boundaries were modified slightly between South Carolina and Georges Bank/United States EEZ due to the incorporation of new data into the Kernal Density Estimation /95 Percent Volume Contour models.

In Final Amendment 10, minor modifications to EFH boundaries were made compared to those proposed in Draft Amendment 10 in the northern Gulf of Mexico close to the western Florida panhandle and Alabama due to relatively small numbers of verified records in this area. EFH boundaries were also modified to reduce the inshore extent and northern extent of dusky shark EFH off New England in consideration of available life history information, distribution data, and public comments received on dusky sharks. Model output published in Draft Amendment 10 as EFH for dusky sharks included Narragansett Bay and parts of Buzzards Bay, however, the salinity of these areas is generally considered to be too low for dusky sharks (C. McCandless, pers. comm, NOAA NEFSC). Parts of Vineyard Sound, Rhode Island Sound, Block Island Sound, and Nantucket Sound were also included, likely as a result of their proximity to a larger cluster of data points located further south and offshore. Generally, dusky sharks are collected in scientific surveys further offshore (C. McCandless, pers. comm, NOAA NEFSC). Therefore, in response to public comment and based on further review of the best available biological information, the EFH boundary designations for dusky shark have been revised to exclude these coastal areas.

6.9.10 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). Benavides et al. (2011) found that Galapagos sharks are morphologically and genetically very similar to dusky sharks. Naylor et al. (2012) completed DNA sequencing suggesting that dusky sharks (*C. obscurus*) and Galapagos sharks (*C. galapagensis*) are likely the same species, and suggest that *C. galapagensis* may represent the oceanic form of *C. obscurus*. G. Naylor (personal communication, College of Charleston, as cited in McCandless et al. (2014)). Corrigan et al. (2014) noted that an ongoing genetic study using mitochondrial DNA sequencing has found that specimens identified as Galapagos sharks from oceanic islands in the northwest Atlantic are indistinguishable from specimens identified as dusky sharks collected off the U.S. east coast from New Jersey to Florida. 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). Pups are born at slightly over 80 cm TL (Dulvy and Reynolds 1997). Litters may range from four to16 pups with the average litter size being 8.7. Juveniles typically inhabit waters shallower than 25 m (Compango 1984). 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.

NMFS has prohibited the possession of this species in the U.S. Atlantic Ocean, Gulf of Mexico, and Caribbean Sea.

Essential Fish Habitat for Galapagos Shark:

At this time insufficient information is available to describe and identify EFH for this species.

6.9.11 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. Although it is primarily found on the Atlantic continental shelf (Garrick 1967; Dodrill and Gilmore 1979; Killam and Parsons 1986), Quieroz et al. (2008) recorded two longfin makos from the mid-North Atlantic. The longfin mako can be found in the western Atlantic off of Florida and the Bahamas throughout the year, and also in the Gulf Stream (Castro, 2011). They have been found as far north as Georges Bank (Mucientes et al. 2013), and Wakida-Kusunoki and de Anda-Fuente (2012) reported a male caught in the southeastern Gulf of Mexico. They have also been found in the eastern Atlantic from Spain to eastern Africa. There are scattered records from the Pacific and western Indian oceans (Ebert and Stehmann 2013).

Prey items determined from stomach contents include porcupine fish and squid (Castro 2011).

Reproductive potential

There is very little data on the reproductive processes of the longfin mako. Castro (2011) reported that all known mature females have been larger than 300 cm, however Mucientes et al. (2013) recorded a mature female of 245 cm TL and a mature male of 229 cm TL. Litters consist of two to eight pups, which may reach 120 cm TL at birth (Castro, unpubl. data).

NMFS has prohibited the possession of this species in the U.S. Atlantic Ocean, Gulf of Mexico, and Caribbean Sea.

Essential Fish Habitat for Longfin Mako Shark:

Figure G 77

Neonate/YOY (≤ 149 cm FL), Juveniles (150 to 225 cm FL), and Adults (≥ 226 cm FL):

EFH in the Atlantic Ocean off seaward of the 200 m depth contour between Cape Cod, Massachusetts and Cape Hatteras, North Carolina; the Blake Plateau off Georgia and Florida; and southern Florida from Miami to the Florida Keys. EFH in the Gulf of Mexico includes areas between the Florida Keys and the southern edge of the West Florida shelf through the Florida Keys, and the central Gulf of Mexico south of Louisiana through the Florida Panhandle (inclusive of the Mississippi River plume).

Summary of Changes Made to EFH
EFH boundaries published in Amendment 1 have been updated in Final Amendment 10. EFH boundaries for all the life stages of longfin mako sharks were reduced in the South Atlantic and Gulf of Mexico due to the incorporation of new data into the Kernal Density Estimation/ 95 Percent Volume Contour models.

There were no changes to EFH boundaries for longfin mako shark from Draft Amendment 10 to Final Amendment 10.

6.9.12 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 from the southwest Atlantic and California coast by Kato et al. (1967) as *C. remotus*, 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 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). The narrowtooth shark uses inshore bays and coasts as nursery areas (Press 2008). 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, but the maximum age is unknown.

NMFS has prohibited the possession of this species in the U.S. Atlantic Ocean, Gulf of Mexico, and Caribbean Sea.

Essential Fish Habitat for Narrowtooth Shark

At this time insufficient information is available to describe and identify EFH for this species.

6.9.13 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). 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.

Reproductive potential

There is little information on night shark reproductive processes. Anecdotal evidence from commercial swordfish fishermen 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 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 were the predominate catch 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).

In 1999, NMFS prohibited the possession of this species in the U.S. Atlantic Ocean, Gulf of Mexico, and Caribbean Sea (NMFS, 1999).

Essential Fish Habitat for Night Shark

Figure G 78

Neonate/YOY (≤ 58 cm FL), Juveniles (59 to 167 cm FL), and Adults (≥ 168 cm FL):

For all life stages the inshore depth extent of EFH is 50m. EFH in the Atlantic Ocean includes areas between Delaware and Georgia, and portions of the southern and mid-east coast of Florida (Blake Plateau). Offshore extent is the 2000 m isobath between Virginia and South Carolina.

EFH in the Gulf of Mexico includes areas spanning from the Florida Keys to the Florida panhandle. In general, EFH is seaward of the southwestern edge of the West Florida Shelf, but comes further inshore in the northern Gulf of Mexico (between the Florida/Alabama line and Cape San Blas).

Summary of Changes Made to EFH
EFH boundaries published in Amendment 1 have been updated in Final Amendment 10. EFH boundaries of all life stages of night shark were expanded in the Atlantic and the eastern Gulf of Mexico due to the incorporation of new data into the Kernal Density Estimation/95 Percent Volume Contour models.

There were no changes to EFH boundaries for night shark from Draft Amendment 10 to Final Amendment 10.

6.9.14 Sand Tiger Shark (*Carcharias taurus*)

The sand tiger shark 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 has NMFS prohibited the possession of this species in the U.S. Atlantic Ocean, Gulf of Mexico, and Caribbean Sea. 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 (Gilmore 1993). The species is a generalized feeder, consuming a variety of teleost and elasmobranch prey (Gelsleichter et al., 1999).

Sand tiger sharks tagged in Delaware Bay spent 95 percent of their time in waters between 17 and 23 °C, with males travelling south to North Carolina in autumn and females moving east to the edge of the continental slope (Teters et al., 2015). Kilfoil et al. (2014) found that tagged sand tiger sharks in Delaware Bay showed site attachment across years and advocates establishment of habitat areas of particular concern. The Cooperative Atlantic States Shark Pupping and Nursery (COASTSPAN) survey conducted in Delaware and New Jersey state waters reports consistent, extensive seasonal use of Delaware Bay by all life stages of sand tigers from 2009 to 2014 (NOAA 2009-2014). McCandless et al. (2002) indicated nursery habitat characteristics in the Delaware Bay consisted of temperatures from 19 to 25 °C, salinities of 23 to 30 ppt at depths of 2.8-7.0 m in sand and mud areas. Kneebone et al. (2012) used PAT tags on juvenile sand tiger sharks to suggest that Plymouth, Kingston, Duxbury Bay constitutes a seasonal nursery area for juvenile sand tigers and warrants the extension of juvenile sand tiger EFH north of Cape Cod, Massachusetts, USA. Movements of juveniles tracked through multiple tagging programs showed extensive seasonal migrations between summer (Maine to Delaware Bay) and winter (Cape Hatteras to central Florida) Kneebone et al. (2014). McCandless et al. (2002) showed nursery area characteristics in nearshore waters of North Carolina consisted of temperatures from 19 to 27 °C, salinities of 30 to 31 ppt at depths of 8.2 to13.7 m in rocky and mud areas and in areas with artificial reefs or wrecks. Jensen et al. (2002) noted that artificial reefs and shipwrecks near the Cape Lookout are seemed to be important nursery habitat for sand tiger sharks. Haulsee et al. (2014) implanted 20 sand tiger sharks with tags that both transmitted and received acoustic signals. These tags showed both shark movement and interactions with tagged sand tiger sharks and other tagged species.

Passerotti et al. (2014) used bomb radiocarbon dating techniques to validate vertebral growth band ages for sand tiger sharks from the western North Atlantic and the southwestern Indian Oceans. They found ages to be accurate up to 12 years, but for larger sharks ages were underestimated up to 18 years. Validated ages of at least 40 years for females and 34 years for males came from this study.

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_0= -2.25; and for females: L_{max}= 323 cm, K= 0.14, and t_0 = -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 shark has an extremely limited reproductive potential, producing only two young per litter (Springer, 1948). 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 northwestern 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 Narragansett Bays as well as coastal sounds. Branstetter and Musick (1994) suggested that the reproductive cycle is biennial, but other evidence suggests annual parturition. Bansemer and Bennett (2009) present evidence for biennial and triennial reproductive cycles of the eastern coast of Australia.

Essential Fish Habitat for Sand Tiger Shark

Figure G 79 – Figure G 80

Neonate/YOY (< 109 cm FL) and Juvenile (109 to 193 cm FL):

Neonate EFH ranges from Massachusetts to Florida, specifically the PKD bay system, Sandy Hook, and Narragansett Bays as well as coastal sounds, lower Chesapeake Bay, Delaware Bay (and adjacent coastal areas), Raleigh Bay and habitats surrounding Cape Hatteras. Juveniles EFH includes habitats between Massachusetts and New York (notably the PKD bay system), and between mid-New Jersey and the mid-east coast of Florida. EFH can be described via known habitat associations in the lower Chesapeake Bay and Delaware Bay (and adjacent coastal areas) where temperatures range from 19 to 25 °C, salinities range from 23 to 30 ppt at depths of 2.8-7.0 m in sand and mud areas, and in coastal North Carolina habitats with temperatures from 19 to 27 °C, salinities from 30 to 31 ppt, depths of 8.2-13.7 m, in rocky and mud substrate or in areas surrounding Cape Lookout that contain benthic structure.

Adults (≥ 194 cm FL): In the Atlantic along the mid-east coast of Florida (Cape Canaveral) through Delaware Bay. Important habitats include lower Chesapeake Bay and Delaware Bay (and adjacent coastal areas) where sand tiger sharks spend 95 percent of their time in waters between 17 and 23 °C. EFH is restricted off the coast of Florida to habitats that are less than 200 meters in depth.

Habitat Area of Particular Concern (HAPC):

(1) Lower portions of Delaware Bay to areas adjacent to the mouth of Delaware Bay for all life stages. The inshore extent of the HAPC reflects a line drawn from Port Mahon east to Egg Point Island (39º11'N lat.), and from Egg Point Island southeast to Bidwell Creek. The HAPC excludes an area rarely used by sand tiger sharks, which is north of a line between Egg Point Island and Bidwell Creek that includes Maurice Cove. The HAPC spans the mouth of Delaware Bay between Cape Henlopen and Cape May, and also includes adjacent coastal areas offshore of Delaware Bay and areas south (between the Indian River inlet and Cape Henlopen, Delaware).

(2) The entire PDK bay system in coastal Massachusetts for neonate/YOY and juvenile sand tiger sharks.

Summary of Changes Made to EFH

EFH boundaries published in Amendment 1 have been updated in Final Amendment 10. Boundaries for the neonate/YOY life stage were expanded from select hotspots located between Massachusetts and North Carolina to a continuous polygon that spans from Massachusetts to Florida due to the availability of new scientific information (tagging data) (C. McCandless pers comm, NOAA NEFSC; Kneebone et al. 2014). Boundaries for juvenile EFH were also adjusted between New Jersey and Massachusetts based on the availability of new scientific information and scientific recommendations from the NOAA NEFSC (C. McCandless pers comm, NOAA NEFSC; Kneebone et al. 2014). Boundaries for the adult life stage were expanded in Onslow Bay, off northeastern South Carolina, off Georgia, and in some parts of coastal Florida due to scientific recommendations from the NOAA NEFSC (C. McCandless pers comm, NOAA NEFSC).

In Final Amendment 10, EFH boundaries for neonate/YOY and juvenile life stages were combined due to new scientific research which indicates that these life stages adopt similar behavioral patterns (C. McCandless pers comm, NOAA NEFSC; Kneebone et al. 2012; Kneebone et al. 2014). The combined neonate/YOY and juvenile EFH boundary was adjusted such that it fully encompassed the spatial extent of the boundaries for each life stage established in Draft Amendment 10. As explained in Section 2.1 under the description of Alternative 2 and in Appendix F (see "Approaches Used to Analyze and Map Data" for a review on how data were adjusted along features), this update was included in response to comments from the SEFSC recommending that these changes be made in order to reflect all available information on distribution and habitat utilization, and thus meets the requirement that these updates be based on the best scientific information.

6.9.15 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 (Compango, 1984). *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 (Compango, 1984). 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 (Compango, 1984).

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 grow to a maximum length of 137 cm TL (Compango, 1984). Size at maturity is about 85 cm for males and 89 to 93 cm for females (Compango, 1984). Maximum size recorded was 214 cm, but was possibly an error (Compango, 1984). 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 sub-adult males. It is believed this indicates the onset of maturity and perhaps sexual activity (Compango, 1984; Frentzel-Beyme and Koster 2002). The lengths of the reproductive and gestation cycles as well as the location of nurseries are unknown.

Essential Fish Habitat for Sevengill Shark

At this time insufficient information is available to describe and identify EFH for this species.

6.9.16 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 by Carey and Clark (1995) and at least 2,500 m by Ebert and Stehmann (2013). Juveniles stray into very shallow, cool waters. Andrews et al. (2009) used PATs on sixgill sharks in Puget Sound and found consistent patterns of diel activity. The tagged sharks were shallower and more active at night, made direst vertical movements at sunrise and sunset, seasonally occupied deeper habitats it autumn and winter versus spring, and were most active during autumn.

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; Compango 1984; Serena 2005).

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 about 482 cm TL (Compango, 1984). Females tend to be slightly larger than males, averaging around 4.3 m in length while males tend to stay near 3.4 m (Baum 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). Tsikliras and Stergiou (2014) noted that Mediterranean sixgill shark length-at-maturity for females and males were 350 cm FL and 300 cm FL, respectively. White and Dharmadi (2010) presented limited data from a study in Indonesia suggested that males attain maturity between 262 and 285 cm TL. 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; Compango, 1984). Reported litter sizes range 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.

Essential Fish Habitat for Sixgill Shark

At this time insufficient information is available to describe and identify EFH for this species.

6.9.17 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 (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. (1999) 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.

Essential Fish Habitat for Smalltail Shark

At this time insufficient information is available to describe and identify EFH for this species.

6.9.18 Whale Sharks (*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). Hsu et al. (2014) used vertebral band counts to establish von Bertalanffy growth parameters of L_∞=15.34 m TL, k=0.021 year^{-1} for both sexes and a longevity estimation of 80.4 years. Whale sharks tagged in the Gulf of Mexico have been tracked over distances at least as far as 7,213 km, moving through the northern Caribbean Sea to the South Atlantic Ocean, and to depths of 1,888 m (Hueter et al.

2013). Schmidt et al. (2009) showed low levels of genetic variation between geographically distinct whale shark populations, suggesting gene flow between populations.

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.

Hoffmayer et al. (2013) and McKinney et al. (2012) summarized the spatial and temporal distribution of whale shark sightings in the northern Gulf of Mexico. Large aggregations (10+ sharks) were reported to exclusively occur during summer along the continental shelf edge, with 41 percent occurring at Ewing Bank. Whale shark aggregations have been documented off of the Yucatan Peninsula of up to 420 individuals feeding on little tunny eggs (de la Parra Venegas et al. 2011). McKinney et al. (2013) investigated whale sharks seasonal habitat use in the northern Gulf of Mexico using both sightings and tagging data to find that their largest home range within the region occurred during summer and fall. Significant use patterns occurred along the continental shelf-edge, encompassing shelf-edge banks south of Louisiana, and near the mouth of the Mississippi River. Habitat suitability modeling efforts by Sequeira et al. (2014) suggest that the northern Gulf of Mexico has a high suitability for whale sharks under current and future environmental modeling scenarios.

Reproductive potential

Joung et al. (1996) indicate that the whale shark is the most prolific of all sharks. Hsu et al. (2014) estimates age at maturity in the Indo-Pacific of 17 years for males and 19-22 years for females. 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.

Essential Fish Habitat for Whale Shark

Figure G 81

Neonate/YOY, Juveniles, and Adults:

Waters off western Florida from Tampa Bay to Charlotte Harbor and the Florida Keys and Straits of Florida. Central Gulf of Mexico from the Florida panhandle to Texas.

Summary of Changes Made to EFH

EFH boundaries published in Amendment 1 have been updated in Final Amendment 10. EFH boundaries for whale shark were expanded in the Gulf of Mexico to include additional offshore areas between the Florida panhandle and Texas, coastal and pelagic waters off west-central peninsular Florida, and the Florida Keys due to incorporation of new data into the Kernal Density Estimation/95 Percent Volume Contour models and scientific recommendations from the SEFSC and NEFSC.

There were no changes to EFH boundaries for whale shark from Draft Amendment 10 to Final Amendment 10.

6.9.19 White Sharks (*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 region the authors identify as the "Mid-Atlantic Bight" (Casey and Pratt, 1985; Curtis et al. 2014). 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; Curtis et al. 2014). White shark sightings are common off New England during the summer (Casey and Pratt, 1985). New research by the Massachusetts Division of Marine Fisheries biologists suggests that tagged white sharks exhibit seasonal site-fidelity over multiple years (Skomal and Chisholm 2014). 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. Water temperatures associated with Atlantic white shark records compiled by Curtis et al. (2014) ranged from 9 to 28 °C and occurred in waters less than 100 m.

A majority (80 percent) of the records associated white sharks with temperatures between 14 and 23 °C, which is thought to be their optimum temperature range. 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. Water temperatures reported in 73 cases of white shark occurrence in Casey and Pratt (1985) ranged from 11 to 24 °C with 75 percent of the occurrences where surface temperatures were between 15 and 22 °C. They suggest that the 15 °C isotherm is the limit in the northern latitudes.

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 than smaller individuals (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° and 43° N lat.) 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 FL 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).

PSAT tagging of white sharks off of South Africa has 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. O'Leary et al. (2015) assessed white shark genetic diversity in the northwest Atlantic and off South Africa, noting that population dynamics are likely more driven by intrinsic reproduction than immigration. Genetic evidence of a population decline was noted for the northwest Atlantic in the mid to late 20th century. 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).

Predator-prey relationships

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 341 cm TL, 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 longer than 300 cm 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).

Off the California coast, large adults prey on seals and sea lions and are sometimes found around seal and sea lion rookeries. Skomal et al. (2012) observed white sharks aggregating in increasing numbers around pinniped colonies that have re-established along the coast of Massachusetts. The white shark is also a scavenger of large dead whales, and there are records of attacks on right whale calves in the southeastern United States (Taylor et al. 2013). Huveneers et al. (2015) noted that white sharks exploit the angle of the sun during predatory approaches and hypothesize this behavior is intended to improve prey detection, avoid retinal overstimulation, and improve concealment upon approach.

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). Other studies have shown white sharks between 108 and 136 cm FL (120-150 cm TL; Francis 1996) at birth, and they are known to reach an adult size of 599 cm FL (640 cm TL; Castro 1983, Compagno 1984). A pregnant female white shark captured by a tunny boat in the Gulf of Gabes (southern Tunisia, central Mediterranean) on February 26 2004 (Saidi et al. 2005) had four developing embryos, three females and one male, ranging in size between 132 and 135 cm TL and weighed between 27.65 and 31.50 kg (Saidi et al. 2005). The embryos exhibited a distended abdomen due to yolk accumulation (Uchida et al. 1996; Saidi et al. 2005). This confirms that the species is known to be 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. Curtis et al. (2014) suggested that large concentrations of YOY and juveniles coupled with diverse prey species in waters of 50 m or less in the New York Bight area could suggest an important nursery area. Domeier and

Nasby-Lucas (2013) were able to track the migratory patterns of adult female white sharks in the Pacific, which comprised a pelagic gestation phase, a coastal pupping phase, movement to an offshore island and an aggregation phase at the offshore island. This behavior matches photo-identification studies that noticed females visiting sites on a two year schedule.

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). Other work has found similar results with Castro (2011) estimating the size at maturity to be about 340 cm for males, and Uchida et al. (1996) estimating size at maturity of 470 for females. 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: $n = 21$, $L_4 = 763.7$ cm, $K = 0.058$, $t_0 = -3.53$. They estimated that a 610 cm TL specimen would be 13 to 14 years old. Casey and Pratt (1985) provided a length-weight curve indicating the white shark is very robust, with its weight increasing an average of 456.4 lb (207 kg) for every 30 cm of length between 415 and 549 cm.

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 (Mollet and Cailliet 2002), and mean generation time was estimated to be 23.1 years. Hamady et al. (2014) found that vertebral bomb radiocarbon dating suggests northwest Atlantic white sharks may live up to, or beyond, 70 years of age. Andrews and Kerr (2015) reanalyzed bomb radiocarbon ages for white sharks in the Pacific, with the largest adult (460.9 cm TL) corresponding to an age minimum between 30 and 37 years. Natanson and Skomal (2015) validated age estimates of white sharks from 77 specimens up to 44 years of age, develop a growth curve for the species and estimate ages at maturity of 26 years for males and 33 years for females, which are much later than previously estimated.

Essential Fish Habitat for White Shark

Figure G 82 – Figure G 83

Neonate/YOY (≤ 159 cm FL): EFH includes inshore waters out to 105 km from Cape Cod, Massachusetts, to an area offshore of Ocean City, New Jersey.

Juveniles (160 – 418 cm FL) and Adults (> 418 cm FL):

Known EFH includes inshore waters to habitats 105 km from shore, in water temperatures ranging from 9 to 28 °C, but more commonly found in water temperatures from 14 to 23 °C from Cape Ann, Massachusetts, including parts of the Gulf of Maine, to Long Island, New York, and from Jacksonville to Cape Canaveral, Florida.

Summary of Changes Made to EFH

EFH boundaries published in Amendment 1 have been updated in Final Amendment 10. EFH boundaries for neonate/YOY were identified separately from juvenile and adult life stages due to distinct differences in behavior, distribution of available data, and scientific recommendations from the NEFSC. Boundaries of the neonate/YOY white shark EFH were adjusted to remove EFH in coastal areas south of New Jersey. Boundaries of the juvenile and adult white shark EFH were modified to remove areas in the Gulf of Mexico, Florida Keys, and mid-Atlantic region due to the incorporation of new data into the Kernal Density Estimation/95 Percent Volume Contour models and scientific recommendations from the NEFSC and SEFSC.

There were no changes to EFH boundaries for white shark from Draft Amendment 10 to Final Amendment 10.

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7 RESEARCH AND INFORMATION NEEDS

Amendment 1 to the 2006 Consolidated HMS FMP outlined a number of research and information needs to improve HMS EFH designation. Amendment 1 noted that, in many cases, movements of HMS are still not well understood or have only been defined in broad terms. Furthermore, although the habitats through which HMS transit may be well 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 HMS, combined with the rarity of some species, has delayed the generation of much of the basic biological and ecological information needed to analyze their habitat affinities.

7.1 EFH Research Priorities

Since publication of Amendment 1 to the 2006 Consolidated HMS FMP, NMFS published the Atlantic HMS Management-Based Research Needs and Priorities document. The document contains a list of near- and long-term research needs and priorities that can be used by individuals and groups interested in Atlantic HMS to identify key research needs, improve management, reduce duplication, prioritize limited funding, and form a potential basis for future funding.

The priorities range from biological/ecological needs to socioeconomic needs and the document can be found at: http://www.nmfs.noaa.gov/sfa/hms/documents/hms_research_priorities_2014.pdf

The Research Needs and Priorities document, along with feedback gathered on the Final Atlantic HMS EFH 5-Year Review and Draft Amendment 10 from NMFS scientists specifically on EFH research needs, were used to develop the following list of research priorities that would support HMS EFH designation and protection:

7.1.1 Priorities for All Atlantic HMS EFH

High Priorities

- Assess long-term socioeconomic and ecological impacts of the Deepwater Horizon oil spill.

Medium Priorities

- Assess the possibility of ecosystem-based assessments and explore the feasibility of ecosystem-based management for all HMS.
- Collect data that would allow for all HMS EFH designations to be based on more than presence/absence data.
- Examine the influence of climate change on range, migration, nursery/pupping grounds, and prey species for HMS in general.
- Collect more data in the U.S. Caribbean to support the identification and description of HMS EFH.
- Investigate new methodologies to designate HMS EFH that account for a range of biases, including effort, data source, spatial, and temporal biases. New methodologies could

include predictive models to expand EFH analyses beyond the areas and times sampled for HMS presence data, and could include the incorporation of environmental data.

7.1.2 Bluefin Tuna EFH

High Priorities

- Enhance information on larval distribution to support stock assessments.
- Determine seasonal migration and localized abundance information including size, distribution, and stock structure.

Medium Priorities

- Investigate potential western Atlantic bluefin tuna spawning sites outside of the Gulf of Mexico. Recent surveys have detected bluefin tuna larvae outside of the Gulf of Mexico, specifically the Slope Sea, possibly indicating additional spawning sites.
- Investigate the relative contribution of spawning sites outside of the Gulf of Mexico to the overall stock of western Atlantic bluefin tuna.
- Investigate the natal origin (i.e., western or eastern stock) of bluefin tuna larvae in the Slope Sea.

Low Priorities

- Examine the feasibility of dynamic area management based on oceanic conditions.

7.1.3 BAYS (Bigeye, Albacore, Yellowfin, and Skipjack) Tunas EFH

High Priorities

- Determine seasonal migration and localized abundance, distribution, and stock structure.

Medium Priorities

- Determine larval distribution.

7.1.4 Billfish EFH

High Priorities

- Determine spawning areas and spawning seasonality, seasonal migration and localized abundance, distribution, and stock structure.

Medium Priorities

- Determine larval distribution through increased sampling and identification of existing samples to higher taxonomic levels.

7.1.5 Swordfish EFH

Medium Priorities

- Determine seasonal migration and localized abundance, distribution, and stock structure.

Low Priorities

- Determine larval distribution.

7.1.6 Shark EFH

High Priorities

- Insufficient information is available to describe and identify EFH for many shark species. Improve data collection for all sharks, especially in areas that are not well-sampled.
- Determine migration and stock structure of all sharks. Consider implications for assessments and management of stocks that straddle multiple national jurisdictional boundaries (e.g., Mexico, Caribbean nations, and the United States).
- Improve life history information of all sharks, particularly commercially and recreationally important species, or species that are caught as bycatch frequently (e.g., fecundity, sex-specific age/length of maturity, pupping grounds, mating grounds, gestation period, reproductive frequency, number of pups); determine if these characteristics have changed over time.
- Monitor stock over spatially broad areas to gain a better understanding of biological and abiotic factors driving distributions in those areas.
- Identify key nursery, feeding, and mating habitats.

Medium Priorities

- Evaluate potential shark nursery habitats using the criteria established in Heupel et al. 2007 to more clearly determine and describe shark nursery habitat. The mere presence of neonate and/or juvenile should not equate to designation of nursery habitat. Criteria for designation should include the following: elevated density, site fidelity, and repeated annual use of habitat areas by sharks in early life stages compared to similar and/or adjacent habitats. Furthermore, multiple nursery areas may need to be defined for some sharks due to habitat differentiation in early stages (neonate, juvenile, etc.).

Low Priorities

- Develop year-round abundance/distribution estimates of sharks in current closed areas or key habitats (e.g., mid-Atlantic shark closure, Charleston Bump); consider how and when sharks use certain key habitat areas.

8 MITIGATION AND UNAVOIDABLE ADVERSE IMPACTS

8.1 Mitigation Measures

According to CEQ guidance,

> “[i]n cases where an environmental assessment is the appropriate environmental document, there still may be mitigation measures or alternatives that would be desirable to consider and adopt even though the impacts of the proposal will not be ‘significant.’ In such cases, the EA should include a discussion of these measures or alternatives to ‘assist [46 FR 18038] agency planning and decisionmaking’ and to ‘aid an agency's compliance with [NEPA] when no environmental impact statement is necessary.’ [40 CFR] Section 1501.3(b), 1508.9(a)(2). The appropriate mitigation measures can be imposed as enforceable permit conditions, or adopted as part of the agency final decision in the same manner mitigation measures are adopted in the formal Record of Decision that is required in EIS cases.”

CEQ. 03/23/81. Council on Environmental Quality - Forty Most Asked Questions Concerning CEQ's NEPA Regulations. Memorandum sent to Agencies.

The actions being considered in this final amendment, to update EFH and update and designate new HAPCs, will not result in any effects on the human environment. No associated management measures are considered in this final amendment that will alter the current use of the environment and there will be no resultant effects. Thus, no mitigation measures are necessary.

8.2 Unavoidable Adverse Impacts

The actions being considered in this final amendment will not result in any unavoidable adverse impacts on the human environment. Since no management measures are being considered in this final amendment that will alter the current use of the environment, there would likely be no unavoidable adverse impacts due to this final amendment.

8.3 Irreversible and Irretrievable Commitment of Resources

There is no irreversible or irretrievable commitment of resources associated with this action. Since no management measures are being considered in this final amendment that will alter the current use of the environment, there will likely be no irreversible or irretrievable commitment of resources due to this final amendment.

9 COMMUNITY PROFILES

Section 102(2)(a) of the National Environmental Policy Act requires Federal agencies to consider the interactions of natural and human environments by using “a systematic, interdisciplinary approach which will ensure the integrated use of the natural and social sciences in planning and decision-making.” Federal agencies should address the aesthetic, historic, cultural, economic, social, or health effects which may be direct, indirect, or cumulative. The Magnuson-Stevens Act also requires, among other matters, consideration of social impacts.

Profiles for HMS fishing communities were included in Chapter 9 of the 2006 Consolidated HMS FMP and updated annually in Chapter 6 of the Atlantic HMS Stock Assessment and Fishery Evaluation Report. The actions being considered in this final amendment will not result in any effects on the human environment. Designation of EFH and HAPCs in itself does not result in any aesthetic, historic, cultural, economic, social, or health effects which may be direct, indirect, or cumulative. Thus, there are no social impacts to consider as a result of this action, and no communities will be disproportionally impacted this action.

10 OTHER CONSIDERATIONS

10.1 Magnuson-Stevens Act: National Standards

NMFS has determined that this action is consistent with the Magnuson-Stevens Act and other applicable laws, subject to further consideration after public comment. The analyses in this document are consistent with the Magnuson-Stevens Act National Standards (NS) (see 50 C.F.R. Part 600, Subpart D for National Standard Guidelines).

NS1 requires NMFS to prevent overfishing while achieving on a continuing basis optimum yield (OY), from each fishery for the U.S. fishing industry. The preferred alternatives in this document to update EFH and update and establish HAPCs do not address, nor are expected to have any impact on, fishing levels or rates.

NS2 requires that conservation and management measures be based on the best scientific information available. The preferred alternatives in this document are consistent with NS2 guidelines. NMFS performed a thorough literature review for information pertaining to HMS EFH to include in the life history section of this document and to modify mapped EFH boundaries. This literature review was formalized as a Draft Atlantic HMS EFH 5-Year Review with a public comment period that encouraged public feedback on the body of literature reviewed, data which should be included in future GIS analyses, EFH delineation methodologies, fishing and non-fishing effects to EFH, and other components of EFH. Following the public comment period, NMFS compiled new information as warranted into a Final Atlantic HMS EFH 5-Year Review. Public feedback was also received at HMS Advisory Panel meetings held in the Fall of 2015 and Spring of 2016, where NMFS briefed Advisory Panel members and members of the public on Atlantic HMS EFH issues and the development of Amendment 10. Furthermore, NMFS contacted a large number of researchers across a variety of fields and institutions to solicit geospatial HMS presence data during the 5-Year Review process and for preparation of the final amendment. This new and updated information and data represents the best scientific information available.

NS3 requires that, to the extent practicable, an individual stock of fish be managed as a unit throughout its range and interrelated stocks of fish be managed as a unit or in close coordination. No management measures are considered as part of this action and it will have no effect on the management units or structure for highly migratory fish stocks.

NS4 requires that conservation and management measures do not discriminate between residents of different states. No management measures are considered as part of this action and it will have no effect on the residents of different states.

NS5 requires that conservation and management measures should, where practicable consider efficiency in the utilization of fishery resources with the exception that no such measure has economic allocations as its sole purpose. No management measures are considered as part of this action and it will present no issues related to efficiency in the utilization of fishery resources.

NS 6 states that conservation and management measures shall take into account and allow for variations among, and contingencies in, fisheries, fishery resources, and catches. No management measures are considered as part of this action.

NS 7 states that conservation and management measures shall, where practicable, minimize costs and avoid unnecessary duplication. No management measures are considered as part of this action.

NS 8 states that conservation and management measures shall, consistent with the conservation requirements of the Magnuson-Stevens Act (including the prevention of overfishing and rebuilding of overfished stocks), take into account the importance of fishery resources to fishing communities in order to provide for the sustained participation of such communities, and to the extent practicable, minimize adverse economic impacts on such communities. No management measures are considered as part of this action.

NS 9 states that conservation and management measures shall, to the extent practicable, minimize bycatch, and to the extent that bycatch cannot be avoided, minimize the mortality of such bycatch. The preferred alternatives in this document are consistent with this NS. No management measures are considered as part of this action.

NS 10 states that conservation and management measures shall, to the extent practicable, promote the safety of human life at sea. No management measures are considered as part of this action

10.2 Consideration of Magnuson-Stevens Act Section 304(g) Measures

Section 304(g) of the Magnuson-Stevens Act sets forth requirements specific to the preparation and implementation of an FMP or FMP amendment for HMS. See 16 U.S.C. 1854(g) for the full text. The summary of the requirements of Section 304(g) and an explanation of how we are consistent with these requirements are below. The impacts of the preferred alternatives and how it meets these requirements are described in more detail in Chapters 2 and 4 of the document.

1. Consult with and consider the views of affected Councils, Commissioners, and advisory groups

During the development of Amendment 10, NMFS consulted with and considered the views of affected Councils, Commissioners, and advisory groups. The Atlantic HMS EFH 5-Year Review was developed and released to consulting parties and HMS Advisory panel (AP) members in June 2015. NMFS presented the 5-Year Review to the HMS AP members at the September 2015 AP meeting to discuss and receive comments. Written comments received on the 5-Year Review and at the HMS AP meeting were considered in the preparation of EA for Amendment 10.

During the public comment period for Amendment 10, NMFS consulted with the five Atlantic Regional Fishery Management Councils, the Atlantic and Gulf of Mexico States Marine Fisheries Commissions, and the HMS Advisory Panel.

2. Establish an advisory panel for each FMP.

As part of the 2006 Consolidated HMS FMP, NMFS combined the Atlantic Billfish and HMS Advisory Panels into one panel. This combined HMS Advisory Panel provides representation from the commercial and recreational fishing industry, academia, non-governmental organizations, state representatives, representatives from the Regional Fishery Management Councils, and the Atlantic and Gulf States Marine Fisheries Commissions and is consulted with for each FMP. NMFS consulted with the established HMS Advisory Panel for this amendment to the 2006 Consolidated HMS FMP.

3. Evaluate the likely effects, if any, of conservation and management measures on participants in the affected fisheries and minimize, to the extent practicable, any disadvantage to U. S. fishermen in relation to foreign competitors.

No management measures are considered as part of this action. Therefore, this requirement is not applicable for this action.

4. With respect to HMS for which the United States is authorized to harvest an allocation, quota, or fishing mortality level under a relevant international fishery agreement, provide fishing vessels with a reasonable opportunity to harvest such allocation, quota, or at such fishing mortality level.

This action does not address or consider harvest rates or fishing access. Therefore, this requirement is not applicable for this action.

5. Review on a continuing basis, and revise as appropriate, the conservation and management measures included in the FMP.

NMFS continues to review the need for any revisions to the existing regulations for Atlantic HMS fisheries.

6. Diligently pursue, through international entities, comparable international fishery management measures with respect to HMS.

No management measures are considered as part of this action. Therefore, this requirement is not applicable for this action.

7. Ensure that conservation and management measures under this subsection:
    a. Promote international conservation of the affected fishery;
    b. Take into consideration traditional fishing patterns of fishing vessels of the United States and the operating requirements of the fisheries;
    c. Are fair and equitable in allocating fishing privileges among United States fishermen and do not have economic allocation as the sole purpose; and
    d. Promote, to the extent practicable, implementation of scientific research programs that include the tagging and release of Atlantic HMS.

No management measures are considered as part of this action. Therefore, these requirements are not applicable for this action.

10.3 Paperwork Reduction Act

There are no public information collection requirements associated with this action.

10.4 E.O. 13132

This action does not contain regulatory provisions with federalism implications sufficient to warrant preparation of a Federalism Assessment under E.O. 13132.

11 LIST OF PREPARERS

The following staff from the Atlantic Highly Migratory Species Management Division of NMFS were involved in the development of this Environmental Assessment:

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The following NMFS staff provided valuable scientific advice that contributed towards the finalization of EFH and HAPC boundaries: Dr. Guillermo Diaz, Dr. Craig Brown, Dr. John Hoolihan, Eric Orbesen, Derke Snodgrass, Dr. Walter Ingram, Dr. David Richardson, Dr. Eric Hoffmayer, Dr. Trey Driggers, Dr. John Carlson, Cami McCandless, Dr. Nancy Kohler, and Dr. Lisa Natanson.

Please contact the HMS Management Division for a complete copy of current regulations for the Atlantic HMS commercial and recreational fisheries:

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12 LIST OF AGENCIES/PERSONS CONSULTED

Discussions relevant to the formulation of the preferred alternatives and the analyses for this document involved input from individuals from several constituent groups and NMFS divisions, including the NOAA Office of General Counsel Fisheries and Protected Resources Section, NMFS Southeast and Northeast Fisheries Science Centers, and the members of the Atlantic HMS Advisory Panel (which include representatives from the commercial and recreational fishing industries, environmental and academic organizations, state representatives, and fishery management councils). NMFS also considered the numerous public comments received at HMS Advisory Panel meetings, Regional Fishery Management Council meetings, Gulf and Atlantic States Marine Fisheries Commission meetings, public hearings, and from individual fishermen and interested parties regarding these issues.

Appendix A Atlantic HMS Stock Status Summaries

Species	**Domestic Stock Status**	**Domestic Outlook**	**Most Recent Assessment**
West Atlantic bluefin tuna	Low recruitment scenario: Not overfished* High recruitment scenario: Overfished*	Low recruitment scenario: Overfishing is not occurring* High recruitment scenario: Overfishing is not occurring*	SCRS; 2014
Atlantic bigeye tuna	Not overfished (Rebuilding)	Overfishing is occurring	SCRS; 2015
Atlantic yellowfin tuna	Not overfished	Overfishing is not occurring	SCRS; 2016
North Atlantic albacore tuna	Not overfished (Rebuilt)	Overfishing is not occurring	SCRS; 2016
West Atlantic skipjack tuna	Not overfished	Overfishing is not occurring	SCRS; 2014
North Atlantic swordfish	Not overfished	Overfishing is not occurring	SCRS; 2013
South Atlantic swordfish	Not overfished	Overfishing is not occurring	SCRS; 2013
Blue marlin	Overfished	Overfishing is occurring	SCRS; 2011
White marlin (and roundscale spearfish)	Overfished	Overfishing is occurring	SCRS; 2012
West Atlantic sailfish	Not Overfished (Rebuilding)	Overfishing is not occurring	SCRS; 2016
Longbill spearfish	*Unknown*	*Unknown*	*1997*
Northwest Atlantic porbeagle sharks	Overfished	Overfishing is not occurring	SCRS; 2009
North Atlantic blue sharks	Not overfished	Overfishing is not occurring	SCRS; 2015
North Atlantic shortfin mako sharks	Not overfished	Overfishing is not occurring	SCRS; 2012
Sandbar sharks	Overfished	Overfishing is not occurring	SEDAR 21; 2011
Gulf of Mexico blacktip sharks	Not overfished	Overfishing is not occurring	SEDAR 29; 2012
Atlantic blacktip sharks	*Unknown*	*Unknown*	SEDAR 11; 2005/2006

Species	**Domestic Stock Status**	**Domestic Outlook**	**Most Recent Assessment**
Dusky sharks	Overfished	Overfishing is occurring	SEDAR 21; 2016
Scalloped hammerhead sharks	Overfished	Overfishing is occurring	Hayes et al. 2009
Atlantic Bonnethead sharks	*Unknown*	*Unknown*	SEDAR 34; 2013
Gulf of Mexico Bonnethead sharks	*Unknown*	*Unknown*	SEDAR 34; 2013
Atlantic sharpnose sharks – Atlantic stock	Not overfished	Overfishing is not occurring	SEDAR 34; 2013
Atlantic sharpnose sharks - Gulf of Mexico stock	Not overfished	Overfishing is not occurring	SEDAR 34; 2013
Atlantic blacknose sharks – Atlantic stock	Overfished	Overfishing is occurring	SEDAR 21; 2011
Atlantic blacknose sharks – Gulf of Mexico stock	*Unknown*	*Unknown*	SEDAR 21; 2011
Finetooth sharks	Not overfished	Overfishing is not occurring	SEDAR 13; 2007
Atlantic smooth dogfish	Not overfished	Overfishing is not occurring	SEDAR 39; 2015
Gulf of Mexico smoothhound shark complex	Not overfished	Overfishing is not occurring	SEDAR 39; 2015

*Future stock productivity is based upon two hypotheses about future recruitment: a “high recruitment scenario” in which future recruitment has the potential to achieve levels that occurred in the early 1970s and a “low recruitment scenario” in which future recruitment is expected to remain near present levels. The SCRS, as stated in the stock assessment, has insufficient evidence to favor either scenario over the other and notes that both are plausible (but not extreme) lower and upper bounds on rebuilding potential.

Literature Cited

Hayes, C.G., Y. Jiao, and E. Cortés. 2009. Stock assessment of scalloped hammerheads in the Western North Atlantic Ocean and Gulf of Mexico. N Amer Journ of Fish Mgmt 29:1406-1417.

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SCRS. 2010. Report of the standing committee on research and statistics. ICCAT SCRS. Madrid, Spain, October 4-8, 2010. 270 pp.

SCRS. 2011. Report of the standing committee on research and statistics. ICCAT SCRS. Madrid, Spain, October 3-7, 2011. 267 pp.

SCRS. 2012a. Report of the standing committee on research and statistics. ICCAT SCRS. Madrid, Spain, October 1-5, 2012. 300 pp.

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SCRS. 2014. Report of the standing committee on research and statistics. ICCAT SCRS. Madrid, Spain, September 29-October 3, 2014. 348 pp.

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SEDAR. 2006. SEDAR 11 complete stock assessment report: HMS Atlantic blacktip shark. SEDAR, 1315 East West Highway, Silver Spring, MD 20910. 387 pp.

SEDAR. 2007. SEDAR 13 complete stock assessment report: HMS Atlantic finetooth shark. SEDAR, 1315 East West Highway, Silver Spring, MD 20910. 395 pp.

SEDAR. 2011a. SEDAR 21 complete stock assessment report: HMS Atlantic blacknose shark. SEDAR, 4055 Faber Place Drive, Suite 201, North Charleston, SC 29405. 438 pp.

SEDAR. 2011b. SEDAR 21 complete stock assessment report: HMS dusky sharks. SEDAR, 4055 Faber Place Drive, Suite 201, North Charleston, SC 29405. 414 pp.

SEDAR. 2011c. SEDAR 21 complete stock assessment report: HMS Gulf of Mexico blacknose shark. SEDAR, 4055 Faber Place Drive, Suite 201, North Charleston, SC 29405. 415 pp.

SEDAR. 2011d. SEDAR 21 complete stock assessment report: HMS sandbar shark. SEDAR, 4055 Faber Place Drive, Suite 201, North Charleston, SC 29405. 459 pp.

SEDAR. 2012. SEDAR 29 stock assessment report: HMS Gulf of Mexico blacktip sharks. SEDAR, 4055 Faber Place Drive, Suite 201, North Charleston, SC 29405. 152 pp.

SEDAR. 2013a. SEDAR 34 stock assessment report: HMS Atlantic Sharpnose Shark. SEDAR, 4055 Faber Place Drive, Suite 201, North Charleston, SC 29405. 298pp.

SEDAR. 2013b. SEDAR 34 stock assessment report: HMS Bonnethead Shark. SEDAR, 4055 Faber Place Drive, Suite 201, North Charleston, SC 29405. 278pp.

SEDAR. 2015a. SEDAR 39 Stock Assessment Report: HMS Atlantic Smooth Dogfish. SEDAR, 4055 Faber Place Drive, Suite 201, North Charleston, SC 29405. 325pp.

SEDAR. 2015b. SEDAR 39 Stock Assessment Report: HMS Gulf of Mexico Smoothhound Sharks. SEDAR, 4055 Faber Place Drive, Suite 201, North Charleston, SC 29405. 337pp.SEDAR. 2016. SEDAR 21 Update Assessment to SEDAR 21: HMS Dusky Shark. SEDAR, 4055 Faber Place Drive, Suite 201, North Charleston, SC 29405. 64pp

SCRS reports are available online at: http://www.iccat.int/en/meetings.asp. All SEDAR reports are available online at: http://www.sefsc.noaa.gov/sedar/. Detailed stock assessments are available at these websites:

Atlantic Bigeye Tuna

Assessed by ICCAT's SCRS in 2015: http://www.iccat.int/Documents/Meetings/Docs/2015_BET%20ASSESS_REPORT_ENG.pdf

Atlantic Blacktip Sharks

Assessed in 2006 through the SEDAR process: http://sedarweb.org/sedar-11

Atlantic Sharpnose Sharks (Atlantic and Gulf of Mexico)

Assessed in 2013 through the SEDAR process: http://sedarweb.org/sedar-34

Atlantic Yellowfin Tuna

Assessed by ICCAT's SCRS in 2011: http://www.iccat.int/Documents/Meetings/Docs/2011_YFT_ASSESS_REP.pdf

Blacknose Sharks (Atlantic and Gulf of Mexico)

Assessed in 2010/2011 through the SEDAR process: http://sedarweb.org/sedar-21

Blue Marlin

Assessed by ICCAT's SCRS in 2011: http://www.iccat.int/Documents/Meetings/Docs/2011_BUM_ASSESS_ENG.pdf

Bonnethead Sharks (Atlantic and Gulf of Mexico)

Assessed in 2013 through the SEDAR process: http://sedarweb.org/sedar-34

Dusky Sharks

Assessed in 2016 through the SEDAR process: http://sedarweb.org/sedar-21u*Finetooth Sharks*

Assessed in 2007 through the SEDAR process: http://sedarweb.org/sedar-13

Gulf of Mexico Blacktip Sharks

Assessed in 2012 through the SEDAR process: http://sedarweb.org/sedar-29

Longbill Spearfish

Longbill spearfish have not been individually assessed by ICCAT's SCRS due to the paucity of data. Some information can be found in the 2009 sailfish stock assessment: https://www.iccat.int/Documents/SCRS/DetRep/DET-SAI.pdf

North Atlantic Albacore Tuna

Assessed by ICCAT's SCRS in 2013:
http://www.iccat.int/Documents/Meetings/Docs/2013_ALB_ASSESS_REP_ENG.pdf

North Atlantic Blue Sharks

Assessed by ICCAT's SCRS in 2015:
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North Atlantic Shortfin Mako Sharks

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North Atlantic Swordfish

Assessed by ICCAT's SCRS in 2013:
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Northwest Atlantic Porbeagle Sharks

Assessed by ICCAT's SCRS in 2009:
http://www.iccat.int/Documents/Meetings/Docs/2009_POR_ASSESS_ENG.pdf

Sandbar Sharks

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Scalloped Hammerhead Sharks

Assessed in Hayes et al. (2009).

Smoothhound Sharks (Atlantic and Gulf of Mexico)

Assessed through the SEDAR process in 2015: http://sedarweb.org/sedar-39

South Atlantic Swordfish

Assessed by ICCAT's SCRS in 2013:
http://www.iccat.int/Documents/Meetings/Docs/2013_SWO_ASSESS_REP_ENG.pdf

West Atlantic Sailfish

Assessed by ICCAT's SCRS in 2009:
http://www.iccat.int/Documents/Meetings/Docs/2009_SAI_ASSESS_ENG.pdf

West Atlantic Skipjack Tuna

Assessed by ICCAT's SCRS in 2014:
http://iccat.int/Documents/Meetings/Docs/2014_SKJ_ASSESS_ENG.pdf
http://www.iccat.int/Documents/SCRS/DetRep/DET-YFT-SKJ.pdf

Western Atlantic Bluefin Tuna

Assessed by ICCAT's SCRS in 2014:
http://www.iccat.int/Documents/Meetings/Docs/2014_BFT_ASSESS-ENG.pdf

White Marlin and Roundscale Spearfish

Assessed by ICCAT's SCRS in 2012:
http://www.iccat.int/Documents/Meetings/Docs/2012_WHM_ASSESS_ENG.pdf

Appendix B Size Ranges for Life Stages of Sharks

This appendix provides size ranges used to characterize different life stages of sharks: neonate/YOY, juvenile, and adult. Size breaks between neonate/YOY and juvenile were determined either by using a reported size for YOY sharks, or by using the methodology identified in Amendment 1 for estimation YOY size from embryos (i.e., reported embryo size + 10 percent). Size breaks between juvenile and adult size classes were determined from reported length at 50 percent maturity of female sharks; if this metric was unavailable, then papers reporting length at first maturity were referenced.

Large Coastal Sharks		**Young-of-the-year** **FL (cm) ≤**	**Juveniles** **FL (cm) =**	**Adults** F 50% mat or max range at 1st maturity **FL (cm) ≥**	Young-of-the- year size range **FL (cm) =**	Embryo size range or maximum embryo size in term females **FL (cm) =**	Length at 1st maturity or range at 50% maturity **FL (cm) =**	**References**
Basking *Cetorhinus maximus*		210	211-887	888		126-172	732-888	Sund (1943) cited in Francis & Duffy (2002), Compagno (1984) and Natanson *et al.* (2008)
Bigeye Sand Tiger* *Odontaspis noronhai*		**	**	**				
Bignose *Carcharhinus altimus*		80	81-172	173		64-80	173-235	Compagno (1984), Crow *et al.* (1996) and Kohler *et al.* (1996)
Blacktip *Carcharhinus limbatus*	Gulf of Mexico	61	61-118	119	45-61	47-51****	119	SEDAR 29 (2012), Baremore & Passerotti (2013), Bethea *et al.* (2014), Carlson *et al.* (2005) and Castro (1993b) & (1996)
	Atlantic	59	60-125	126	43-59	45-49****	126	Castro (1996) and Carlson *et al.* (2006)
Bull *Carcharhinus leucas*		77	78-188	189	59-77		189	Branstetter & Stiles (1987), Froeschke *et al.* (2010) and Natanson (2014)
Caribbean Reef *Carcharhinus perezi*		73	74-163	164	58-73		164	Garla *et al.* (2006), Compagno (1984), Tavares (2009)
Dusky *Carcharhinus obscurus*		98	99-226	227	56-98		227	Simpfendorfer (2000), Ulrich *et al.* (2007) and J. Romine pers. comm. cited in Natanson *et al.* (2014)
Galapagos* *Carcharhinus galapagensis*		78	79-176	177		65	177-203	Wetherbee *et al.* (1996), McCandless pers. comm. (2016) and Kohler *et al.* (1995)

Large Coastal Sharks	**Young-of-the-year** **FL (cm) ≤**	**Juveniles** **FL (cm) =**	**Adults** F 50% mat or max range at 1st maturity **FL (cm) ≥**	Young-of-the- year size range **FL (cm) =**	Embryo size range or maximum embryo size in term females **FL (cm) =**	Length at 1st maturity or range at 50% maturity **FL (cm) =**	**References**
Great Hammerhead *Sphyrna mokarran*	< 224		224			224	Compagno (1984), Miller *et al.* (2014), Piercy and Carlson, unpublished data; Carlson pers. comm.
Lemon *Negaprion brevirostris*	75	76-200	201	49-75	55	201	Freitas *et al.* (2006), Hueter & Tyminski (2002), Clarke & von Schmidt (1965) and Compagno (1984)
Narrowtooth* *Carcharhinus brachyurus*	**	**	**				
Night *Carcharhinus signatus*	42-58	59-167	168	42-58		168-172	Hazin *et al.* (2000), Raschi *et al.* (1982), Kohler *et al.* (1996) and Carlson *et al.* (2008)
Nurse *** *Ginglymostoma cirratum*	TL ≤ 52 cm	TL = 53-230	TL ≥ 231	28-52	28-30.5	222-231	Pratt & Carrier (2002), Castro (2000) and Hueter (1994)
Sandbar *Carcharhinus plumbeus*	66	67-154	155	39-66	64	154.9	Merson (1998), Castro (1993b), Baremore and Hale (2012) and Kohler et al. (1996)
Sand Tiger *Carcharhinus taurus*	108	109-193	194	79-108	89	185-194	Gilmore *et al.* (1983) and Goldman *et al.* (2006)
Scalloped Hammerhead *Sphyrna lewini*	45	46-139	140	31-46	23-31	140	Piercy *et al.* (2007) and Miller *et al.* (2013)
Silky *Carcharhinus falciformis*	74	75-201	202	51-74	61	191-202	Bonfil *et al.* (1993) and Kohler *et al.* (1996)
Smooth Hammerhead *Sphyrna zygaena*	68	69-199	200	68	43	180-200	Piercy pers. comm. in CITES (2013), Compagno (1984), , Coelho *et al.* (2011) and Ebert & Stehmann (2013)

Large Coastal Sharks	**Young-of-the-year** **FL (cm) ≤**	**Juveniles** **FL (cm) =**	**Adults** F 50% mat or max range at 1st maturity **FL (cm) ≥**	Young-of-the- year size range **FL (cm) =**	Embryo size range or maximum embryo size in term females **FL (cm) =**	Length at 1st maturity or range at 50% maturity **FL (cm) =**	**References**
Spinner *Carcharhinus brevipinna*	57	58-150	151	44-57	44	151	Carlson & Baremore (2005)
Tiger *Galeocerdo cuvier*	101	102-266	267	101		263-267	Driggers et al. (2008); J. Carlson and C. McCandless, pers comm; Kneebone *et al.* (2008)
Whale *Rhincodon typus*	**	**	**				
White *Carcharodon carcharias*	159	160-418	419	159	136	419	Kohler *et al.* (1996); Francis (1996); Pratt (1996); Wintner & Cliff (1999);Curtis *et al.* (2014)

Small Coastal Sharks		**Young-of-the-year** **FL (cm) ≤**	**Juveniles** **FL (cm) =**	**Adults** F 50% mat or max range at 1st maturty **FL (cm) ≥**	Young-of-the- year size range **FL (cm) =**	Embryo size range or maximum embryo size in term females **FL (cm) =**	Length at 1st maturity or range at 50% maturity **FL (cm) =**	**References**
Atlantic Angel *Squatina dumeril*		< 81		81			81	Baremore (2010)
Atlantic Sharpnose *Rhizoprionodon terraenovae*	Gulf of Mexico	49	50-61	62	26-49	25	62.3	SEDAR (2013), Carlson & Baremore (2003) & Loefer & Sedberry (2003)
	Atlantic	51	52-59	60	27-51	27	60.5	SEDAR (2013), Carlson & Baremore (2003) & Loefer & Sedberry (2003)
Blacknose *Carcharhinus acronotus*	Gulf of Mexico	45	46-84	85	37-45	37	85	Carlson *et al.* (1999), Driggers (2010) and Bethea *et al.* (2014)
	Atlantic	42	43-90	91	42-51	42	91	Carlson *et al.* (1999); M. Grace, unpublished; and Driggers *et al.* (2010)
Bonnethead	Gulf of Mexico	45	46-65	66		40.4	66.3	Lombardi (2007)

Small Coastal Sharks		**Young-of-the-year** **FL (cm) ≤**	**Juveniles** **FL (cm) =**	**Adults** F 50% mat or max range at 1st maturty **FL (cm) ≥**	Young-of-the- year size range **FL (cm) =**	Embryo size range or maximum embryo size in term females **FL (cm) =**	Length at 1st maturity or range at 50% maturity **FL (cm) =**	**References**
Sphyrna tiburo	Atlantic	31	32-81	82		27.8	81.6	Frazier *et al.* (2013)
Caribbean Sharpnose* *Rhizoprionodon porosus*		**	**	**				
Finetooth *Carcharhinus isodon*		68	69-102	103	53-69	43	103	Carlson *et al.* (2003), Drymon *et al.* (2006), Castro (1993a) & Hendon *et al.* (2014)
Smalltail* Carcharhinus porosus		**	**	**				

Pelagic Sharks	**Young-of-the-year** **FL (cm) ≤**	**Juveniles** **FL (cm) =**	**Adults** F 50% mat or max range at 1st maturty **FL (cm) ≥**	Young-of-the- year size range **FL (cm) =**	Embryo size range or maximum embryo size in term females **FL (cm) =**	Length at 1st maturity or range at 50% maturity **FL (cm) =**	**References**
Bigeye Sixgill* *Hexanchus nakamurai*	**	**	**				Springer & Waller (1969)
Bigeye Thresher *Alopias superciliosus*			216			209-216	Stillwell & Casey (1976), Moreno & Moron (1992)
Blue *Prionace glauca*	76	77-184	185	30-76	46.61	185	Stevens (1975), Silva (1996), Skomal & Natanson (2003) and Pratt (1979)
Bluntnose Sixgill* **Hexanchus griseus**	**	**	**				
Common Thresher *Alopias vulpinus*	111	112-212	213		94	213	Moreno *et al.* (1989), Gervelis (2005)
Longfin Mako *Isurus paucus*			225			225	Guitart-Manday (1966)
Oceanic Whitetip *Carcharhinus longimanus*	68	69-179	180	42-68	55	180	Leesa *et al.* (1999), Seki *et al.* (1998), ICCAT (2014)^

Pelagic Sharks	**Young-of-the-year FL (cm) ≤**	**Juveniles FL (cm) =**	**Adults** F 50% mat or max range at 1st maturty **FL (cm) ≥**	Young-of-the- year size range **FL (cm) =**	Embryo size range or maximum embryo size in term females **FL (cm) =**	Length at 1st maturity or range at 50% maturity **FL (cm) =**	**References**
Porbeagle *Lamna nasus*	105	106-196	197	57-105	66	197	Jensen *et al.* (2002), Natanson *et al.* (2002)
Sharpnose Sevengill* **Heptranchias perlo**	**	**	**				
Shortfin Mako *Isurus oxyrinchus*	128	129-274	275	64-128	70	275	Duffy & Francis (2001), Natanson et al. (2006), ICCAT (2014)^
Smoothhound Shark Complex (GOM) includes smooth dogfish, gulf smoothhound, and narrowfin smoothhound	44	45-74	75			75	Jones et al. 2014 (SEDAR31-DW-22); SEDAR39-DW-22; Kohler *et al.* (2014)
Smooth Dogfish (Atlantic) *Mustelus canis*	52	53-88	89				Conrath and Musick (2002), as cited in SEDAR 2015

*Insufficient data to designate EFH.

**Insufficient data to determine life stage size breaks and life history conversion factors.

***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 cm TL). This litter was not included because it was unusually large for this species.

^ICCAT manual, with notations on life history parameters. https://www.iccat.int/Documents/SCRS/Manual/Appendices/Appendix%204%20III_SHK.pdf

Species	**Citation**
Atlantic Angel	Baremore, I.E. (2010) Reproductive aspects of the Atlantic angel shark Squatina dumeril. Journal of Fish Biology, 76 (7): 1682-1695.
Atlantic Sharpnose	Carlson, J.K. and Baremore, I.E. 2003. Changes in the biological parameters of Atlantic sharpnose shark Rhizoprionodon terraenovae in the Gulf of Mexico: evidence for density-dependent growth and maturity? Marine and Freshwater Research 54:227-234.
Atlantic Sharpnose	Loefer, J.K. and G.R. Sedberry. 2003. Life history of the Atlantic sharpnose shark (Rhizoprionodon terraenovae) (Richardson, 1836) off the southeastern United States. Fish. Bull. 101(1):75-88.
Atlantic Sharpnose	[SEDAR] Southeast Data, Assessment and Review. 2013. SEDAR 34 Stock Assessment Report: Atlantic Sharpnose Sharks. SEDAR, North Charleston, SC.

Species	Citation
Basking	Francis, M.P. and C. Duffy. 2002. Distribution, seasonal abundance and bycatch of basking sharks (Cetorhinus maximus) in New Zealand, with observations on their winter habitat. Marine Biology 140:831-842.
Basking	Natanson, L. J., S.P. Wintner, F. Johansson, A. Piercy, P. Campbell, A.de Maddalena, S.J.B. Gulak, B. Human, F.C. Fulgosi, D.A. Ebert, F. Hemida, F.H. Mollen, S. Vanni, G.H. Burgess, L.J.V. Compagno, and A. Wedderburn-Maxwell. 2008. Ontogenetic vertebral growth patterns in the basking shark *Cetorhinus maximus*. Marine Ecology Progress Series, 361: 267-278.
Basking, Great Hammerhead, Smooth Hammerhead, Bignose, Caribbean Reef, Lemon	Compagno, L.J.V. 1984. FAO Species Catalog Vol. 4 Part 1: Sharks of the world: an annotated and illustrated catalogue of shark species known to date. FAO Fisheries Synopsis 125. FAO, Rome, Italy. 249pp. http://www.fao.org/docrep/009/ad122e/ad122e00.HTM
Bigeye Sixgill	Springer, S. and Waller, R.A. 1969. *Hexanchus vitulus*, a new sixgill shark from the Bahamas. Bulletin of Marine Science 19(1):159-174.
Bigeye Thresher	Moreno, J.A. and Moron, J. 1992. Reproductive biology of the bigeye thresher shark, Alopias superciliosus (Lowe, 1839). Aust. J. Mar. Freshwater Res. 43:77-86.
Bigeye Thresher	Stillwell, C.E., and Casey, J.G. 1976. Observations on the bigeye thresher shark, Alopias superciliousus, in the western North Atlantic. Fish. Bull. 74(1):221-225.
Bignose	Crow, G.L., C.G. Lowe, and B.M. Wetherbee. 1996. Shark records from longline fishing programs in Hawai'I with comments on Pacific Ocean distributions. Pacific Science 50(4):382-392.
Blacknose	Carlson, J.K., Cortés, E. and Johnson, A.G. 1999. Age and growth of the blacknose shark, Carcharhinus acronotus, in the eastern Gulf of Mexico. Copeia 1999:684-691.
Blacknose	Driggers III, W.B., Carlson, J.K., Frazier, B., Ingram, G.W., Quattro, J.M., Sulikowski, J.A., Ulrich, G.F. 2010. Life history and population structure of blacknose sharks, *Carcharhinus acronotus*, in the western North Atlantic Ocean. SEDAR Working Document, SEDAR 21- DW-36.
Blacktip	Baremore, I.E. & Passerotti, M.S. 2013. Reproduction of the Blacktip Shark in the Gulf of Mexico. Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science, 5 (1): 127-138.
Blacktip	Carlson, J.K., Sulikowski, J.R., Baremore, I.E. 2005. Life history parameters for blacktip sharks, Carcharhinus limbatus, from the United States South Atlantic Bight and Eastern Gulf of Mexico. Large Coastal Shark SEDAR Data Workshop Document: LCS05/06-DW-10. National Marine Fisheries Service. Panama City, FL. 10pp.
Blacktip	Carlson, J.K., Sulikowski, J.R. & Baremore, I.E. 2006. Do differences in life history exist for blacktip sharks, Carcharhinus limbatus, from the United States South Atlantic Bight and Eastern Gulf of Mexico? Environmental Biology of Fishes, 77 (3-4): 279-292.
Blacktip	Castro, J.I. 1996. Biology of the blacktip shark, Carcharhinus limbatus, off the southeastern United States. Bulletin of Marine Science 59(3):508-522.

Species	Citation
Blacktip	Southeast Data, Assessment and Review. (SEDAR) 29. 2012. HMS Gulf of Mexico Blacktip Shark. May 2012. http://www.nmfs.noaa.gov/sfa/hms/species/sharks/documents/s29_gom_blacktip_report_sar_final.pdf
Blacktip, Blacknose	Bethea D.M., Ajemian M.J., Carlson J.K., Hoffmayer E.R., Imhoff J.L., Grubbs R.D., Peterson C.T., Burgess G.H. 2014. Distribution and community structure of coastal sharks in the northeastern Gulf of Mexico. Environ Biol Fish DOI: 10.1007/s10641-014-0355-3.
Blacktip, Sandbar	Castro, J.I. 1993b. The shark nursery of Bulls Bay, South Carolina, with a review of the shark nurseries of the southeastern coast of the United States. Environmental Biology of Fishes 38:37-48.
Blue	Pratt, Jr., H.L. 1979. Reproduction in the blue shark, Prionace glauca. Fishery Bulletin 77(2):445-470.
Blue	Silva, A.A., Silva, H.M. and Erzini, K. 1996. Some results on the biology of the blue shark, Prionace glauca, in the North Atlantic based on data form a research cruise of the R/V Arquipelago in Azorean waters: a summary paper, 9 pp. Universidade dos Azores, Horta, Azores, Portugal.
Blue	Skomal, G.B. and L.J. Natanson. 2003. Age and growth of the blue shark (Prionace glauca) in the North Atlantic Ocean. Fish. Bull. 101:627-639.
Blue	Stevens, J.D. 1975. Vertebral rings as a means of age determination in the blue shark (Prionace glauca L.) of southwest England. J. Mar. Biol. Assoc. U.K. 53:357-361.
Bonnethead (ATL)	Frazier, B.S., D.H. Adams, W.B. Driggers, III, C.M. Jones, J.K. Loefer, L.A.Lombardi. 2013. Validated age and growth of the bonnethead (Sphyrna tiburo) in the western North Atlantic Ocean. SEDAR34-WP-07. SEDAR, North Charleston, SC. 29 pp.
Bonnethead (GOM)	Lombardi-Carlson LA. 2007. Life history traits of bonnethead sharks, Sphyrna tiburo, from the eastern Gulf of Mexico. SEDAR13-DW-24, SEDAR, North Charleston, SC.
Bull	Branstetter, S. and R. Stiles. 1987. Age and growth estimates of the bull shark, Carcharhinus leucas, from the northern Gulf of Mexico. Env. Biol. Fish. 20(3):169-181.
Bull	Froeschke, J.T. & Stunz, G.W. & Sterba-Boatwright, B. & Wildhaber, M.L. 2010. An empirical test of the "shark nursery area concept" in Texas bays using a long-term fisheries-independent data set. Aquatic Biology, 11 (1): 65-76.
Bull	Natanson, L.J., Adams, D.H., Winton, M.V., and Maurer, J.R. 2014. Age and Growth of the Bull Shark in the Western North Atlantic Ocean, Transactions of the American Fisheries Society, 143:3, 732-743.

Species	Citation
Caribbean Reef	Garla, R.C., D.D. Chapman, M.S. Shivji, B.M. Wetherbee, A.F. Amorim. 2006. Habitat of juvenile Caribbean reef sharks, Carcharhinus perezi, at two oceanic insular marine protected areas in the southwestern Atlantic Ocean: Fernando de Noronha Archipelago and Atol das Rocas, Brazil. Fisheries Research 81(2-3):236-241.
Caribbean Reef	Tavares R 2009. Fishery biology of the Caribbean reef sharks, Carcharhinus perezi (Poey, 1876), in a Caribbean insular platform: Los Roques Archipelago National Park, Venezuela. Panam J Aquat Sci 4:500–512.
Common Thresher	Gervelis, B.J. 2005. Age and Growth of the Thresher Shark, Alopias Vulpinas, in the Northwest Atlantic Ocean. Master's Thesis. University of Rhode Island, Kingston, Rhode Island.
Common Thresher	Moreno, J.A., Parajua, J.I., and Moron, J. 1989. Biologia reproductiva y fenologia de Alopias vulpinus (Bonnaterre, 1788) (Squaliformes: Alopiidae) en el Atlantico nor-oriental y Mediterraneo occidental. Scientia Marina (Barcelona) 53(1):37-46.
Dusky	Natanson, L. J., B. J. Gervelis, M. V. Winton, L. L. Hamady, S. J. B. Gulak, and J. K. Carlson. 2014. Validated age and growth estimates for Carcharhinus obscurus in the northwestern Atlantic Ocean, with pre- and post management growth comparisons. Environ. Biol. Fish., 97, 881-896, doi: 10.1007/s10641-013-0189-4.
Dusky	Simpfendorfer, C.A. 2000. Growth rates of juvenile dusky sharks, Carcharhinus obscurus (Lesueur, 1818), from southwestern Australia estimated from tag recapture data. Fish. Bull. 98(4):9=811-822.
Dusky	Ulrich, G. F., C.M. Jones, W.B. Driggers, III, M. Drymon, D. Oakley, C. Riley. 2007. Habitat utilization, relative abundance, and seasonality of sharks in the extuarine and nearshore waters of South Carolina. In C.T. McCandless, N.E. Kohler, and H.L.Pratt Jr.(editors): Shark nursery grounds of the Gulf of Mexico and the East Coast waters of the United States. American Fisheries Society Symposium 50, Bethesda, Maryland.
Finetooth	Carlson, J.K., E. Cortés & D. Bethea. 2003. Life history and population dynamics of the finetooth shark, Carcharhinus isodon, in the northeast Gulf of Mexico. Fishery Bulletin 101:281-292.
Finetooth	Castro, J.I. 1993a. The biology of the finetooth shark, Carcharhinus isodon. Environmental Biology of Fishes 36:219-232.
Finetooth	Drymon, J.M., Driggers, W.B., Oakley, D., Ulrich, G.F. 2006. Investigating differences in life history parameters among small coastal sharks: comparing the finetooth shark, *Carcharhinus isodon*, between the Gulf of Mexico and the Northwest Atlantic Ocean. Gulf of Mexico Science 2006 (1/2): 2-10.
Finetooth	Hendon, J., Higgs, J., Sulikowski, J. 2014. A cooperative approach to updating and investigating anomalies in critical life history parameters of two exploited shark species, Blacknose and Finetooth sharks in the northern Gulf of Mexico. NOAA/NMFS Cooperative Research Program Final Report, 31 pp.

Species	Citation
Galapagos	Kohler, N.E. & Casey, J.G. & Turner, P.A. 1995. Length-weight relationships for 13 species of sharks from the western North Atlantic. Fishery Bulletin, 93 (2); 412-418, tabs 1-3.
Galapagos	Wetherbee, B.M., G.L. Crow, and C.G. Lowe. 1996. Biology of the Galapagos shark, Carcharhinus galapagensis, in Hawaii. Env. Biol. Fish. 45:299-310.
Great Hammerhead	Miller, M.H., Carlson, J., Hogan, L. and D. Kobayashi. 2014. Status review report: great hammerhead shark (*Sphyrna mokarran*). Final Report to National Marine Fisheries Service, Office of Protected Resources. June 2014. 116 pp.
Lemon	Clarke, E. and K. von Schmidt. 1965. Sharks of the central Gulf coast of Florida. Bulletin of Marine Science 15(1):13-83.
Lemon	Freitas, R.H.A., R.S. Rosa, S.H. Gruber, and B.M. Wetherbee. 2006. Early growth and juvenile population structure of lemon sharks Negaprion brevirostris in the Atol das Rocas Biological Reserve, off north-east Brazil. Journal of Fish Biology 68:1319-1332.
Lemon	Hueter, R.E. and J.P. Tyminski. 2002. Center for Shark Research (CSR) U.S. Shark Nursery Research Overview 1991-2001. Pages 116-135 in C.T. McCandless, H.L.Pratt Jr., and N.E. Kohler (editors): Shark nursery grounds of the Gulf of Mexico and the East Coast waters of the United States: an overview. An internal report to NOAA's Highly Migratory Species Office. NOAA Fisheries Narragansett Lab, 28 Tarzwell Drive, Narragansett, RI 02882.
longfin mako	Guitart-Manday, D. 1966. Nuevo nombre para una especie de tiburon del genero Isurus (Elasmobranchii: Isuridae) de aguas Cubanas. Poeyana 15:1-9.
Night	Carlson, J.K. & Cortés, E. & Neer, J.A. & McCandless, C.T. & Beerkircher, L.R. 2008. The status of the United States population of night Shark, Carcharhinus signatus. Marine Fisheries Review, 70 (1): 1-13.
Night	Hazin, F.H.V., F.M. Lucena, T.S.A.L. Souza, C.E. Boeckman, M.K. Broadhurst, and R.C. Menni. 2000. Maturation of the night shark, Carcharhinus signatus, in the southwestern equatorial Atlantic Ocean. Bulletin of Marine Science 66(1):173-185.
Night	Raschi, W., J.A. Musick, and L.J.V. Compagno. 1982. Hypoprion bigelowi, a synonym of Carcharhinus signatus (Pisces: Carcharhinidae), with a description of ontogenetic heterodonty in this species and notes on its natural history. Copeia 1982(1):102-109.
Nurse	Castro, J.I. 2000. The biology of the nurse shark, Ginglymostoma cirratum, off the Florida east coast and the Bahama Islands. Environmental Biology of Fishes 58:1-22.
Nurse	Hueter, R.E. 1994. Bycatch and catch-release mortality of small sharks and associated fishes in the estuarine nursery grounds of Tampa Bay and Charlotte Harbor. Final Report to Florida Department of Environmental Protection, FDEP Grant Agreement 7237/7849. https://dspace.mote.org/dspace/bitstream/2075/1591/1/MTR%20367.pdf

Species	Citation
Nurse	Pratt, Jr., H.L. and J.C. Carrier. 2002. The Florida Keys Nurse Shark Breeding and Nursery Grounds. Pages 136-142 in C.T. McCandless, H.L.Pratt Jr., and N.E. Kohler (editors): Shark nursery grounds of the Gulf of Mexico and the East Coast waters of the United States: an overview. An internal report to NOAA's Highly Migratory Species Office. NOAA Fisheries Narragansett Lab, 28 Tarzwell Drive, Narragansett, RI 02882.
Oceanic Whitetip	Leesa, R., Paglerani, R., Santana, F.M. 1999. Biology and morphometry of the oceanic whitetip shark, Carcharhinus longimanus (Carcharhinidae), off northeastern Brazil. Cybium 23(4):353-368.
Oceanic Whitetip	Seki, T., Taniuchi, T., Nakano, H., and Shimizu, M. 1998. Age, growth and reproduction of the oceanic whitetip shark from the Pacific Ocean. Fisheries Science 64(1):14-20
Porbeagle	Jensen, C.F., Natanson, L.J., Pratt, Jr., H.L., Kohler, N.E. and Campana, S.E. 2002. The reproductive biology of the porbeagle shark (Lamna nasus) in the western North Atlantic Ocean. Fish. Bull. 100:727-738.
Porbeagle	Natanson, L.J., Mello, J.J. and Campana, S.E. 2002. Validated age and growth of the porbeagle shark (Lamna nasus) in the western North Atlantic Ocean. Fish. Bull. 100(2):266-278.
Sand Tiger	Gilmore, R.G., J.W. Dodrill, and P.A.Linley. 1983. Reproduction and embryonic development of the sand tiger shark, Odontaspis taurus (Rafinesque) Fish. Bull. 81(2):201-225.
Sand Tiger	Goldman, K.J. & Branstetter, S. & Musick, J.A. 2006. A re-examination of the age and growth of sand tiger sharks, Carcharias taurus, in the western North Atlantic: the importance of ageing protocols and use of multiple back-calculation techniques. Environmental Biology of Fishes, 77 (3-4): 241-252
Sandbar	Baremore, I.E. & Hale, L.F. 2012. Reproduction of the Sandbar Shark in the Western North Atlantic Ocean and Gulf of Mexico. Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science, 4 (1): 560-572
Sandbar	Merson, R.R. 1998. Nursery grounds and maturation of the sandbar shark in the western North Atlantic. Ph.D. Dissertation, University of Rhode Island, Kingston, RI. 150pp.
Scalloped Hammerhead	Miller, M.H., Carlson, J., Cooper, P., Kobayashi, D., Nammack, M., and J. Wilson. 2013. Status review report: scalloped hammerhead shark (Sphyrna lewini). Report to National Marine Fisheries Service, Office of Protected Resources. March 2013.131 pp.
Scalloped Hammerhead	Piercy, A.N., J.K. Carslon, J.A. Sulikowski, and G.H. Burgess. 2007. Age and growth of the scalloped hammerhead shark, *Sphyrn lewini*, in the north-west Atlantic Ocean and the Gulf of Mexico. Marine and Freshwater Research 58(1):34-40.
Shortfin Mako	Duffy, C. and Francis, M.P. 2001. Evidence of summer parturition in shortfin mako (Isurus oxyrinchus) sharks from New Zealand waters. New Zealand Journal of Marine and Freshwater Research 35(2):319-324.

Species	Citation
Shortfin Mako	Natanson, L.J., Kohler, N.E., Ardizzone, D., Cailliet, G.M., Wintner, S.P., and Mollet, H.F. 2006. Validated age and growth estimates for the shortfin mako, Isurus oxyrhinchus, in the North Atlantic Ocean. Environmental Biology of Fishes 77:367-383.
Silky	Bonfil, R., R. Mena and D. de Anda. 1993. Biological parameters of commercially exploited silky sharks, Carcharhinus falciformis, from the Campeche Bank, Mexico. In S. Branstetter (ed.): Conservation biology of sharks. NOAA Technical Report NMFS 115. U.S. Dept. Comm., Miami. pp. 72-86.
Smooth Hammerhead	CITES 2013. CoP16 Prop. 43. Consideration of Proposals for Amendment of Appendices I and II. https://cites.org/sites/default/files/eng/cop/16/prop/E-CoP16-Prop-43.pdf
Smooth Hammerhead	Coelho, R. & Fernandez-Carvalho, J. & Amorim, S. & Santos, M.N. 2011. Age and Size of the smooth hammerhead shark, Sphyrna zygaena, in the Eastern Equatorial Atlantic Ocean, using vertebral sections. Aquatic Living Resources, 24 (4): 351-357.
Smooth Hammerhead	Ebert, D.A., and Stehmann, M.F.W. 2013. Sharks, batoids, and chimaeras of the North Atlantic. FAO Species Catalogue for Fishery Purposes. No. 7. Rome, FAO. 523 pp.
Smoothhound Shark (ATL)	SEDAR. 2015. SEDAR 39 Stock Assessment Report: HMS Atlantic Smooth Dogfish Shark. Southeast Data Assessment & Review, Charleston SC. http://sedarweb.org/docs/sar/S39_Atl_smooth_dog_SAR.pdf
Smoothhound Shark Complex (GOM)	Kohler NE, Turner PA, Pezzullo M, McCandless CT. 2014. Mark/Recapture Data for the Smooth Dogfish, Mustelus canis, in the Western North Atlantic from the NMFS Cooperative Shark Tagging Program. 2014 SEDAR Data Workshop Document, SEDAR39-DW-20.
Smoothhound Shark Complex (GOM)	Jones LM, Driggers WB, Hannan KM, Hoffmayer ER, Jones CM. 2014. Identification, life history and distribution of *Mustelus canis, M. norrisi,* and *M. sinusmexicanus* in the northern Gulf of Mexico. SEDAR Data Workshop, SEDAR 39-DW-22. http://sedarweb.org/docs/wpapers/S39_DW_22_jonesetal_final.pdf
Spinner	Carlson, J.K. & Baremore, I.E. 2005. Growth dynamics of the Spinner Shark, Carcharhinus brevipinna, off the United States Southeast and Gulf of Mexico coasts: a comparison of methods. Abstract. American Elasmobranch Society 21th Annual Meeting, Tampa, Florida.
Tiger	Kneebone, J. & Natanson, L.J. & Andrews, A.H. & Howell, W.H. 2008. Using bomb radiocarbon analyses to validate age and growth estimates for the tiger shark, Galeocerdo cuvier, in the western North Atlantic. Marine Biology, 154 (3): 423-434.
Tiger	Driggers, W.B. III, G.W. Ingram, Jr., M.A. Grace, C.T. Gledhill, T.A. Henwood, C.N. Horton and C.M. Jones. 2008. Pupping areas and mortality rates of young tiger sharks Galeocerdo cuvier in the western North Atlantic Ocean. Aquatic Biology 2:161-170.

Species	Citation
White	Curtis, T.H. & McCandless, C.T. & Carlson, J.K. & Skomal, G.B. & Kohler, N.E. & Natanson, L.J. & Burgess, G.H. & Hoey, J.J. & Pratt, H.L. 2014. Seasonal Distribution and Historic Trends in Abundance of White Sharks, Carcharodon carcharias, in the Western North Atlantic Ocean. PLoS ONE, 9 (6): e99240.
White	Francis, M.P. 1996. Observations on a pregnant white shark with a review of reproductive biology. Pages 157-172 in Great white sharks: the biology of Carcharodon carcharias. Academic Press, Inc. San Diego, CA.
White	Pratt, H.L. 1996. Reproduction in the Male White Shark. In: Klimley, A.P. & Ainley, D. (Eds.) Great White Sharks. The biology of Carcharodon carcharias: 131-138.
White	Wintner, S.P. and G. Cliff. 1999. Age and growth determination of the white shark, Carcharodon carcharias, from the east coast of South Africa. Fish. Bull. 97(1):153-169.
White, Bignose, Night, Sandbar, Silky	Kohler NE, Casey JG, Turner PA. 1996. Length-length and length-weight relationships for 13 shark species from the Western North Atlantic. U.S. Dep Commer, NOAA Tech Memo NMFS NE 110; 22 p.

Appendix C Size Ranges for Life Stages of Billfish, Swordfish and Tunas

This appendix provides size ranges used to characterize different life stages of tunas, billfish, and swordfish: adults, juveniles, and the spawning, eggs, and larvae life stages. Size breaks between adult and juvenile were based on the reported length at 50 percent maturity (L50) or a reported size at sexual maturity. NMFS primarily uses the size at maturity identified by the International Commission for the Conservation of Atlantic Tunas (ICCAT) for management purposes. The spawning, eggs, and larvae life stage is not designated by a size; rather, this life stage is identified by the presence or absence of eggs and larvae.

Billfish and Swordfish	Spawning, Eggs and Larvae	Juveniles FL (cm) <	Adults Length of female 50% maturity FL (cm) ≥	References
Blue Marlin *Makaira nigricans*	Presence of eggs or larvae	20-190	190	Arocha and Marcano 2006; ICCAT 2006-2016
White Marlin *Tetrapurus albidus*	Presence of eggs or larvae	160	160	Arocha and Barrios 2009; ICCAT 2006-2016
Atlantic Sailfish *Istiophorus platypterus*	Presence of eggs or larvae	20-179	180	Arocha and Marcano 2006; ICCAT 2006-2016
Roundscale Spearfish *Tetrapturus georgii*	Presence of eggs or larvae	20-154	155	Arocha. unpublished; ICCAT 2006-2016
Longbill Spearfish *Tetrapturus pflueger*	EFH combined for all life stages			ICCAT 2006-2016 (no information available)
Swordfish *Xiphias gladius*	Presence of eggs or larvae	180	180	Arocha and Lee 1996; ICCAT 2006-2016

Atlantic Tunas	Spawning, Eggs and Larvae	Juveniles CFL (cm) <	Adults Length of female 50% maturity CFL (cm) ≥	References
Albacore Tuna *Thunnus alalunga*	Presence of eggs or larvae	90	90	Bard 1981; ICCAT 2006-2016
Bigeye Tuna *Thunnus obesus*	Presence of eggs or larvae	100	100	Matsumoto and Miyabe 2002; ICCAT 2006-2016
Skipjack Tuna *Katsuwonus pelamis*	Presence of eggs or larvae	45	45	Hazin et al. 2001; ICCAT 2006-2016
Yellowfin Tuna *Thunnus albacares*	Presence of eggs or larvae	108	108	Albarent 1977; ICCAT 2006-2016
Bluefin Tuna *Thunnus thynnus*	Presence of eggs or larvae	185	185	ICCAT 2006-2016; G. Diaz pers comm., NOAA SEFSC

Species	Citation
Albacore Tuna	BARD, F. X. 1981. Le thon germon (Thunnus alalunga) de l'Océan Atlantique. PhD Thesis presented at the University of Paris, 333 p
All Tunas, Billfish and Swordfish	ICCAT. 2006-2016. ICCAT Manual. International Commission for the Conservation of Atlantic Tuna. In: ICCAT Publications [on-line]. Updated 2016. [Cited 01/27/]. http://www.iccat.int/en/ICCATManual.asp, ISBN (Electronic Edition): 978-92-990055-0-7

Species	Citation
Bigeye	MATSUMOTO, T. & N. Miyabe. 2002. Preliminary report on the maturity and spawning of bigeye tuna Thunnus obesus in the Central Atlantic Ocean. Collect. Vol. Sci. Pap, ICCAT, 54(1): 246-260.
Swordfish	AROCHA, F., and D. W. Lee. 1996. Maturity at size, reproductive seasonality, spawning frequency, fecundity and sex ratio in swordfish from the Northwest Atlantic. Collect. Vol. Sci. Pap. ICCAT, 45(2): 350-357.
Sailfish, Blue Marlin	AROCHA, F. and L. Marcano. 2006. Life history characteristics of Makaira nigricans, Tetrapturus albidus, and Istiophorus albicans from the eastern Caribbean Sea and adjacent waters. Pgs. 587-597 In J. Nielsen, J. Dodson, K. Friedland, T. Hamon, N. Hughes, J. Musick and E. Verspoor, Eds. Proceedings of the Fourth World Fisheries Congress: Reconciling Fisheries with Conservation. Amer. Fish. Soc. Symp. 49, Bethesda, Maryland.
White Marlin	Arocha, F. and Bárrios, A. 2009. Sex ratios, spawning seasonality, sexual maturity, and fecundity of white marlin (Tetrapturus albidus) from the western central Atlantic. Fisheries Research, 95: 98-111.
Skipjack Tuna	HAZIN, F. H. V., H. G. Hazin, C.R. Zagaglia, P. Travassos & M.F.G. Júnior. 2001. Analices des captures de la pêche à la senne réalisées par le “B.P. Xixili” dans l`Ocean Atlantique Équatorial. Collect. Vol. Sci. Pap, ICCAT, 52(2): 488-498.

Appendix D Shark Length Conversion Formulas

This appendix provides the conversion formulas used to convert shark length data collected from various sources into a common format. Unless otherwise specified, formulas show conversion from a unit of measure into Fork Length (FL) in centimeters (cm).

Species	Region	Conversion Formula	Citation
Atlantic Angel *Squatina dumeril*		FL=0.9511 (TL) + 0.1125	Baremore (2010)
Atlantic Sharpnose *Rhizoprionodon terraenovae*	Gulf of Mexico	FL=0.8981 (TL) - 4.1023	Hoffmayer *et al.* (2013)
		FL=0.840 (STL) - 1.670	Bethea et al. 2014
		FL=1.067 (PCL) +1.278	Bethea et al. 2014
	Atlantic	FL=0.8636 (TL) - 1.2746	Loefer and Sedberry 2003
		FL=0.840 (STL) - 1.670	Bethea et al. 2014
		FL=1.075 (PCL) + 11.249	Loeffer and Sedberry 2003
Basking *Cetorhinus maximus*		FL=0.9174 (TL) - 11.0183	Natanson *et al.* (2008)
		FL=1.14 (PCL) - 8.32	Natanson *et al.* (2008)
Bigeye Thresher Alopias superciliosus		FL=0.5598 (TL) + 17.6660	Kohler *et al.* (1996)
Bignose *Carcharhinus altimus*		FL=0.8074 (TL) + 7.7694	Kohler *et al.* (1996)
Blacknose *Carcharhinus acronotus*	Gulf of Mexico	FL=0.842 (TL) - 1.052	Bethea *et al.* (2014)
		FL= 0.8419 (STL) - 3.81221	Driggers *et al.* (2004)
		FL=1.0785 (PCL) - 1.66397	Driggers *et al.* (2004)
	Atlantic	FL=0.9292 (TL) - 9.08075	M Grace, unpublished
		FL=0.810213 (STL) - 0.99324	McCandless pers comm.
		FL=1.0785 (PCL) - 1.66397	Driggers *et al.* (2004)
Blacktip *Carcharhinus limbatus*	Gulf of Mexico	FL=0.830 (TL) - 0.828	Bethea et al. 2014
		FL=0.803 (STL) - 0.626	Bethea et al. 2014
		FL=1.1009(PCL) - 0.53	Carlson et al. (2006)
	Atlantic	FL=0.8301(TL) - 2.900425	Castro (1996)
Blue *Prionace glauca*		FL=0.8313 (TL) + 1.3908	Kohler *et al.* (1996)
		TL = 2.5447 + 1.3315 (PCL)	Vandeperre *et al.* (2014)
Bonnethead *Sphyrna tiburo*	Gulf of Mexico and Atlantic Stocks	FL=0.847 (TL) - 2.049	Bethea et al. 2014
		FL=0.8347 (STL) - 3.26377	Frazier *et al.* (2013)
		FL=1.0811 (PCL) + 9.7622	Frazier *et al.* (2013)
Bull *Carcharhinus leucas*		FL=0.8696(TL) - 6.3652	Branstetter & Stiles (1987)
		FL=1.0696(PCL) + 5.3740	Branstetter & Stiles (1987)
		FL=0.806692(STL) + 1.948212	McCandless pers. comm.
Caribbean Reef *Carcharhinus perezi*		FL=0.8347(TL) - 2.5768	Tavares (2009)
Caribbean Sharpnose *Rhizoprionodon porosus*		FL=0.8636 (TL) - 1.2746	McCandless pers. comm. (2016)
			Loefer and Sedberry (2003)
Common Thresher *Alopias vulpinus*		FL=0.5474 (TL) + 7.0262	Kohler *et al.* (1996)
		TL = 1.93 (PCL) + 2.34	Liu et al. 1999
Dusky *Carcharhinus obscurus*		FL=0.8396(TL) -3.1902	Kohler *et al.* (1995), Natanson *et al.* (2014)

Species	Region	Conversion Formula	Citation
		FL=1.09179(PCL) + 1.594169	McCandless pers. comm. (2016)
Finetooth *Carcharhinus isodon*		FL=0.818 (TL) + 0.123	Bethea *et al.* (2014)
		FL=0.794 (STL) - 0.015	Bethea *et al.* (2014)
Galapagos *Carcharhinus galapagensis*		FL=0.8396 (TL) - 3.1902	McCandless pers. comm. (2016) Kohler et al. (1995)
Great Hammerhead *Sphyrna mokarran*		FL=0.7979 (TL) - 2.7703	Piercy et al. (2010)
		FL=0.775 (STL) - 2.775	Stevens and Lyle 1989
		FL=1.1325 (PCL) - 1.1699	Hueter 1994
Lemon *Negaprion brevirostris*		FL=0.8201 (TL) + 4.1981	J Carlson, unpubl. data / pers comm (3/28/16)
		FL=0.812374 (STL) + 2.999339	McCandless pers comm (COASTSPAN data, 2016)
		FL=1.1149 (PCL) - 1.295	Hueter 1994
Longfin Mako *Isurus paucus*		FL=0.9286 (TL) - 1.7101	Kohler *et al.* (1996) NEFSC pers. comm.
Narrowtooth *Carcharhinus brachyurus*		FL=0.823 (TL) + 0.283	Mas 2012
		FL=1.074 (PCL) + 6.666	Mas 2012
Night *Carcharhinus signatus*		FL=0.8390 (TL) + 0.5026	Kohler *et al.* (1996)
Oceanic Whitetip *Carcharhinus longimanus*		FL=0.8812 (TL) - 11.0484	ICCAT 2014
Porbeagle *Lamna nasus*		0.8971 (TL) + 1.7939	Kohler *et al.* (1996)
Sandbar *Carcharhinus plumbeus*		0.8175 (TL) +2.5675	Kohler *et al.* (1996)
		0.8 (STL) +0.291	Bethea *et al.* (2014)
		1.0934PCL+2.239029	McCandless pers. comm. (2016)
Sand Tiger *Carcharhinus taurus*		FL=0.8471 (TL) - 0.592	Goldman *et al.* (2006)
		FL=1.095 (PCL) + 4.9378	
Silky *Carcharhinus falciformis*		FL=0.8388 (TL) - 2.6510	Kohler *et al.* (1996)
Shortfin Mako *Isurus oxyrinchus*		0.9286 (TL) - 1.7101	Kohler et al. 1996
		0.8918 (STL) + 1.3315	Maia et al. 2007
Smooth Hammerhead *Sphyrna zygaena*		FL=0.794978 (TL) - 1.89416	McCandless pers. comm.
		0.751 (STL) -1.670	Bethea et al. 2014
Spinner *Carcharhinus brevipinna*		0.855(TL) - 2.743	Bethea et al. 2014
		1.136 (PCL) - 1.708	Carlson and Baremore (2005)
Scalloped Hammerhead *Sphyrna lewini*		0.784 (TL) -0.479	Bethea et al. 2014
		1.0893 (PCL) + 2.239029	Piercy et al. 2007
		FL = 49.20722 $(WT)^{0.3692}$	ICCAT 2014
Smoothhound Shark Complex Gulf of Mexico; includes smooth dogfish, gulf smoothhound, and narrowfin smoothhound		FL=0.9162 (TL) - 3.2965	SEDAR39-DW-22
		FL=0.8797 (STL) - 1.8914	SEDAR39-DW-22
		FL=1.062 (PCL) + 1.0483	SEDAR39-DW-22

Species	Region	Conversion Formula	Citation
Smooth Dogfish *Mustelus canis*	Atlantic	FL=1.11099 (TL) - 13.22075 FL=0.8921 (STL) - 2.2689 FL=1.0671 (PCL) + 0.8937	SEDAR39-DW-22 SEDAR39-DW-31 SEDAR39-DW-31
Tiger *Galeocerdo cuvier*		0.8761 (TL) - 13.3535	Kohler et al. (1996)
Bigeye Sand Tiger *Odontaspis noronhai*		0.8471 (TL) - 0.592	McCandless pers comm (used sand tiger as an estimate)
White *Carcharodon carcharias*		0.9442 (TL) - 5.7441 1.173 (PCL) - 11.791	Kohler et al. 1996 Cliff and Dudley 1989

FL= Fork length. TL = Total length. PCL = Precaudal length. STL = Stretch total length.

*All conversion formulas in centimeters.

Species	Citation
Atlantic Angel	Baremore, I.E. 2010. Reproductive aspects of the Atlantic angel shark Squatina dumeril. Journal of Fish Biology, 76 (7): 1682-1695
Atlantic Sharpnose, Blacktip, Blacknose, Bonnethead, Finetooth, Sandbar, Scalloped Hammerhead, Spinner	Bethea, D.M. & Ajemian, M.J. & Carlson, J.K. & Hoffmayer, E.R. & Imhoff, J.L. & Grubbs, R.D. & Peterson, C.T. & Burgess, G.H. 2014. Distribution and community structure of coastal sharks in the northeastern Gulf of Mexico. Environmental Biology of Fishes, 98 (5): 1233-1254
Atlantic Sharpnose	Hoffmayer, E.R., Driggers III, W.B., Jones, L.M., Hendon, J.M. & Sulikowski, J.A. 2013. Variability in the Reproductive Biology of the Atlantic Sharpnose Shark in the Gulf of Mexico, Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science, 5:1, 139-151, DOI: 10.1080/19425120.2013.783518.
Atlantic Sharpnose	Loefer, J.K. and G.R. Sedberry. 2003. Life history of the Atlantic sharpnose shark (Rhizoprionodon terraenovae) (Richardson, 1836) off the southeastern United States. Fish. Bull. 101(1):75-88.
Smoothhound (Atlantic and Gulf of Mexico Stocks)	Hoffmayer ER, Driggers WB, Grubbs RD, Giresi MM, Gelsleichter J, Latour R. 2014. Length/weigth relationships and life history data for *Mustelus canis* off of the Atlantic coast of the U.S. SEDAR Data Workshop, SEDAR 39-DW-31.
Basking	Natanson, L. J., S.P. Wintner, F. Johansson, A. Piercy, P. Campbell, A.de Maddalena, S.J.B. Gulak, B. Human, F.C. Fulgosi, D.A. Ebert, F. Hemida, F.H. Mollen, S. Vanni, G.H. Burgess, L.J.V. Compagno, and A. Wedderburn-Maxwell. 2008. Ontogenetic vertebral growth patterns in the basking shark *Cetorhinus maximus*. Marine Ecology Progress Series, 361: 267-278.
Bigeye Thresher, Bignose, Blue, Common Thresher, Night, Porbeagle, Sandbar, Scalloped HH, Shortfin Mako, Silky, Tiger, White	Kohler NE, Casey JG, Turner PA. 1996. Length-length and length-weight relationships for 13 shark species from the Western North Atlantic. U.S.US Dep Commer, NOAA Tech Memo NMFS NE 110; 22 p.

Species	Citation
Blacknose	Driggers III WB, Carlson JK, Frazier B, Ingram Jr GW, Quattro JM, Sulikowski JA, Ulrich GF. 2007. Life history and population structure of blacknose sharks, *Carcharhinus acronotus*, in the western North Atlantic Ocean. SEDAR Data Workshop, SEDAR21-DW-36. http://sedarweb.org/docs/wpapers/S21_DW_36.pdf
Blacktip	Carlson, J.K., Sulikowski, J.R. & Baremore, I.E. 2006. Do differences in life history exist for blacktip sharks, Carcharhinus limbatus, from the United States South Atlantic Bight and Eastern Gulf of Mexico? Environmental Biology of Fishes, 77 (3-4): 279-292.
Blacktip	Castro, J.I. 1996. Biology of the blacktip shark, Carcharhinus limbatus, off the southeastern United States. Bulletin of Marine Science 59(3):508-522.
Blue	Vandeperre F, Aires-da-Silva A, Fontes J, Santos M, Serrao Santos R, Afonso P. 2014. Movements of blue shark (Prionace glauca) across their life history. PLoSOne 9(8): e103538. doi: 10.1371/journal.pone.0103538.
Bonnethead	Frazier BS, Loefer JK. 2013. Update to maximum observed age of Atlantic sharpnose sharks (*Rhizoprionodon terraenovae*) in the western North Atlantic Ocean based on a direct age estimate of a long term recapture. SEDAR34-WP-06. SEDAR, North Charleston, SC. 5 pp.
Bull	Branstetter, S. and R. Stiles. 1987. Age and growth estimates of the bull shark, Carcharhinus leucas, from the northern Gulf of Mexico. Env. Biol. Fish. 20(3):169-181.
Caribbean Reef Sharks	Tavares R. 2009. Fishery biology of the Caribbean reef sharks, Carcharhinus perezi (Poey, 1876), in a Caribbean insular platform: Los Roques Archipelago National Park, Venezuela. Panam J Aquat Sci 4:500–512.
Common Thresher	Liu, K.M., Chen, C.-T., Liao, T.-H. and Joung, S.-J. 1999. Age, growth, and reproduction of the pelagic thresher shark, Alopias pelagicus in the Northwestern Pacific. Copeia 1999(1): 68-74.
Dusky, Galapagos, Longfin Mako	Kohler, N.E. & Casey, J.G. & Turner, P.A. 1995. Length-weight relationships for 13 species of sharks from the western North Atlantic. Fishery Bulletin, 93 (2); 412-418, tabs 1-3.
Dusky	Natanson, L. J., B. J. Gervelis, M. V. Winton, L. L. Hamady, S. J. B. Gulak, and J. K. Carlson. 2014. Validated age and growth estimates for Carcharhinus obscurus in the northwestern Atlantic Ocean, with pre- and post management growth comparisons. Environ. Biol. Fish., 97, 881-896, doi: 10.1007/s10641-013-0189-4.
Great Hammerhead, Lemon	Hueter, R.E. 1994. Bycatch and catch-release mortality of small sharks and associated fishes in the estuarine nursery grounds of Tampa Bay and Charlotte Harbor. Final Report to Florida Department of Environmental Protection, FDEP Grant Agreement 7237/7849. https://dspace.mote.org/dspace/bitstream/2075/1591/1/MTR%20367.pdf
Great Hammerhead	Piercy, A.N. & Carlson, J.K. & Passerotti, M.S. 2010. Age and growth of the great hammerhead shark, *Sphyrna mokarran*, in the north-westernAtlantic Ocean and Gulf of Mexico. Marine and Freshwater Research, 61 (9): 992-998.
Great Hammerhead	Stevens, J. D. & Lyle, J. M. 1989. Biology of three hammerhead sharks (Eusphyra blochii, Sphyrna mokarran and S. lewini) form Northern Australia. Australian Journal of Marine and Freshwater Research 40:129-146.

Species	Citation
Gulf of Mexico Smoothhound Complex	Jones LM, Driggers WB, Hannan KM, Hoffmayer ER, Jones CM. 2014. Identification, life history and distribution of Mustelus canis, M. norrisi, and M. sinusmexicanus in the northern Gulf of Mexico. SEDAR Data Workshop, SEDAR 39-DW-22. http://sedarweb.org/docs/wpapers/S39_DW_22_jonesetal_final.pdf
Narrowtooth	Mas, F. 2012. Biodiversidad, abundancia relativa y estructura poblacional de los tiburones capturados por la flota de palangre pelágico en aguas uruguayas durante 1998-2009. Tesis de Licenciatura en Ciencias Biológicas, Facultad de Ciencias, UDELAR, Montevideo, Uruguay. 95p.
Oceanic Whitetip, Scalloped Hammerhead, Smooth Hammerhead	ICCAT 2014. Sharp Species Group Intersessional Report. https://www.iccat.int/Documents/SCRS/Manual/Appendices/Appendix%204%20III_SHK.pdf
Sand Tiger	Goldman, K.J. & Branstetter, S. & Musick, J.A. 2006. A re-examination of the age and growth of sand tiger sharks, Carcharias taurus, in the western North Atlantic: the importance of ageing protocols and use of multiple back-calculation techniques. Environmental Biology of Fishes, 77 (3-4): 241-252.
Shortfin Mako	Maia, A., Queiroz, N., Correia, J.P., Cabral, H. 2007. Food habits of the shortfin mako, Isurus oxyrinchus, off the southwest coast of Potugal. Environ. Biol. Fish. 77:157-167.
Spinner	Carlson, J.K. & Baremore, I.E. 2005. Growth dynamics of the Spinner Shark, Carcharhinus brevipinna, off the United States Southeast and Gulf of Mexico coasts: a comparison of methods. Abstract. American Elasmobranch Society 21th Annual Meeting, Tampa, Florida.
Scalloped Hammerhead	Piercy, A.N., J.K. Carslon, J.A. Sulikowski, and G.H. Burgess. 2007. Age and growth of the scalloped hammerhead shark, *Sphyrn lewini*, in the north-west Atlantic Ocean and the Gulf of Mexico. Marine and Freshwater Research 58(1):34-40.
White	Cliff, G., Dudley, S. F. J. and B. Davis, 1989. Sharks caught in the protective gill nets off Natal, South Africa. 2. The great white shark Carcharodon carcharias (Linnaeus), South African Journal of Marine Science, 8:1, 131-144.

Appendix E Billfish, Swordfish and Atlantic Tunas Length Conversion Formulas

This appendix provides the conversion formulas used to convert Atlantic billfish, swordfish, and tunas length data collected from various sources into a common format. Unless otherwise specified, formulas show conversion from a unit of measure into lower jaw fork length (LJFL) for billfish and swordfish. Units vary for Atlantic tunas, and readers are encouraged to review ICCAT (2006-2016) and recent ICCAT SCRS documents for conversion formulas.

Species	Sex	Conversion Formula (to LJFL)	Citation
Blue Marlin *Makaira nigricans*	**Female** **Male** **Combined**	-3.563 + 0.784(TL) 19.182 + 0.691(TL) 2.000 + 0.763(TL)	Prager et al. 1995; ICCAT 2006-2016 (citation includes other conversion formulas)
White Marlin *Tetrapurus albidus*	**Female** **Male** **Combined**	5.923 + 0.731(TL) 18.664 + 0.667(TL) -0.720 – 0.760(TL)	Prager et al. 1995; ICCAT 2006-2016 (citation includes other conversion formulas)
Atlantic Sailfish *Istiophorus platypterus*	**Female** **Male** **Combined**	32.188 + 0.623(TL) 21.961 + 0.657(TL) 18.171 + 0.686(TL)	Prager et al. 1995; ICCAT 2006-2016 (citation includes other conversion formulas
Roundscale Spearfish *Tetrapturus georgii*	**Female** **Male** **Combined**	*No Conversion Factors Available*	ICCAT 2006-2016
Longbill Spearfish *Tetrapturus pflueger*	**Female** **Male** **Combined**	*No Conversion Factors Available*	ICCAT 2006-2016
Swordfish *Xiphias gladius*	**Female** **Male** **Combined**	*Data did not need to be converted*	ICCAT 2006-2016

LJFL = Lower Jaw Fork Length. TL = Total length. *All conversion formulas in centimeters.

Species	Sex	Conversion Formula	Citation
Albacore Tuna *Thunnus alalunga*	**Female** **Male** **Combined**	FL = 3.6221 x (LDl^0.9722)	Bard 1981; ICCAT 2006-2016
Bigeye Tuna *Thunnus obesus*	**Female** **Male** **Combined**	LD1 = -21.451 + 5.28756 √LF *if LD1 > 48:* LF = [(LD1 + 0.5+21.45108)/5.28756]^2	Champagnat and Pianet 1974; See ICCAT 2006-2016 for additional conversions
Bluefin Tuna *Thunnus thynnus*	**Female** **Male** **Combined**	*Data was already in correct format; see ICCAT 2006 - 2016*	ICCAT 2006 – 2016; See Appendix A4.3
Skipjack Tuna *Katsuwonus Pelamis*	**Female** **Male** **Combined**		ICCAT 2006 – 2016; See Appendix A4.3
Yellowfin Tuna *Thunnus albacares*	**Female** **Male** **Combined**	If LD1 > 49: FL = 81.3 + 1.98 (LD1 +0.5) If LD < 49, : Log FL = 1.183 log LD1 + 0.269	ICCAT 2006 – 2016; Caveriviere 1976

CFL = Curved Fork Length. FL= Fork length. LDl = Pre-dorsal length. *All conversion formulas in centimeters.

Species	Citation
All Atlantic Tunas	ICCAT. 2006-2016. *ICCAT Manual. International Commission for the Conservation of Atlantic Tuna. In: ICCAT Publications* [on-line]. Updated 2016. [Cited 01/27/]. **http://www.iccat.int/en/ICCATManual.asp**, ISBN (Electronic Edition): 978-92-990055-0-7
Albacore Tuna (combined M & F)	BARD, F. X. 1981. Le thon germon (Thunnus alalunga) de l'Océan Atlantique. PhD Thesis presented at the University of Paris, 333 p.
Bigeye Tuna	CHAMPAGNAT, C. & R. Pianet. 1974. Croissance du patudo (Thunnus obesus) dans les régions de Dakar et de Pointe-Noire. Collect. Vol. Sci. Pap, ICCAT, 2(1): 141-144.
Yellowfin Tuna	CAVERIVIÈRE, A. 1976. Longueur prédorsale, longueur a la fourche et poids des albacores (Thunnus albacares) de l'Atlantique. Cah. ORSTOM, ser. Océanogr., 14(3): 201-208.
Blue Marlin, White Marlin, Sailfish	PRAGER M.H., D.W. Lee and E.D. Prince. 1995. Empirical length and weight conversion equations for blue marlin, white marlin, and sailfish from the North Atlantic. Bull. Mar. Sci., 56: 201-210.

Appendix F EFH Delineation Methods & Bluefin Tuna Example

This appendix reviews the data sources and methodology used to update Atlantic HMS EFH. An example is also presented to demonstrate how this process was applied to bluefin tuna.

Data Sources Used to Update HMS EFH

The regulations implementing the Magnuson-Stevens Act EFH provisions require that in describing and identifying EFH, NMFS use the best available sources, including peer-reviewed literature, unpublished scientific reports, data files of government resource agencies, fisheries landing reports, and other sources of information (600.815). Delineations must be based on one of 4 “levels” of available data. Atlantic HMS EFH updates are based on distribution data (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 diversity of sample designs influencing the way in which data is collected, including the types of gear used to collect HMS at different life stages and across geographic ranges. For example, data from McCandless et al. (2007), a synthesis volume on shark nursery grounds in the Gulf of Mexico and east coast waters of the United States, 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 are contained in the volume, 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. 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 (e.g. longline, rod and reel, handline, harpoon, gillnet), causes difficulties in standardizing effort for nearly all HMS; however, the information is useful in providing an overview of the current and historical distributions, suggesting habitat requirements and nursery areas for HMS. Although there are exceptions, most of the data collections were restricted to areas in which the surveys occurred and did not encompass all areas that could potentially be considered EFH. Level 3 information regarding growth, reproduction, or survival rates within habitats, and level 4 information regarding production rates by habitat type are often not available for HMS; although SEAMAP and bluefin tuna larval studies conducted by the SEFSC provide some of this information for teleost early life stages. Other exceptions to level 1 data limitations are the GULF and COAST Shark Pupping and Nursery studies conducted along the northern coast of the Gulf of Mexico and Atlantic Ocean, respectively. As explained below, the models used to develop EFH boundaries are reliant on Level 1 data. Level 2 data, although available from some studies, was not available in a standardized format across all datasets; therefore, it could not be incorporated into models used to delineate the polygons used to depict EFH boundaries.

Despite the sparsity of data at levels 2 through 4, 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.

It is due to the long-term, systematic research produced by the GULFSPAN survey that higher-level data is now described in the EFH delineations for neonate/YOY and juvenile sharks in Chapter 6. EFH for these life stages in both the Gulf of Mexico and Atlantic Ocean was delineated based on these surveys and expert input from the researchers who designed, conducted, and provided summaries of the results annually over the past decade.

The point data for each species was concatenated from one or more of the following sources (as indicated on the EFH maps in Appendix E): NMFS Cooperative Tagging Centers (NEFSC and SEFSC); NMFS SE Pelagic, SE BLL, NEFSC, Gulf Reef Fish, Shrimp, and Gillnet Observer Programs; COASTSPAN; GULFSPAN; NEFSC; SEAMAP Small Pelagics, Shrimp/Bottomfish, larval surveys, and trawl surveys; NRDA (DIVER database – bluefin tuna satellite tag tracks); SEFSC BLL shark survey; HMS Exempted Fishing Permits reports; and additional surveys, tagging programs, and data provided by researchers at NOVA Southeastern University, Texas Parks and Wildlife, University of Southern Mississippi, Virginia Institute of Marine Science, East Carolina University, NASA, South Carolina Department of Natural Resources, Georgia Department of Natural Resources, the Rosential School of Marine and Atmospheric Sciences, University of Miami, the Massachusetts Division of Marine Fisheries, University of Windsor, University of Southern Alabama, the Gulf of Mexico Fishery Management Council, Gulf Coast Research Laboratory (University of South Mississippi), NEAMAP, Dauphin Island Sea Lab, NOVA Southeastern University and the Guy Harvey Research Institute, and Mote Marine Laboratory, the North Carolina Department of Natural Resources, the Billfish Foundation, and the North Atlantic Right Whale Consortium.

Data Preparation for EFH Analyses

Due to the diverse nature and type of information collected, NMFS undertook several steps to ensure that data could be converted to a standardized format. At a minimum, these data used to generate the probability boundaries described in Alternative 2 had to include latitude and longitude coordinates of the location of tagging or capture, species identification, length of the animal, date of capture, and identification of the source or program responsible for collecting the data. Researchers were also asked to provide tagging information, environmental information if available (e.g., temperature, depth), assessment of maturity, and any additional contextual information that might be useful. NMFS is required to identify and describe EFH for each species by life stage (adult, juvenile, YOY or larvae/eggs/spawning areas) where possible, and has adopted approaches to delineate size based on length (see Appendix B and Appendix C). Point data that did not include size information or geographic information (i.e., latitude and longitude) were generally excluded from analyses. In some cases, NMFS retained point data without corresponding length information for data poor species; data for these species were often combined across life stages (in which case, the length was not needed to determine how to group individuals)

Additional Data Considerations for EFH Analyses

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 or refute 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 NMFS scientists familiar with the biology, life history, and habitat requirements of HMS to assist in updating EFH boundaries. Environmental information was included in the habitat requirements descriptions, when available. This information may include temperature, salinity ranges, DO, depths, seasons, benthic habitat type (in the case of shark pupping areas), and geographic locations.

Other factors that were taken into consideration include gear selectivity and the type of fishing effort (e.g., 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 YOY and juvenile sharks are more abundant. Commercial longline fishery data from the shark BLL and pelagic observer programs tends to be collected further offshore and consists predominantly of adult sharks. Geographic difference in data by gear type were also evident for gillnet gear which is typically fished closer to shore than BLL gear. Since NMFS sorted the species by size and life stage, the inherent gear biases in the data collection were minimized.

In previous analyses completed for Amendment 1 and earlier revisions to Atlantic HMS EFH, 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. This has not changed with the most recent incorporation of new information into Amendment 10. 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 was noted that the distribution data that were used to develop the probability boundaries likely included areas where the highest CPUEs would have occurred.

Much of the scientific literature and evidence supporting EFH and HAPC designations for sharks pertains to the identification of shark nursery habitats. The scientific literature lacks clear, consistently used definitions for shark nursery habitats, especially regarding nursery habitats (see Heupel et al. 2007 for a thorough discussion). Bass (1978) identifies nursery habitats as *"those where the young sharks are actually born and spend the first part of their lives"* and secondary nursery habitats as *"those inhabited by slightly older but not yet adolescent or mature sharks".* Beck (2001) noted that areas may be identified as nursery habitats without empirical testing of the nursery-role concept simply because of the presence of appropriately-aged individuals. Many areas identified as nursery habitats contain adolescent or mature sharks, therefore not strictly meeting the definition of these habitats from Beck (1978) (Heupel et al. 2007; J. Carlson pers comm; C. McCandless pers comm). NMFS encourages the application of the shark nursery habitat definition identified in Heupel et al. 2007 as habitats in which: *"1) sharks are more commonly encountered in these areas versus other areas; 2) sharks remain or return to these areas for extended periods of time (i.e., site fidelity that is greater than mean fidelity to all sites across years); 3) the habitat is repeatedly used across all years, whereas others are not".* NMFS has considered this definition in groundtruthing shark EFH model results against the body of known scientific information and literature, and in application of the HAPC criteria to shark nursery habitats identified in alternatives which consider the creation or modification of HAPCs.

NMFS also made adjustments, when warranted by empirical evidence and recommendation from the Science Center staff, to remove migratory pathways from EFH. While migration pathways are important in their own right, they do not strictly meet the definition of EFH as identified in 600.10, i.e., those habitats necessary for breeding, feeding, spawning, or growth to maturity.

Approach Used to Analyze and Map Data

NMFS has periodically evaluated the methodologies used to designate EFH geographic boundaries for Atlantic HMS (i.e., in the historical EFH actions identified under Section 1.2). The current EFH methodology used for Atlantic HMS was developed in Amendment 1 to the 2006 Consolidated Atlantic HMS FMP (referred to in this section as "Amendment 1"), and subsequent EFH designations also utilized this approach. In Amendment 1, NMFS selected the current EFH methodology after evaluating four alternatives to delineate EFH, which ranged between a no action alternative, consideration of the full range of a species as EFH, and two analysis methods that would reduce EFH to the areas with the highest concentration of data points. NMFS provided comparative EFH maps in Amendment 1 showing how EFH would change based on the analysis methodology. In Amendment 1, NMFS preferred an Arcview extension called Hawth's Analysis Kernel Density Estimator (or Hawth's analysis tool) to establish 95 percent volume contours (or probability boundaries) as the basis for establishing new EFH boundaries. This preferred methodology was selected because it was less subjective and more reproducible, and the approach was derived from actual data points instead of data merged and interpolated from a grid. The 95 percent probability boundary also represented the most precautionary approach of the four probability boundaries that were considered in Amendment 1, 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.

The Final Atlantic HMS EFH 5-Year Review concluded that the methodology used in Amendment 1 to the 2006 Consolidated HMS FMP to delineate Atlantic HMS EFH continued to be the best approach. This methodology inferred habitat use and EFH from available point data instead of attempting to model habitat associations on data in which distribution information and habitat parameters were often not collected in a consistent and statistically robust manner, and/or were not comparable across datasets. This methodology allowed for the incorporation of multiple complex datasets into the analysis, was transparent, and was more easily reproducible. More sophisticated models and statistical techniques are available; however, these models were found to require high-resolution catch per unit effort or density data, or concurrent ecological data, which is not, in all cases, available for Atlantic HMS. Consultation with the HMS Advisory Panel and the public did not yield alternate approaches for EFH delineation methods. Furthermore, NMFS provided updates and opportunities for comments at two HMS Advisory Panel meetings since the finalization of the Atlantic HMS EFH 5-Year Review and no additional comments or concerns have been raised regarding the current HMS EFH delineation methodology. Therefore, NMFS determined that the HMS EFH delineation methodology used in Amendment 1 could continue to be used for the analyses in Draft and Final Amendment 10. The methodology is described in detail in the below sections.

For the analyses used to generate the maps in Amendment 10, new data collected since Amendment 1 to the 2006 Consolidated HMS FMP, as well as previously existing data used to identify previous EFH boundaries, were analyzed using Geographic Information System (GIS) software (ESRI ArcMap 10.2 and 10.3). The previous software tool used to generate the kernal density maps and contour boundaries, Hawths Analysis tools, was no longer supported for recent versions of ArcGIS that are available to NMFS. The software developer replaced Hawths Analysis tools with Geospatial Modeling Environment, which offers the same tools but allows for more sophisticated and flexible modeling and analysis by GIS users. The data from all the datasets described above were first formatted, combined into datasets for each species and life stage, input into GIS, and used to create projected (Albers Equal Area) shapefiles. Geospatial analyses then consisted of a two-step process whereby NMFS generated kernal density estimates for point data, and then derived probability boundaries depicting the locations containing 95 percent of the data points. These shapefiles in turn were imported into a Kernel Density Estimation modeling tool in the GIS software Geospatial Modeling Environment to establish probability boundaries) as the basis for establishing new EFH boundaries. The Kernal Density Estimator tool creates a raster (gridded surface) shapefile as output which estimates the density of point data across a surface (i.e., each grid cell is assigned a density value). NMFS used the following model specifications in the Kernal Density Estimation models:

- a Gaussian (bivariate normal) kernal, which the programmer recommended over other kernals for biological and ecological analyses (H. Beyer, http://www.spatialecology.com/gme/images/SpatialEcologyGME.pdf);
- a smooth cross validation bandwidth estimation algorithm, which is not as sensitive as other algorithms to datasets containing identical data points (N. Farmer pers comm; H. Beyer http://www.spatialecology.com/gme/images/SpatialEcologyGME.pdf);
- a scaling factor of 100,000,000 (density estimates are usually very small, so multiplying them by a scaling factor ensures that raster ouput is fully supported and precision is not lost); and
- equal weighting across all data points (i.e., density estimates were based on the geographic distribution of data points only).

The second step in the geospatial analysis was to input the raster shapefile into the Geospatial Modeling Environment Isopleth tool, which calculated probability boundaries. The probability boundary analysis evaluated distance between points, thereby excluding the least dense points or outliers, from the resulting probability boundary. The probability boundary represented the boundary of the area that contains a certain percent of the volume of a 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 extracted several probability boundaries for Atlantic HMS as part of the model output (i.e., 50, 75, 80, 90, and 95 percent probability boundaries). Due to the inherent difficulties in identifying EFH for HMS, a precautionary approach of using the 95 percent probability boundary was used (as in Amendment 1, described above).

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, neritic, and offshore pelagic environments. HMS are typically associated with fronts and current boundaries or oceanographic conditions with specific temperatures, salinity, DO, 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 alone may therefore not be the most appropriate means for identifying true Atlantic EFH. Where possible, NMFS used the following parameters to delineate EFH boundaries:

- Shorelines: Depending on the species and/or life stage, if the probability boundary overlapped with the shoreline, NMFS clipped the resulting probability boundary along the shoreline. In some cases, this resulted in EFH being designated in inshore (i.e., lagoons, embayments, sounds) waters. Based on recommendations from the NMFS Office of Habitat Conservation, NMFS designated EFH in state waters.

- Isobaths (Depth Contours): 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 may have been clipped along the 100m isobath, thus removing the probability boundary from areas shallower than the 100m isobath. Conversely, 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 may have been 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.
- United States' EEZ: For some pelagic species such as tunas, swordfish, billfish, and pelagic sharks, ranges extend beyond the U.S. EEZ and data points outside the EEZ may have resulted in probability boundaries being generated inside and outside the EEZ. The Magnuson-Stevens Act limits U.S. jurisdiction to areas within 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.
- Stationary features such as shelf edges and sea mounts: These features are more easily identifiable than current boundaries, and represent sites of higher abundance for some HMS on a seasonal basis.
- Depth limitations: Depth preferences of many Atlantic HMS are unknown, but reduced cost of archival tags has enabled researchers to provide more information on depths occupied by certain species. This information could be used to infer depth limitations in EFH descriptions; however, many HMS are broadly distributed in the pelagic environment, are poorly studied, and may exhibit variability in occupied depths (i.e., diurnal vertical movement through the water column or diving behaviors). Any definitions of EFH based on depth would therefore be done conservatively so as to not exclude habitats due to limited information available.

If none of the above parameters appeared to coincide with the edge of a probability boundary, NMFS would manually delineated straight lines around the perimeter of the probability boundary. Any modifications made to the 95 percent probability boundaries between the analyses completed for Amendment 1 and the analyses completed for Amendment 10 are the result of including new data into the model, or adjusting model output based on scientific advice concerning model results received from the Northeast or Southeast Fisheries Science Centers. Maps in Appendix G**Error! Reference source not found.** depict EFH by life stage and a visual comparison of the EFH boundaries delineated in Amendment 1 and the updated Amendment 10 EFH boundaries.

NMFS then subjected the probability boundaries to a QA/QC and peer review process that included multiple steps. In some cases, usually for data poor species, the probability boundaries resulted in discrete polygons drawn around clusters of points. In a few extreme cases, every known data point for a data poor species may have been included in the 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 was handled on a species by species basis depending upon expert knowledge of a given species' habitat requirements. NMFS either incorporated smaller pockets into larger areas if they fell within a given distance of a larger probability boundary or excluded them if they were smaller than a given size or beyond a given distance of a larger probability boundary. Where appropriate, NMFS also created new boundaries based on expert knowledge.

The resulting probability boundaries were 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 and distribution for a particular species; and then, if necessary, modified based on input from the scientists and analysis of the data. As mentioned above, EFH boundaries were determined based primarily on the data indicating the presence of species in a specific area. However, in some cases, new information from studies of life history dynamics of HMS, reports, and expert opinion were used to identify EFH. For some species and life stages, particularly YOY sharks (age less than one year) 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. However, in the case of some species, aggregation areas are recognized but the specific habitat characteristics that make these discrete habitats are unknown.

The sources that are used to identify EFH areas are referenced in the text and on the maps. 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.

The EFH regulations state that "FMPs must describe and identify EFH in text that clearly states the habitats or habitat types determined to be EFH for each life stage of the managed species" (600.815 (a)(1)). For each species in Chapter 6, NMFS has also provided text that clearly and concisely describes EFH boundaries and characteristics. This text describes finalized versions of the 95 percent volume contour boundaries subjected to QAQC and internal agency review with subject matter experts, as described above.

Maps depicting the updated EFH boundaries are included in this chapter, in Appendix G, and on the Atlantic HMS webpage. Shapefiles will also be made available in an online mapping program through the final implementation of this final amendment and on the Atlantic HMS webpage. After the amendment has been finalized in 2017, the updated EFH boundaries will replace those currently presented in the EFH Habitat Mapper: http://www.habitat.noaa.gov/protection/efh/efhmapper/index.html

EFH Delineation: Bluefin Tuna Example

This section demonstrates how EFH was updated for a species. This section does not demonstrate how a HAPC is delineated; that demonstration is provided below.

The data used to evaluate EFH for the "Spawning, Eggs, and Larval" life stage largely consists of Southeast Area Monitoring and Assessment Program (SEAMAP) data (annual ichthyoplankton surveys for larval fish). Other data sources include scientists from the NOAA SEFSC, and data from Richardson et al. 2016. The example below shows the individual data points; however, other EFH maps included in this final amendment do not display data points in accordance with NOAA Fisheries' data confidentiality protocols. Since the Gulf of Mexico data points are scientific survey data, this example does not have the same confidentiality concerns associated with other data. The input data are shown in Figure F 1, and include 1,174 data points where bluefin tuna larvae were collected between 1982 and 2014.

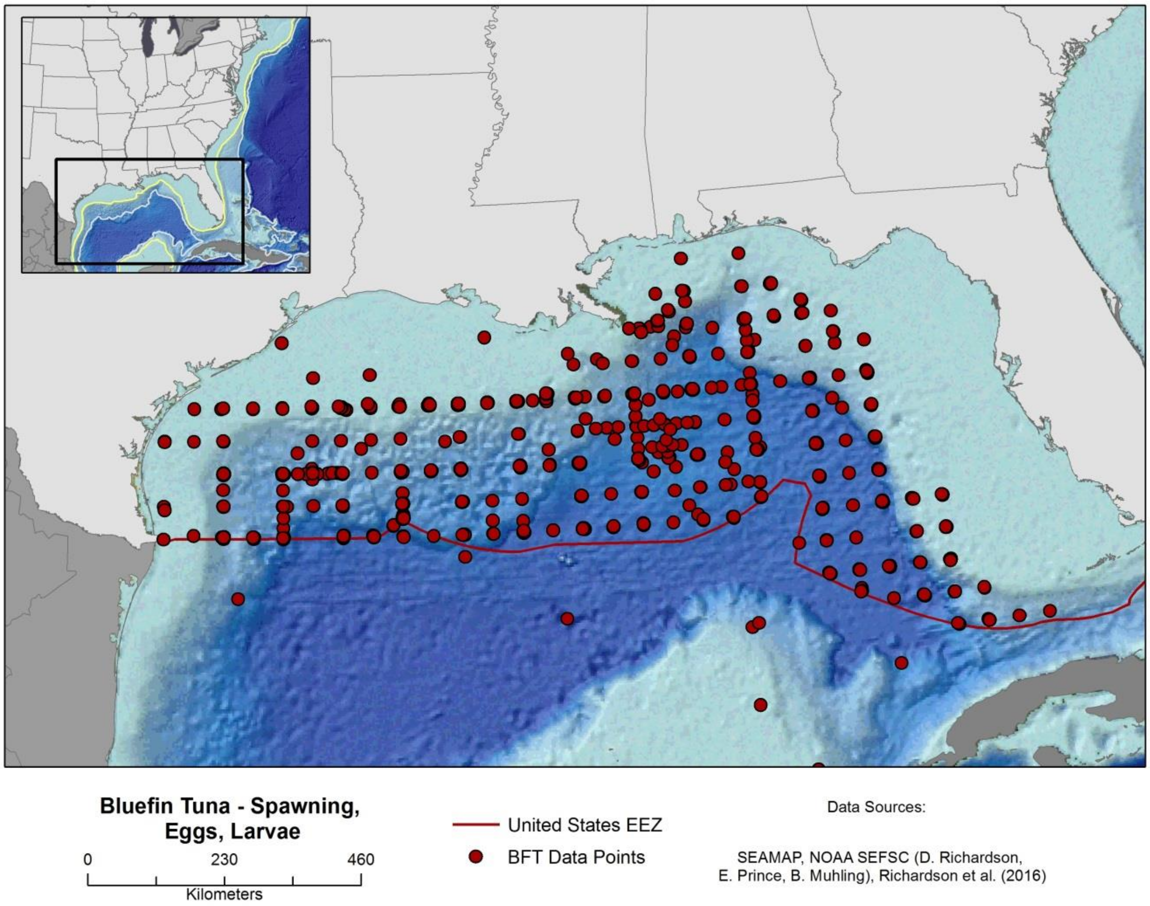
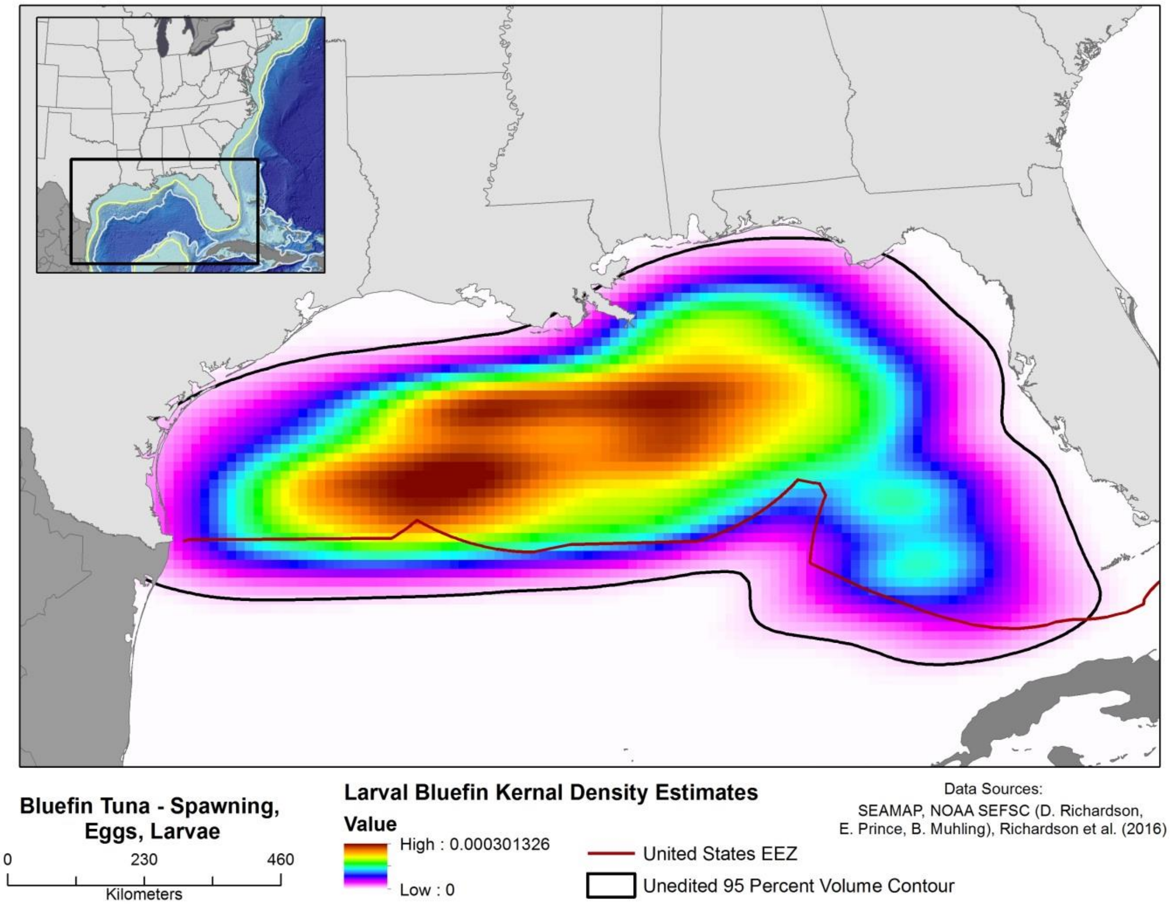


Figure F 1 Raw data points representing locations where bluefin tuna larvae were collected by NMFS' SEAMAP ichthyoplankton surveys

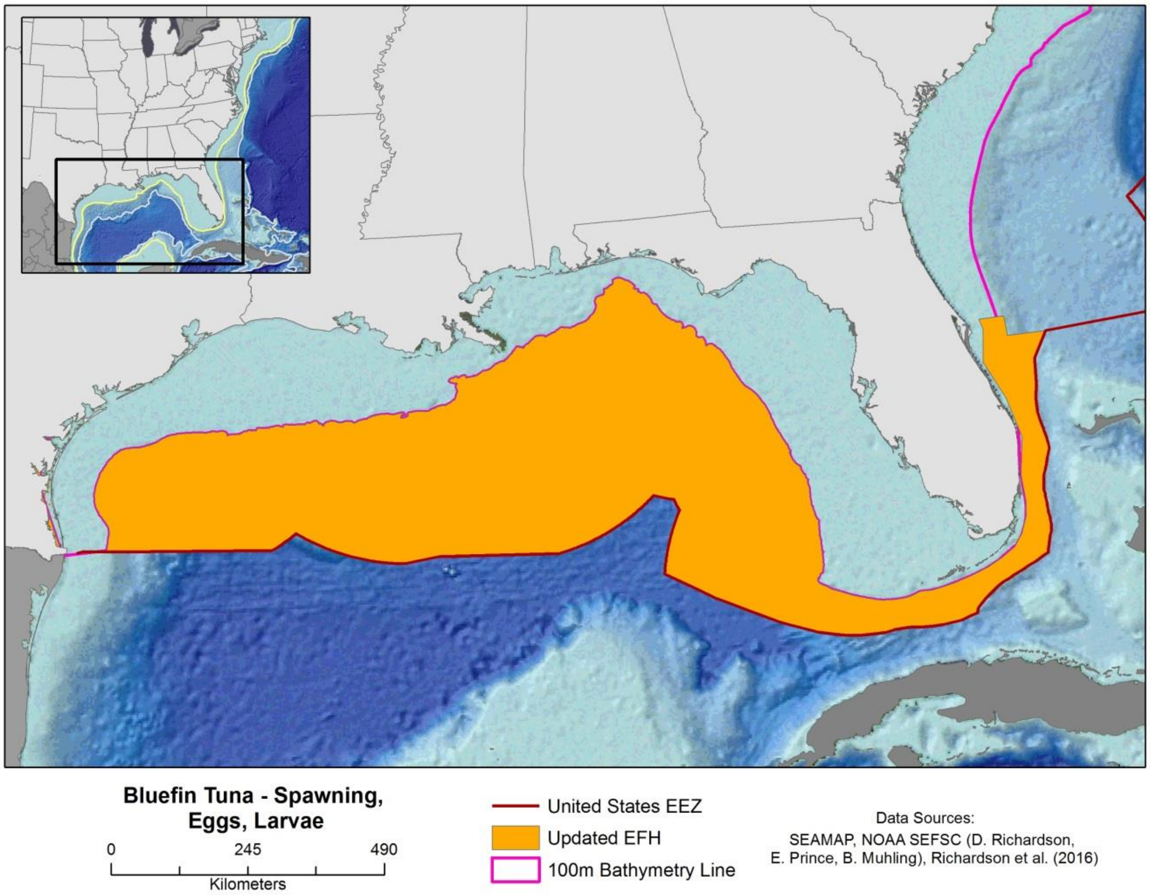
The Geospatial Modeling Environment kernal density estimation model, produced model output in the form of a raster grid, with each grid cell assigned an estimated density of larval bluefin tuna, shown in Figure F 2. High density values are shown in dark red. Low density values are represented by blue, purple, and pink (areas where the model estimates no larval bluefin are shown in white). Using the Isopleth tool that is available in Geospatial Modeling Environment, NMFS calculated the 95 percent volume contour (shown as a heavy black line) surrounding an estimated 95 percent of the data points used in the analysis.



Data Sources:
SEAMAP, NOAA SEFSC (D. Richardson, E. Prince, B. Muhling), Richardson et al. (2016)

Figure F 2 Output from a kernal density estimation model displaying estimated densities of larval bluefin tuna in the Gulf of Mexico

After generating the 95 percent volume contour shapefile, NMFS then performed QAQC procedures to generate an EFH boundary that is consistent with EFH policies and the best available scientific information. In this case, NMFS clipped the 95 percent volume contour at the United States' EEZ (since NMFS cannot designate EFH outside of U.S. territorial waters) and along the 100m isobath in the Gulf of Mexico, and extended EFH for this life stage through the Florida Straits (Figure F3). The original 95 percent volume contour, shown in Figure F 2, was clipped at the 100-m bathymetric line, at the United States' EEZ, and extended through the Florida Straits in accordance with scientific advice provided by the NOAA SEFSC. Clipping at the 100m bathymetric contour removed locations where the EFH intersected with land and inshore waters. NMFS removed land from all EFH designations, and where appropriate, removed areas that intersected with inshore waters (e.g., sounds, bays, rivers, lakes, etc.).



Data Sources:
SEAMAP, NOAA SEFSC (D. Richardson, E. Prince, B. Muhling), Richardson et al. (2016)

Figure F 3 Updated Essential Fish Habitat for Bluefin Tuna Spawning, Eggs, and Larvae in the Gulf of Mexico and the Florida Straits

Recently, research was published suggesting that the Slope Sea could be considered spawning grounds for western Atlantic bluefin tuna (Figure F4, from Richardson et al. 2016). The Slope Sea is defined as a region located off the continental shelf of the northeastern United States, roughly between Cape Hatteras and Georges Bank, which is bounded to the south by the Gulf Stream. NMFS included data associated with this paper in the delineation of EFH, and kernal density estimation model output implied that two discrete areas could be considered as EFH for this life stage (Figure F 5); one off the coast of North Carolina, and one south of Georges Bank along the outer extent of the United States' EEZ.

This region has not yet been recognized as a spawning ground for stock assessment purposes. NMFS recommends additional research in this region to assess production and contribution of this area to overall stock numbers, natal origin of larvae (western or eastern stock), and additional survey research to better delineate the boundaries of spawning within this area.

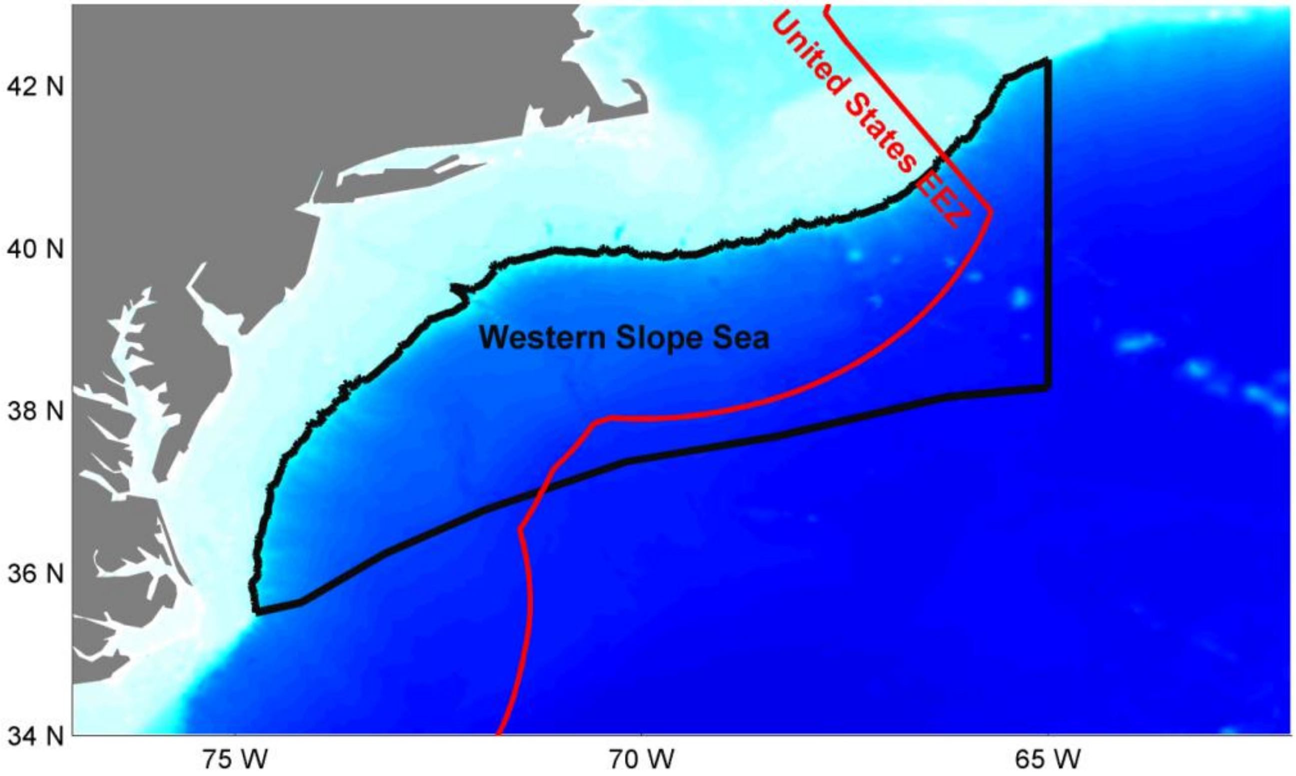


Figure F 4 Approximate location of the Slope Sea off the northeastern United States

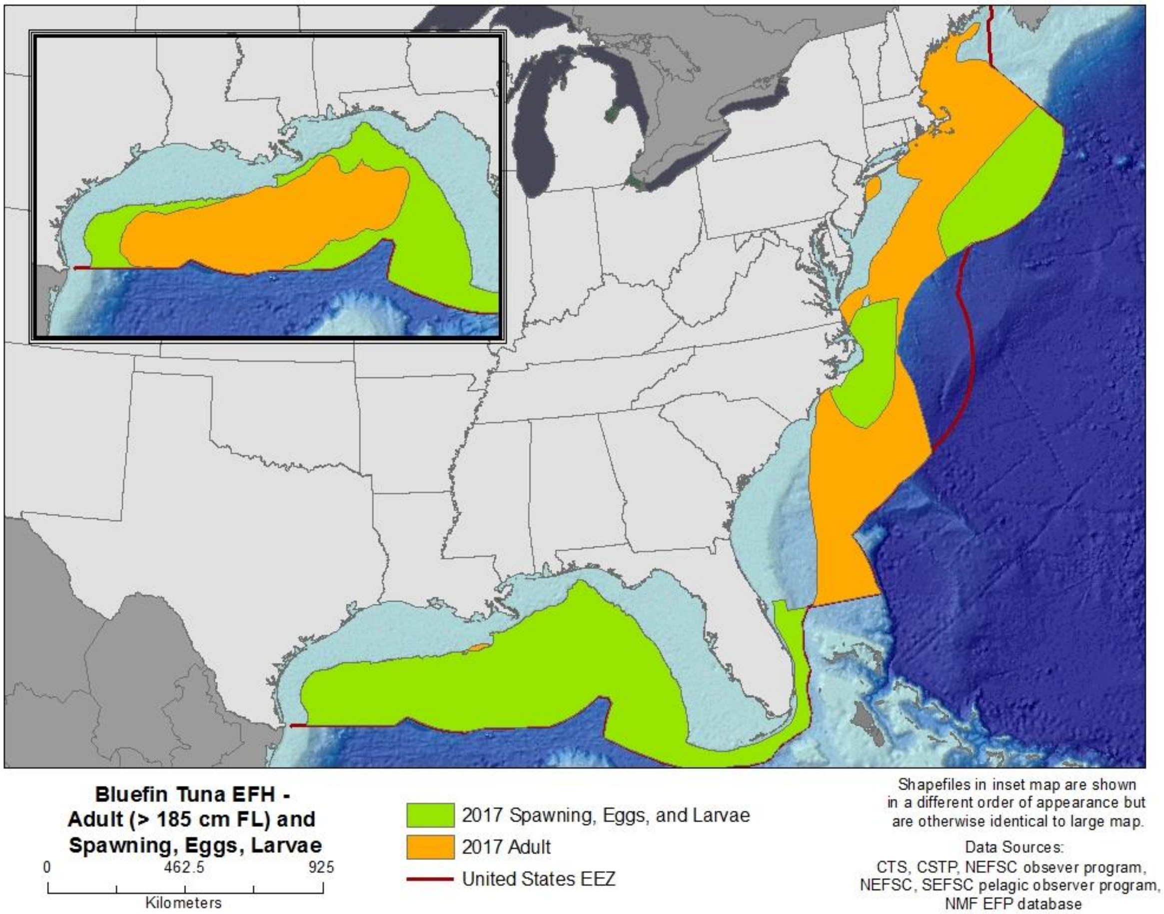


Figure F 5 Bluefin Tuna EFH Model Output in the Northeastern United States EEZ, primarily based on recent research by Richardson et al. (2016) which suggests possible spawning activity in the Slope Sea

Appendix G Maps of Existing and Updated Essential Fish Habitat for Atlantic HMS

This appendix provides a library of EFH maps for 44 species (46 stocks) of Atlantic HMS. The shark species have been separated into neonate/young-of-year (YOY), juvenile, and adult life stages where possible; and tunas, billfishes, and swordfish have been separated into spawning/eggs/larvae, juvenile, and adult life stages where possible, based on literature and advice provided by NOAA Fisheries scientists. The sizes used to determine species life stages are in Appendix B. Geospatial analysis methods are in Appendix F.

Atlantic Tunas

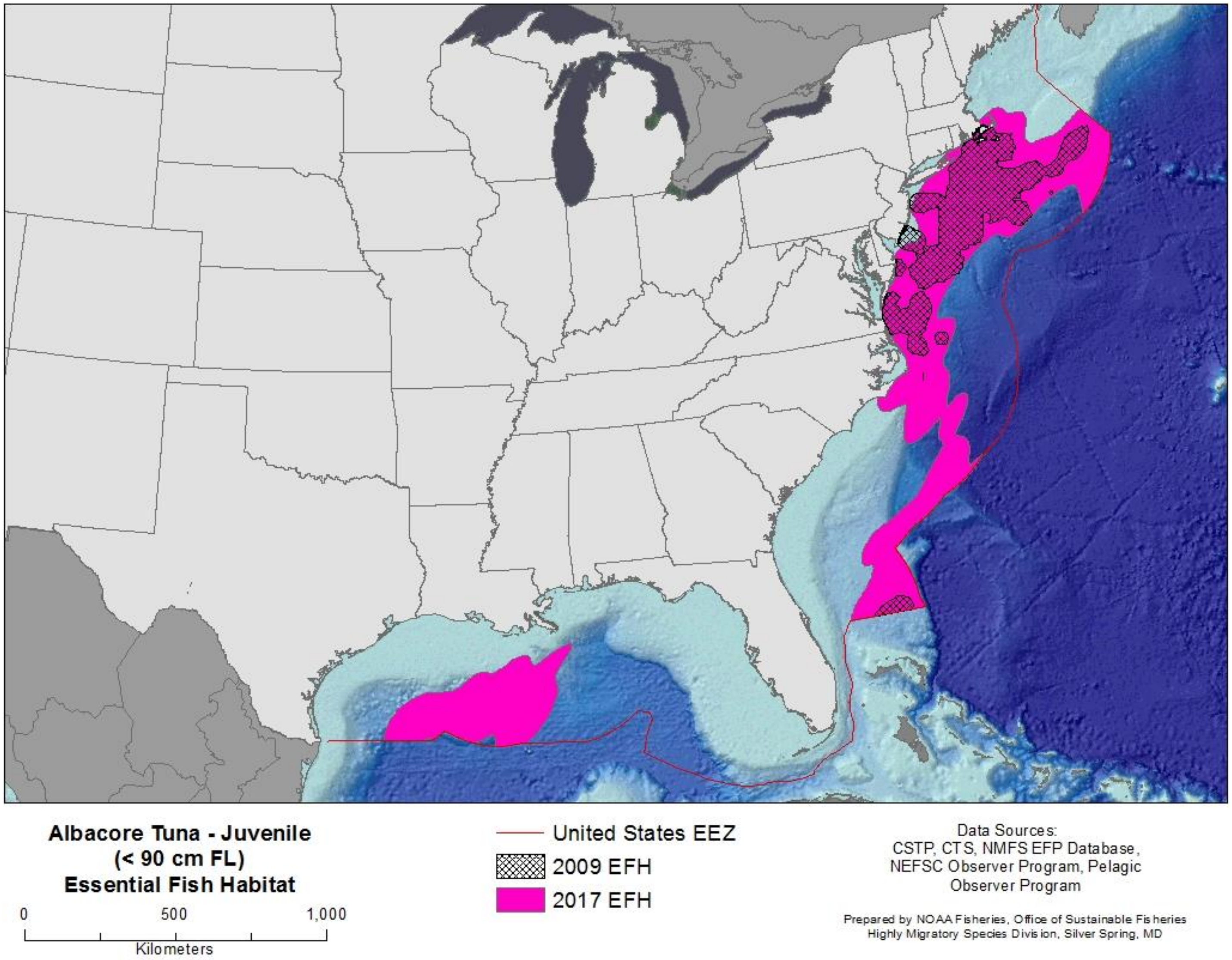


Figure G 1 **Albacore Tuna - Juvenile**

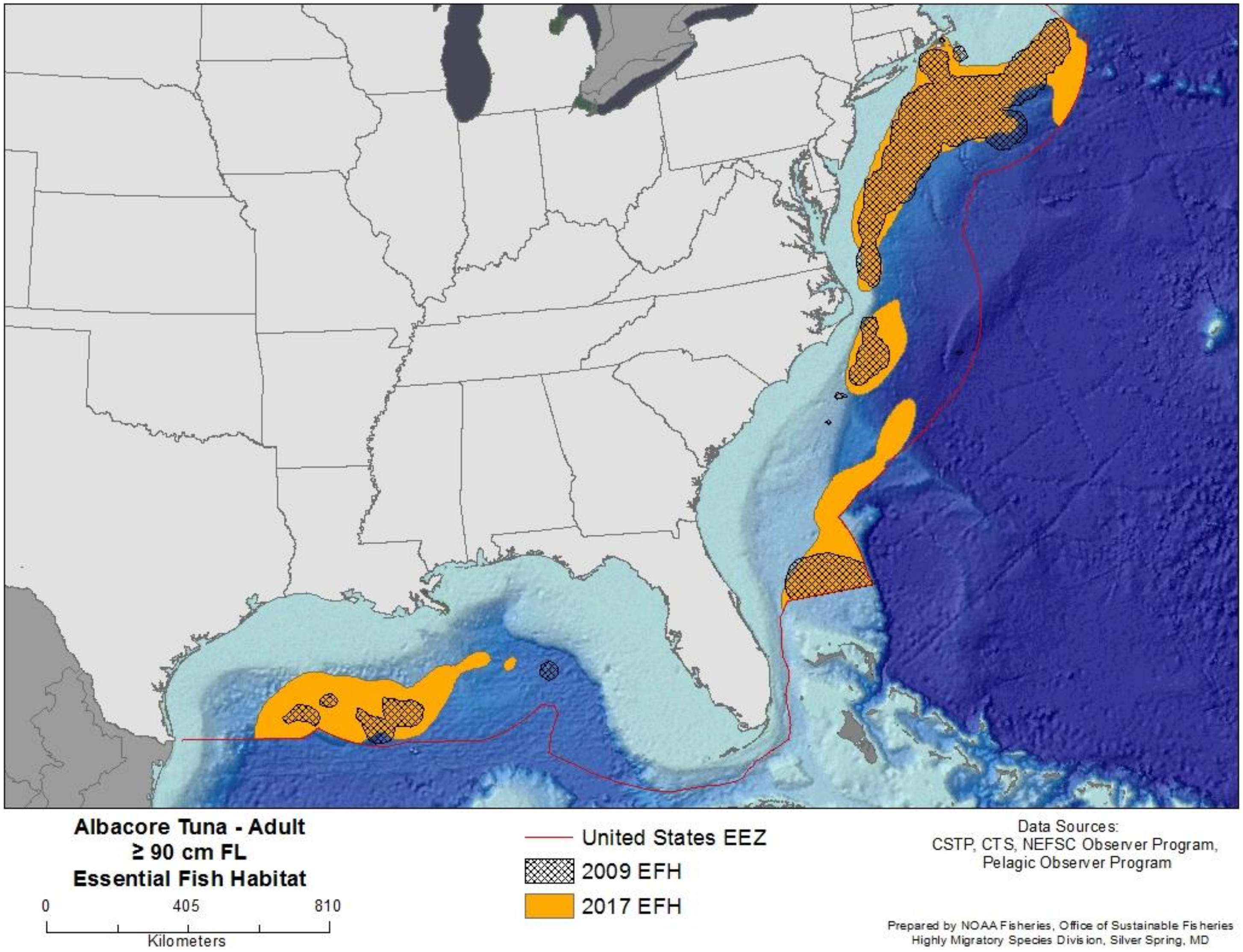


Figure G 2 **Albacore Tuna - Adult**

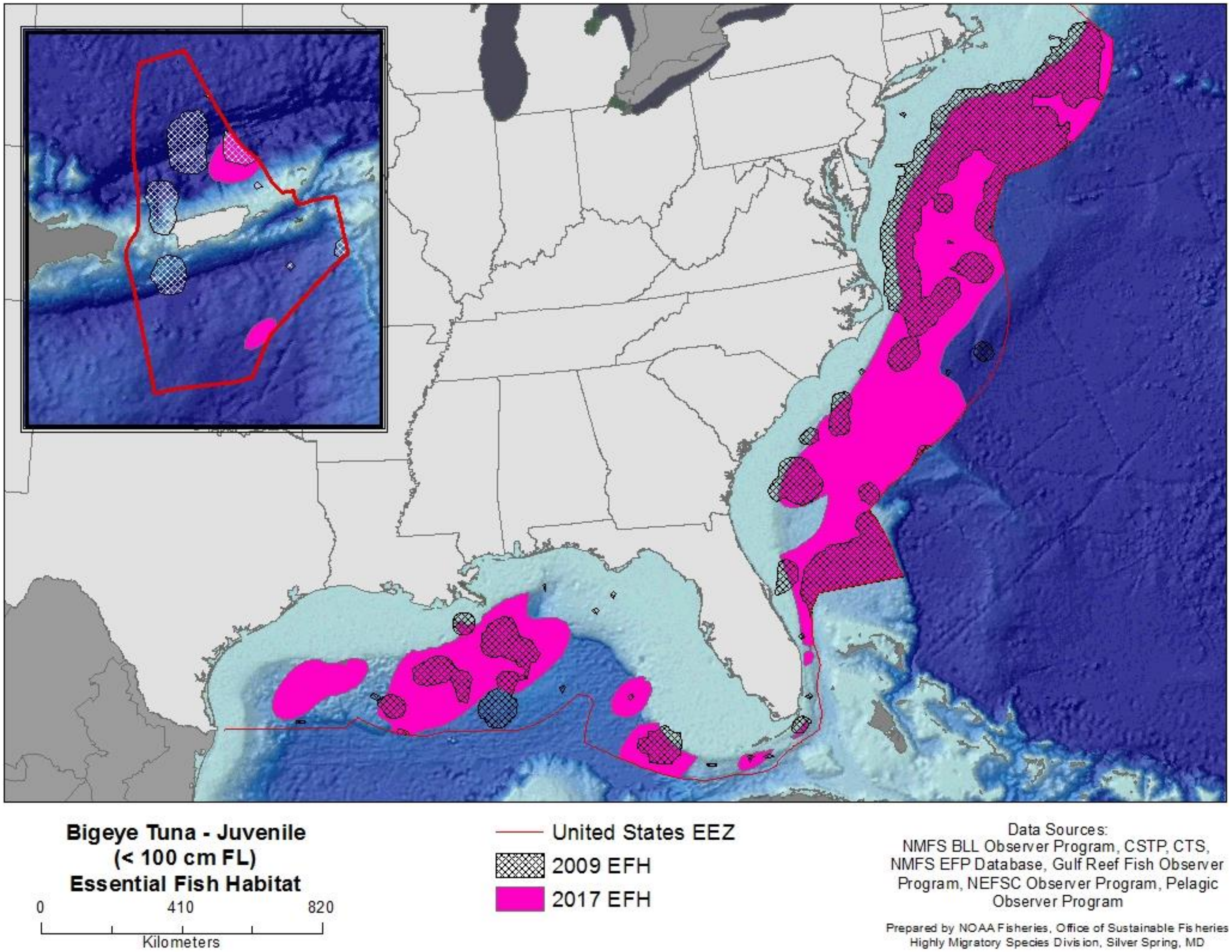


Figure G 3 **Bigeye Tuna - Juvenile**

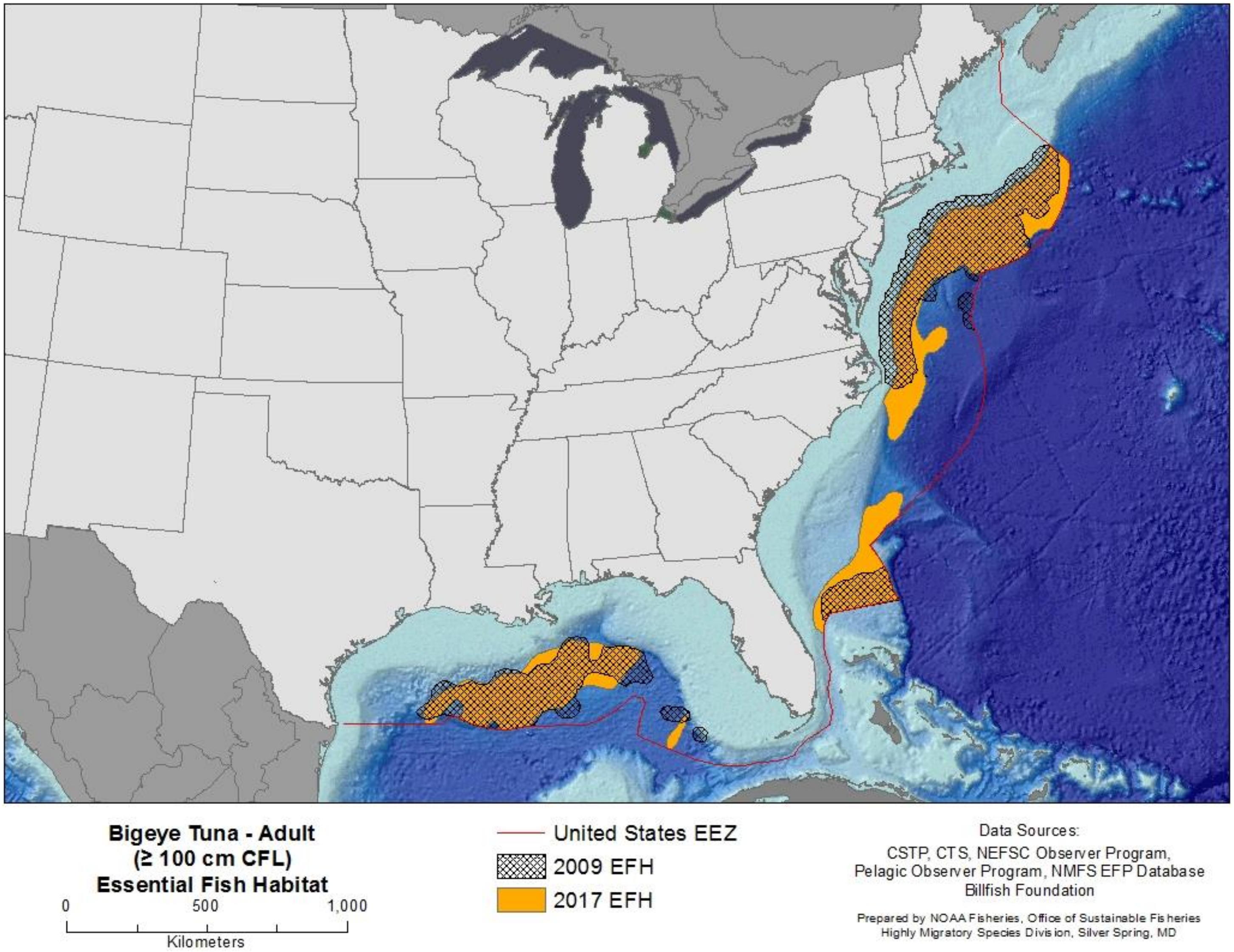
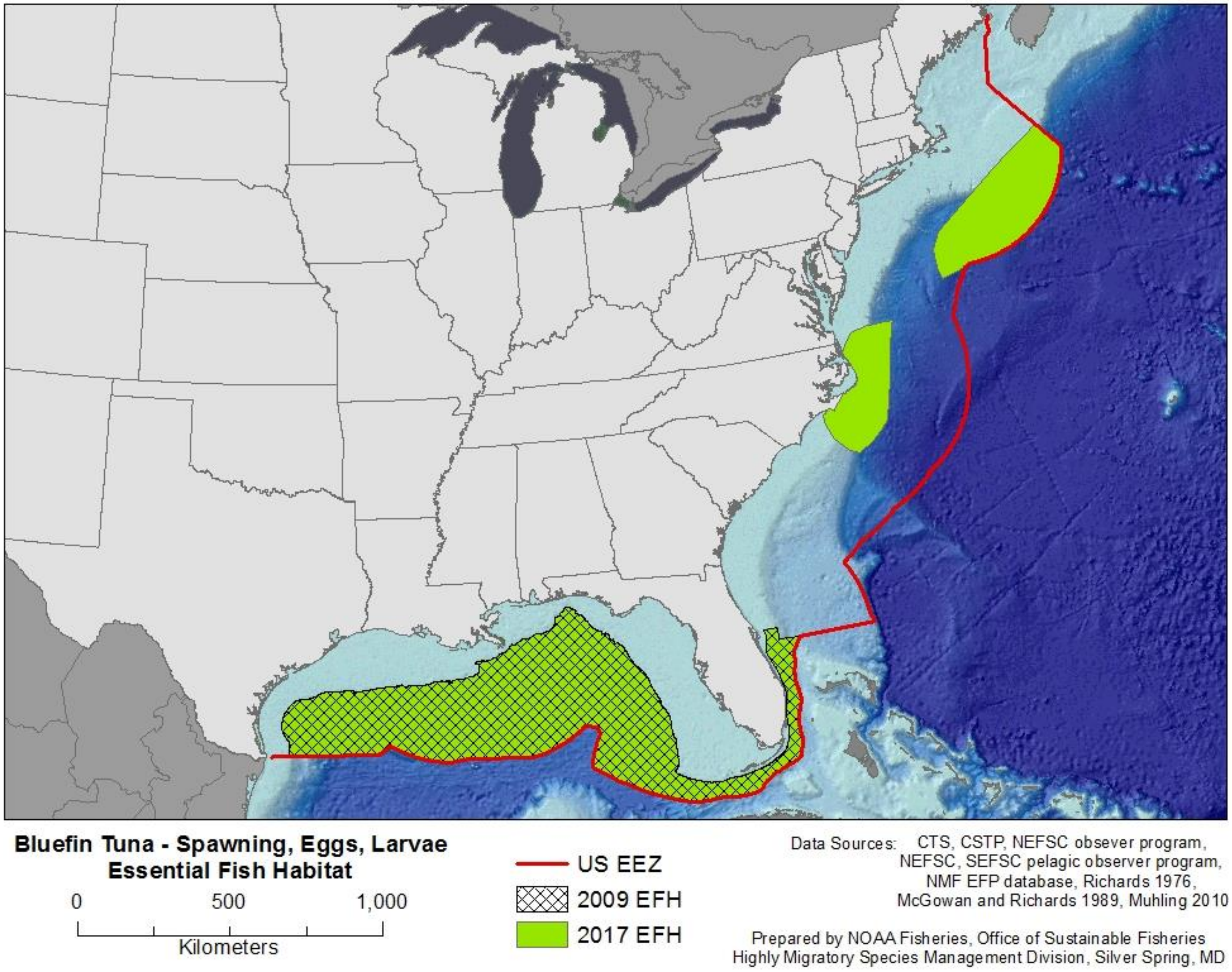


Figure G 4 **Bigeye Tuna – Adult**



Data Sources: CTS, CSTP, NEFSC observer program, NEFSC, SEFSC pelagic observer program, NMF EFP database, Richards 1976, McGowan and Richards 1989, Muhling 2010

Prepared by NOAA Fisheries, Office of Sustainable Fisheries Highly Migratory Species Management Division, Silver Spring, MD

Figure G 5 Bluefin Tuna – Spawning, Eggs, and Larvae

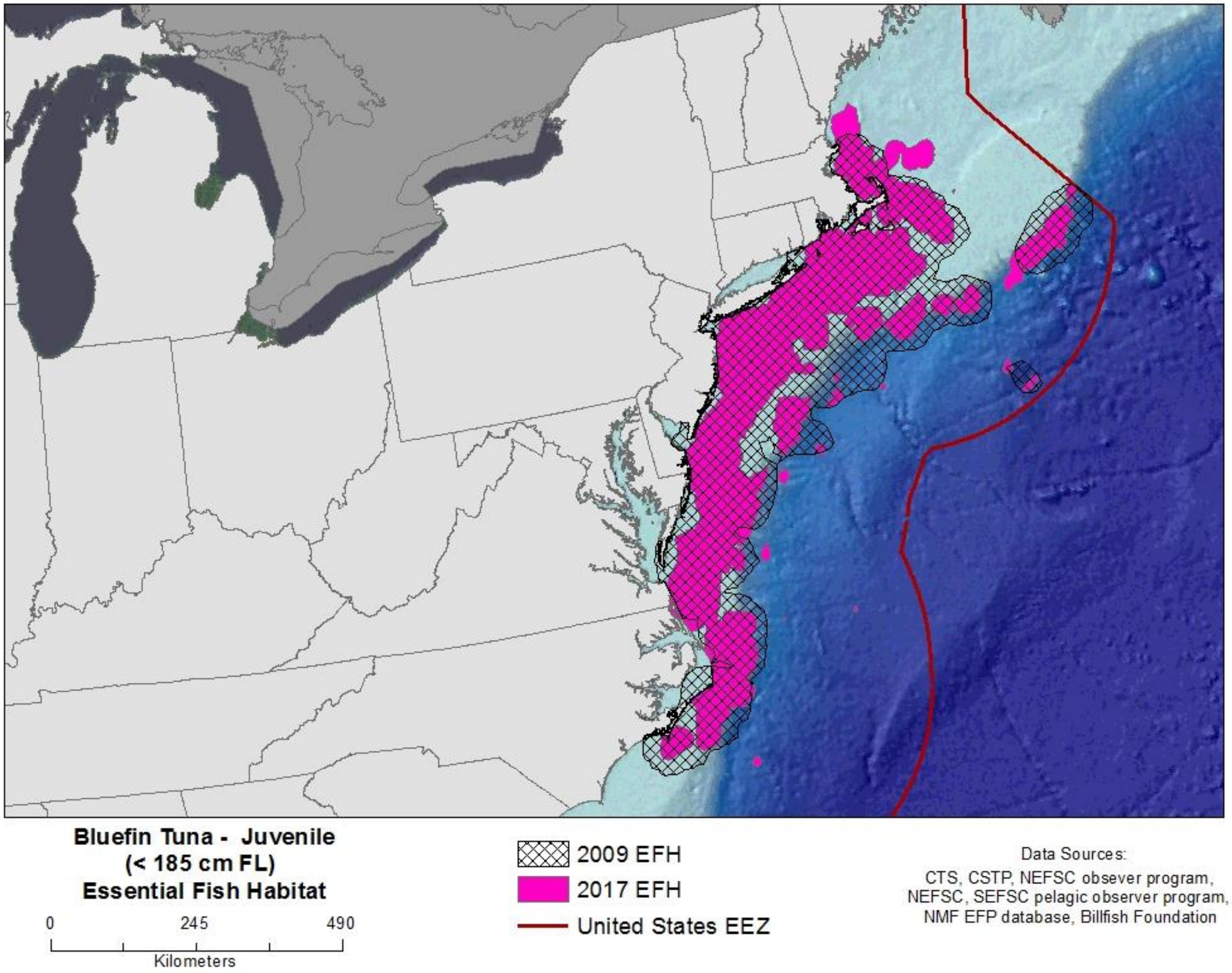


Figure G 6 **Bluefin Tuna – Juvenile**

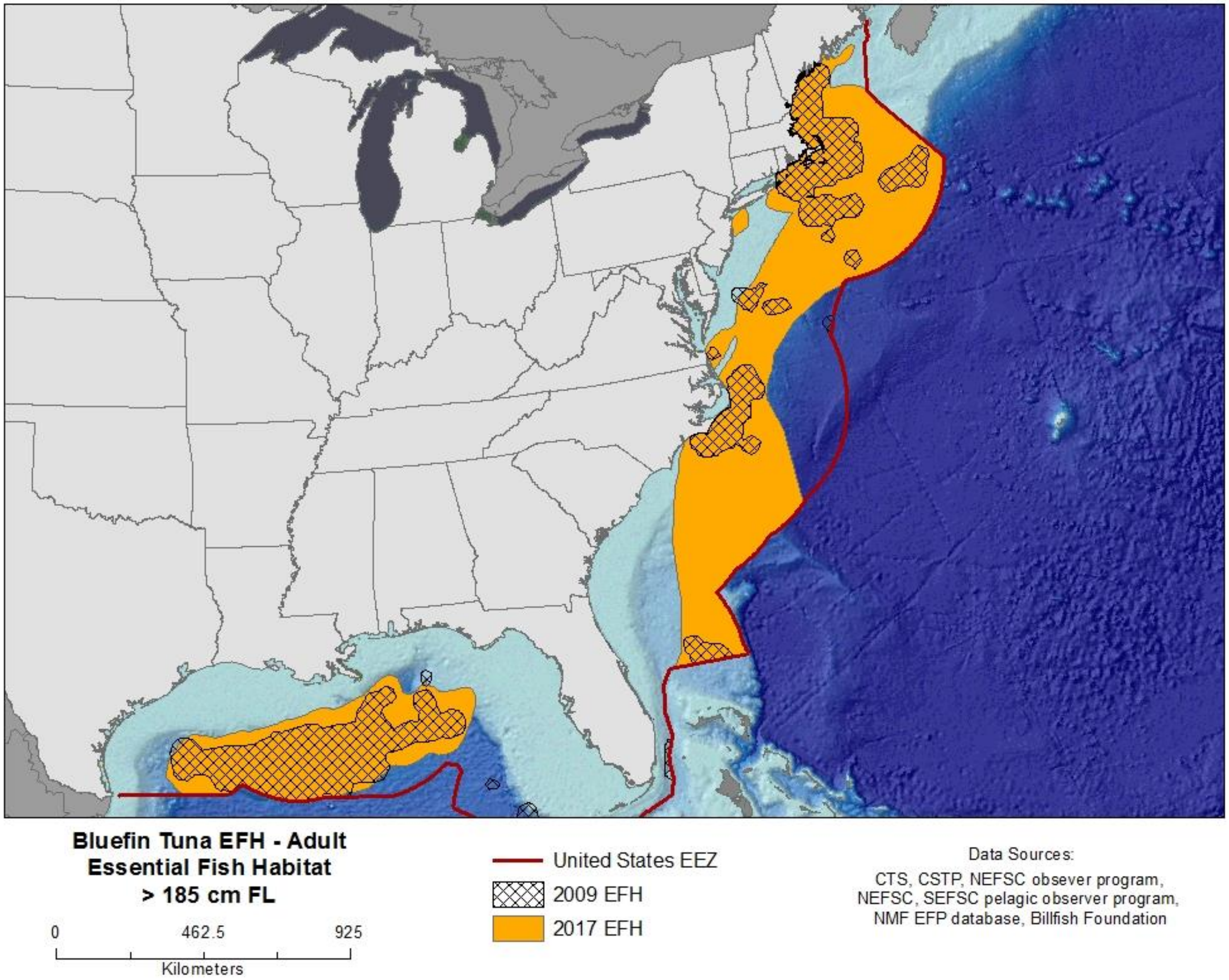


Figure G 7 **Bluefin Tuna - Adult**

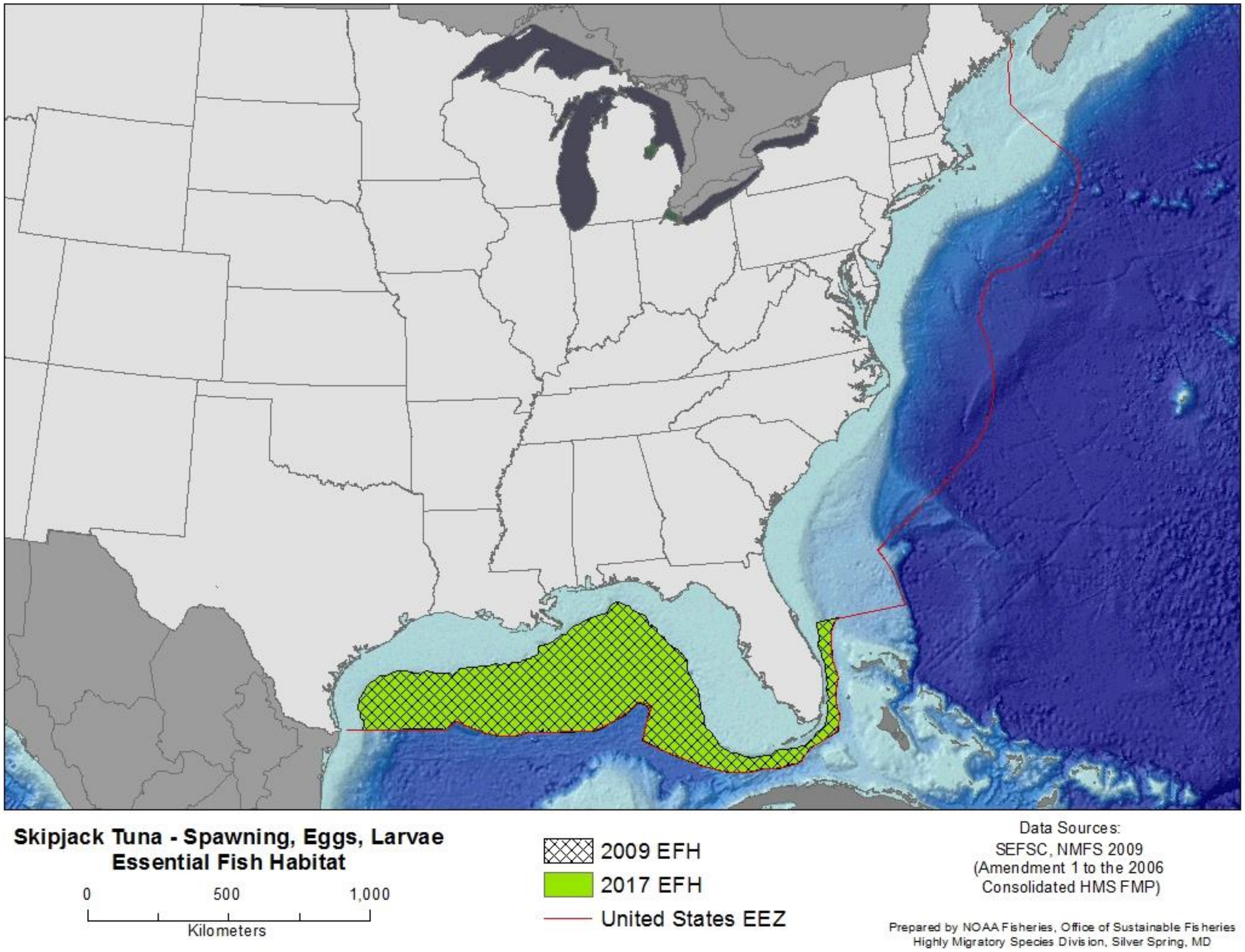


Figure G 8 **Skipjack Tuna – Spawning, Eggs, and Larvae**

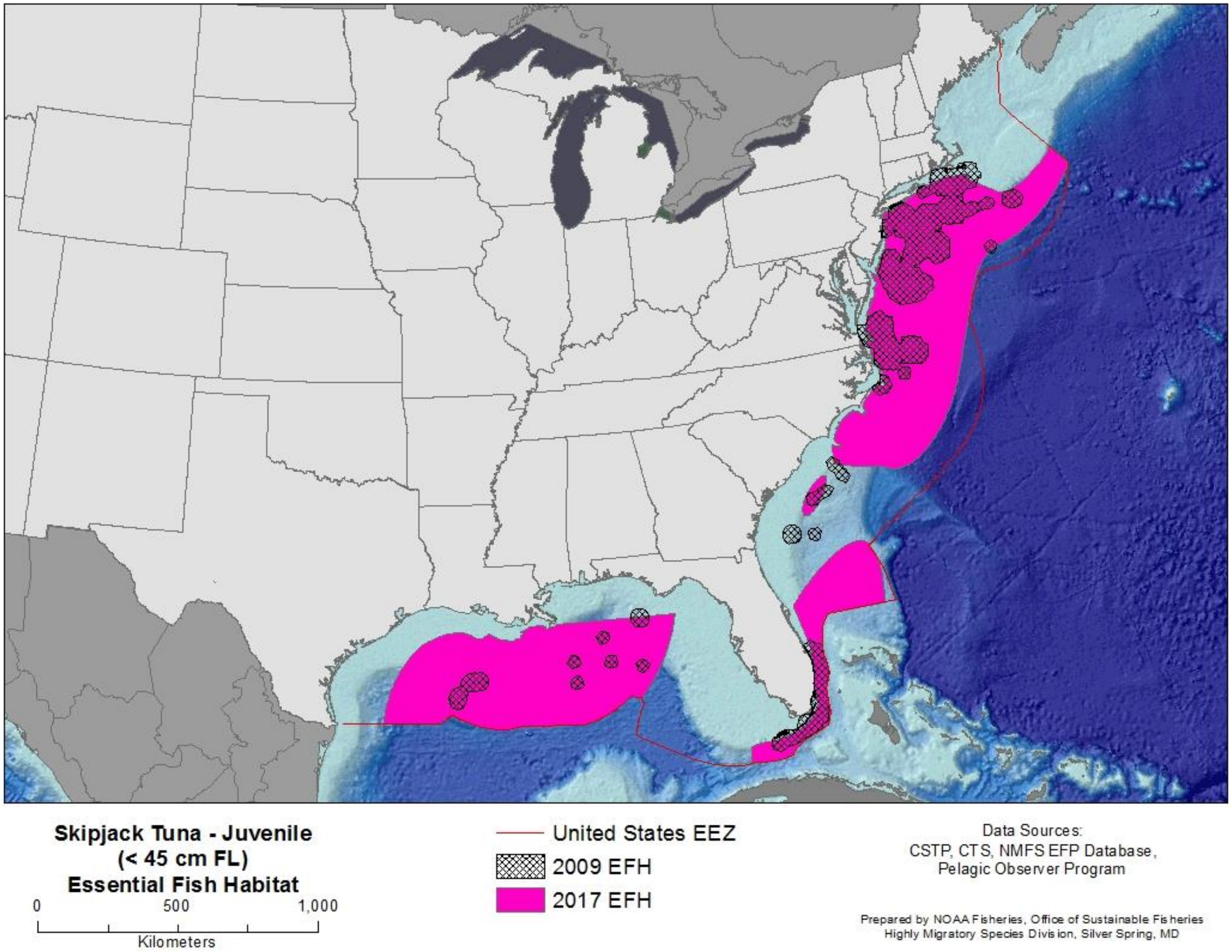


Figure G 9 **Skipjack Tuna - Juvenile**

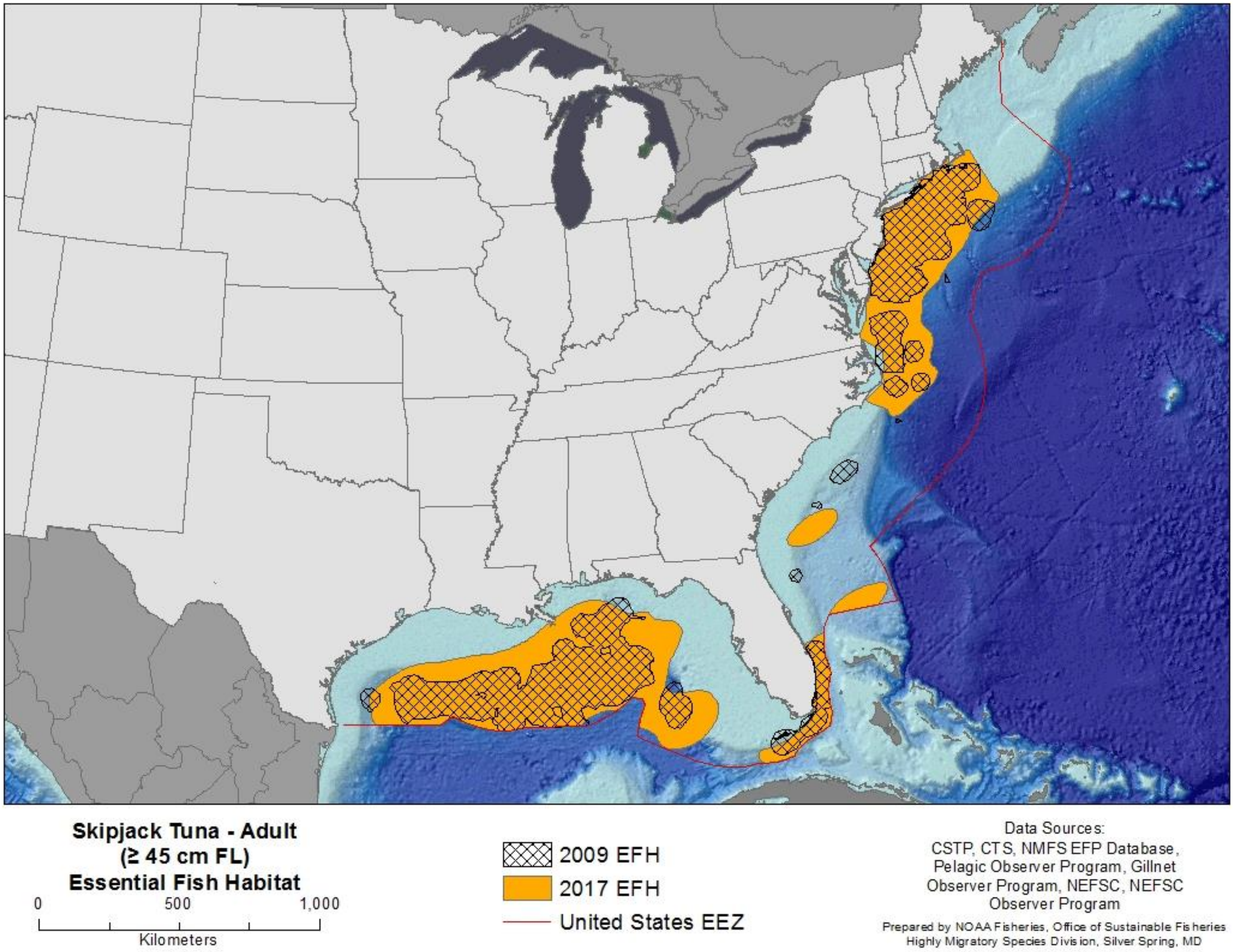


Figure G 10 **Skipjack Tuna - Adult**

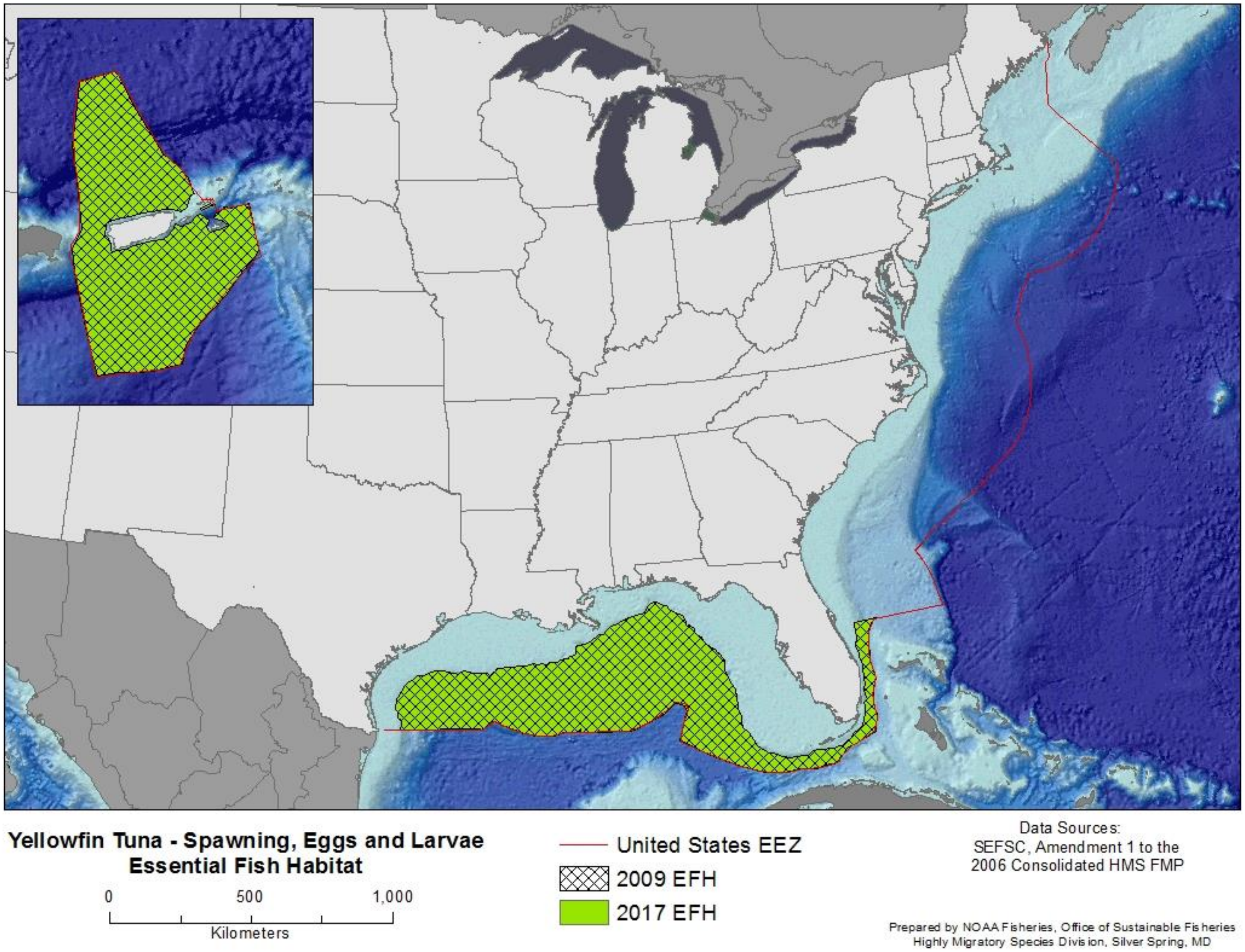


Figure G 11 Yellowfin Tuna – Spawning, Eggs, and Larvae

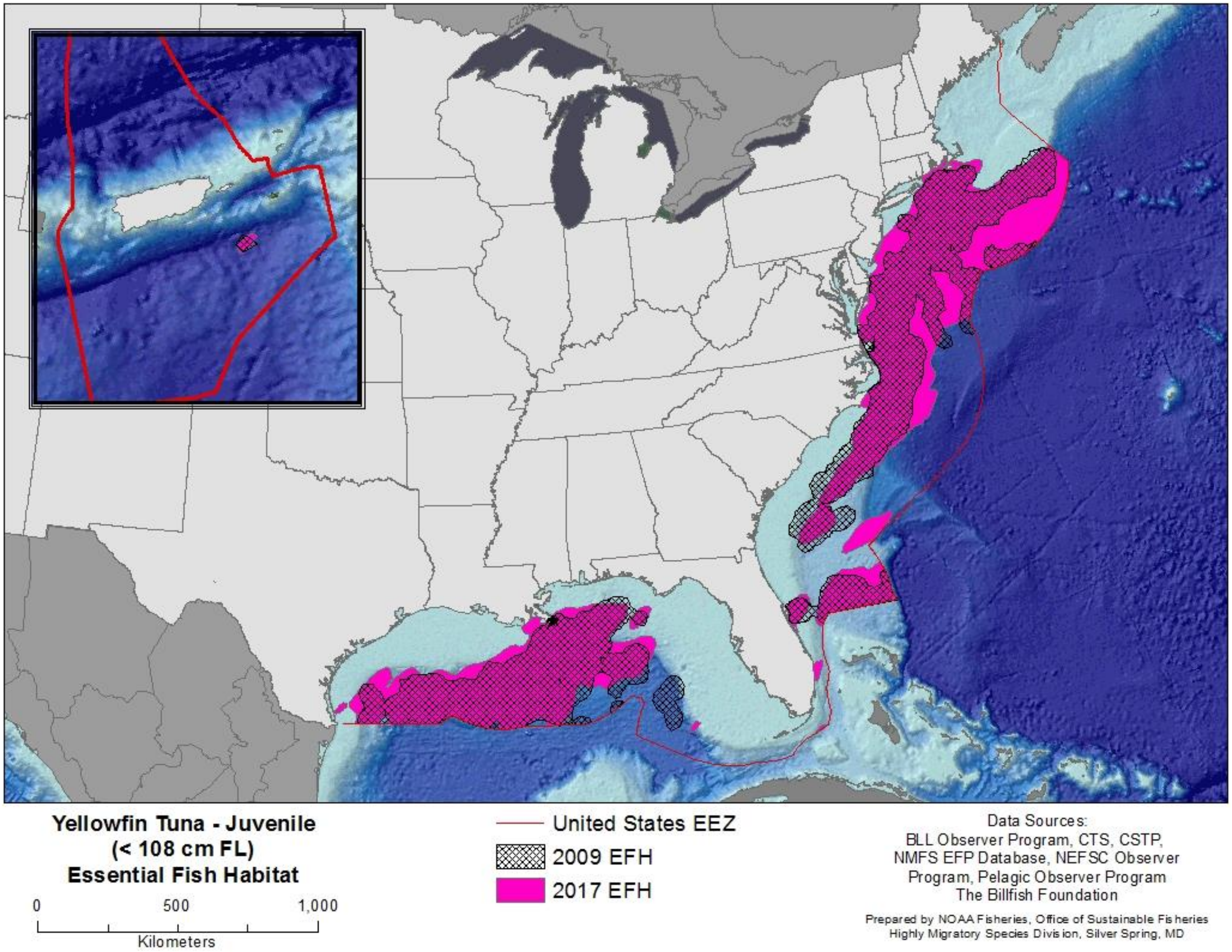
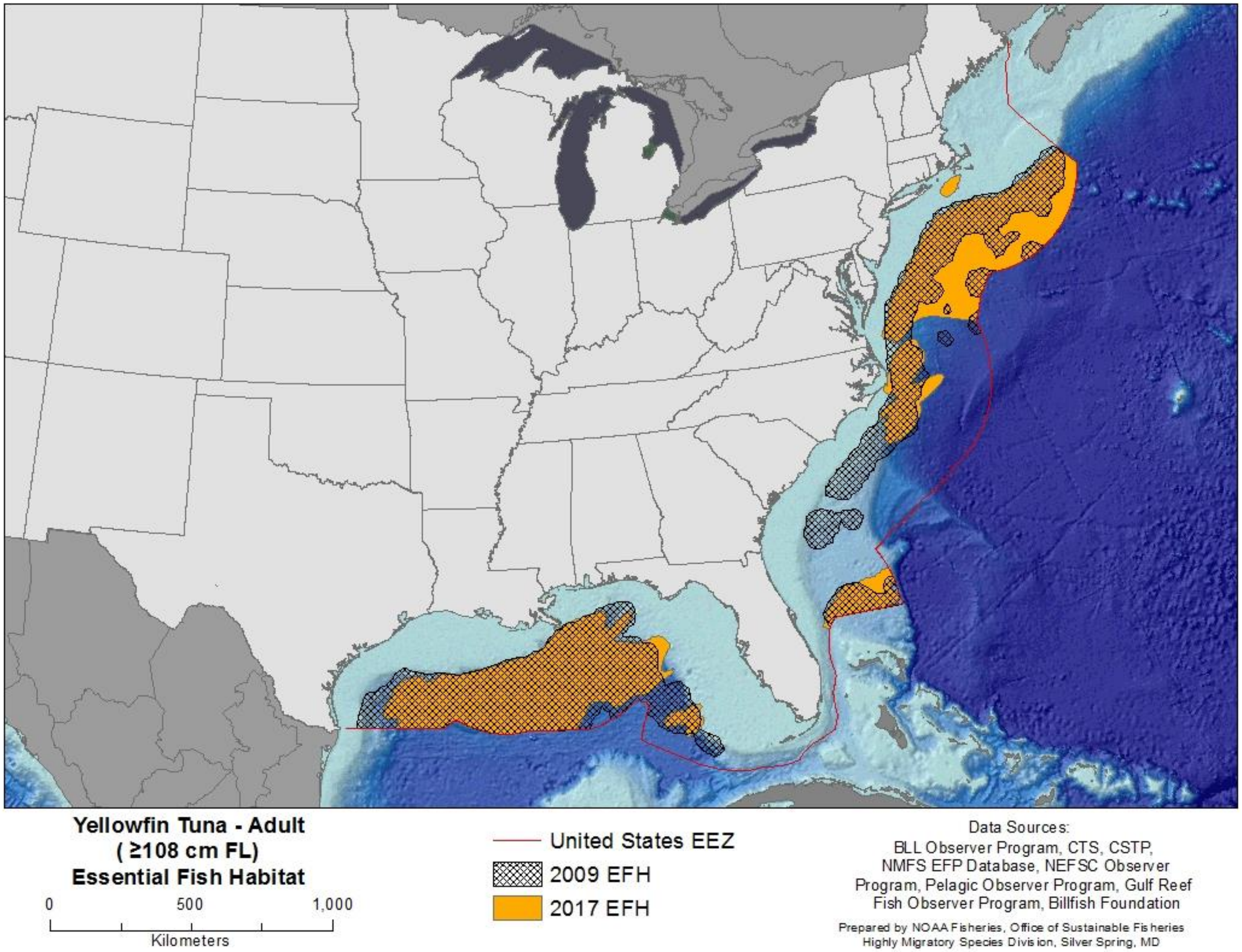


Figure G 12 **Yellowfin Tuna - Juvenile**



Data Sources:
BLL Observer Program, CTS, CSTP, NMFS EFP Database, NEFSC Observer Program, Pelagic Observer Program, Gulf Reef Fish Observer Program, Billfish Foundation

Prepared by NOAA Fisheries, Office of Sustainable Fisheries
Highly Migratory Species Division, Silver Spring, MD

Figure G 13 **Yellowfin Tuna - Adult**

Swordfish

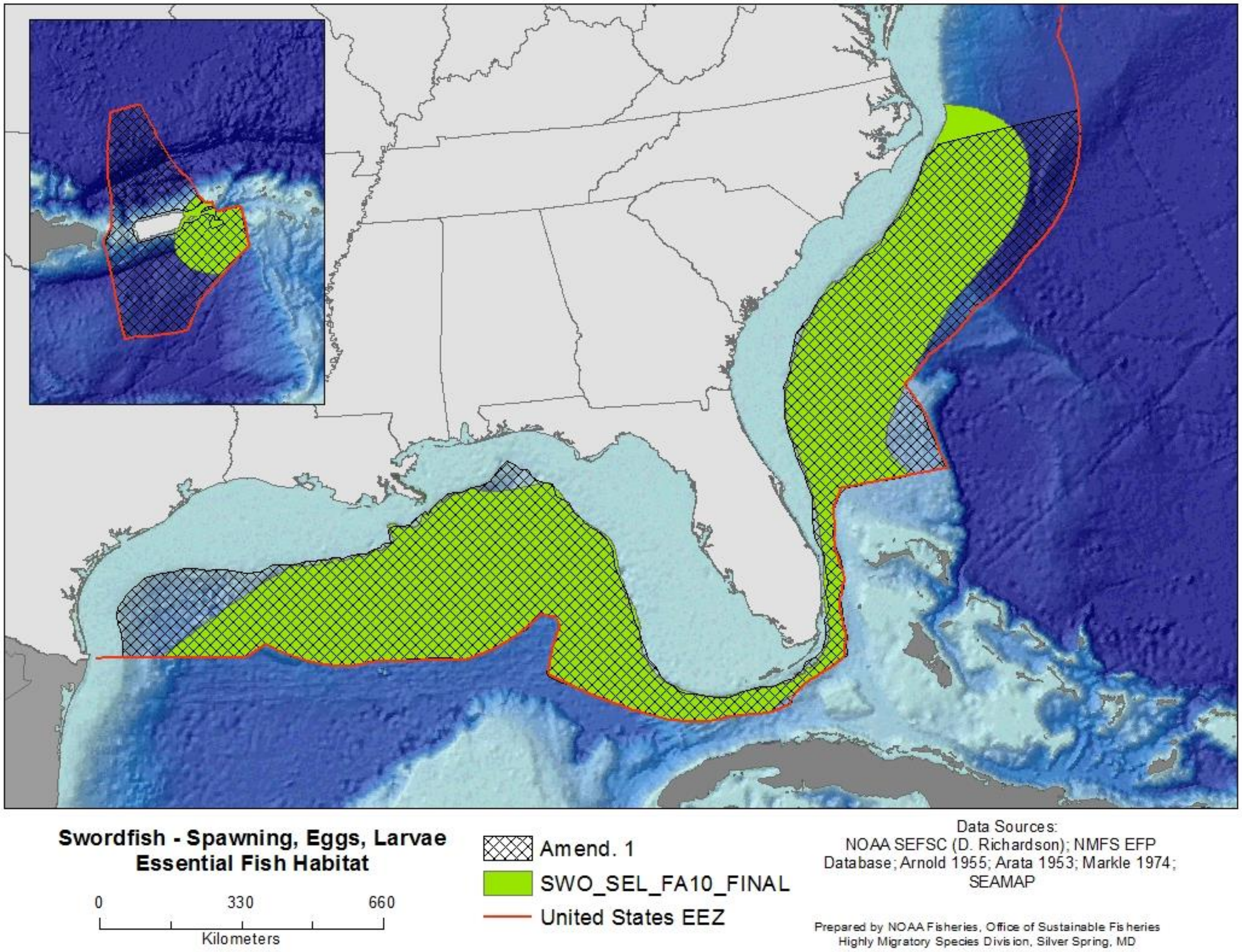
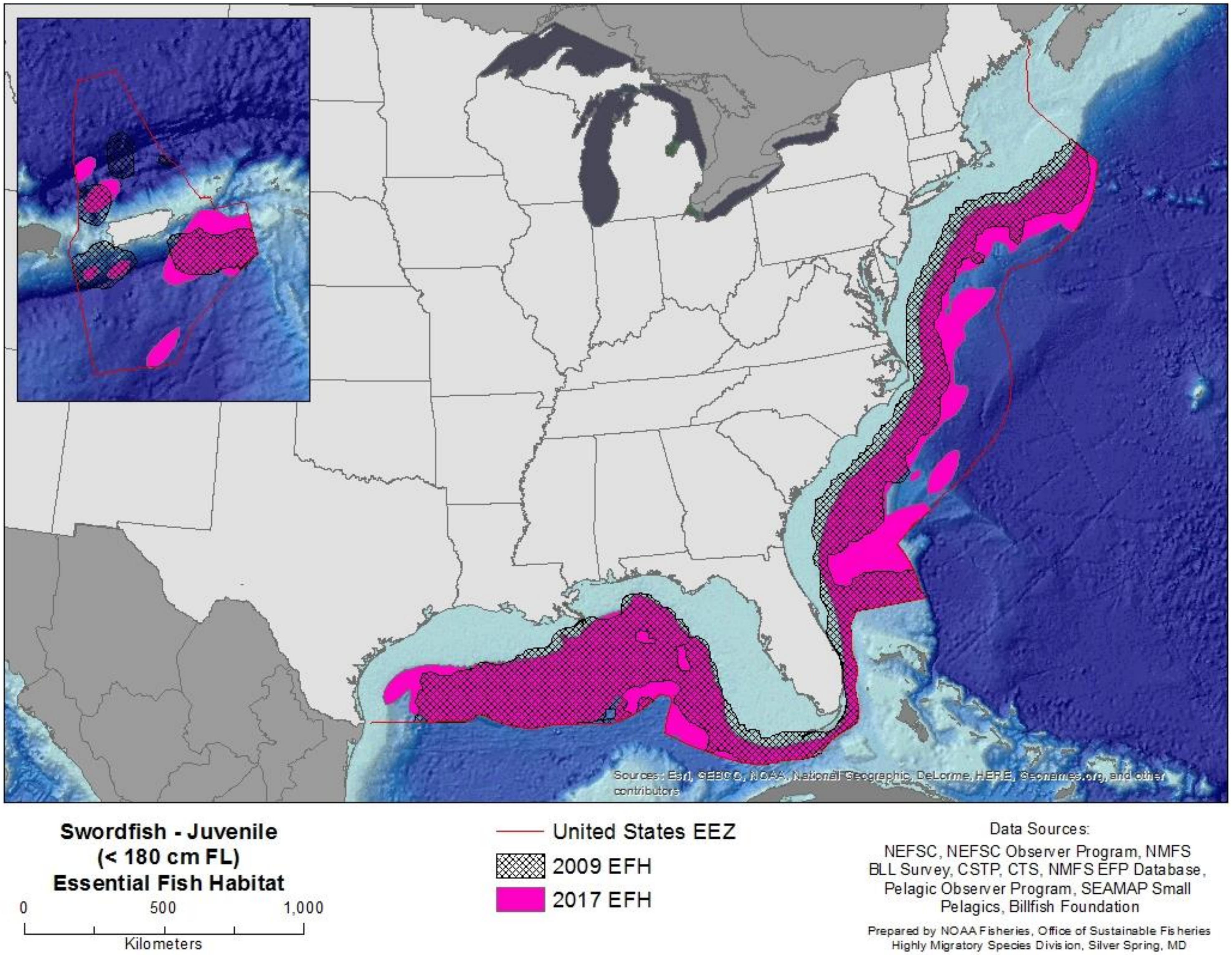


Figure G 14 Swordfish – Spawning, Eggs, Larvae



Sources: Esri, GEBCO, NOAA, National Geographic, DeLorme, HERE, Geonames.org, and other contributors

Data Sources:
NEFSC, NEFSC Observer Program, NMFS BLL Survey, CSTP, CTS, NMFS EFP Database, Pelagic Observer Program, SEAMAP Small Pelagics, Billfish Foundation

Prepared by NOAA Fisheries, Office of Sustainable Fisheries
Highly Migratory Species Division, Silver Spring, MD

Figure G 15 **Swordfish - Juvenile**

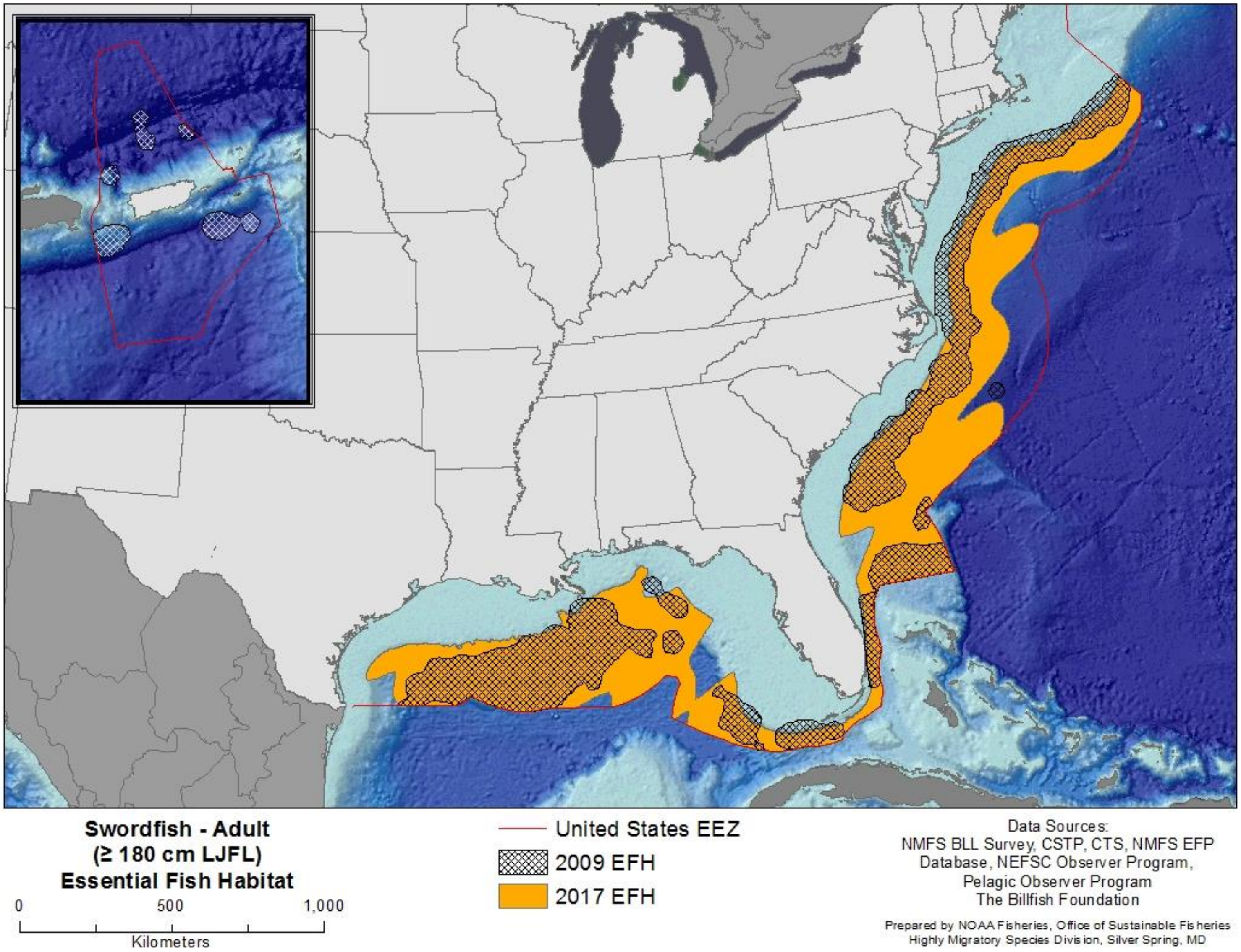
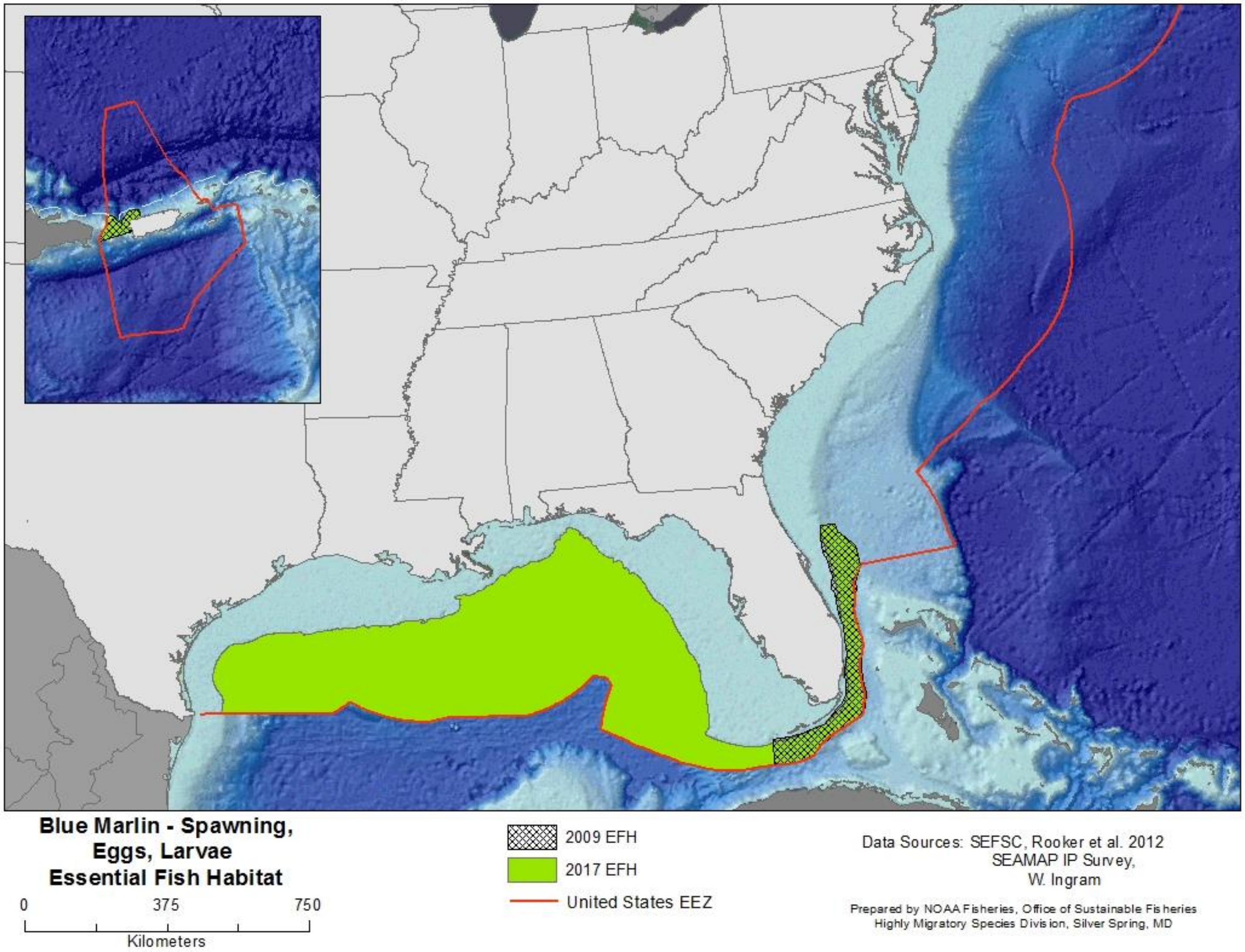


Figure G 16 **Swordfish - Adult**

Billfishes



Data Sources: SEFSC, Rooker et al. 2012
SEAMAP IP Survey,
W. Ingram

Prepared by NOAA Fisheries, Office of Sustainable Fisheries
Highly Migratory Species Division, Silver Spring, MD

Figure G 17 **Blue Marlin – Spawning, Eggs, Larvae**

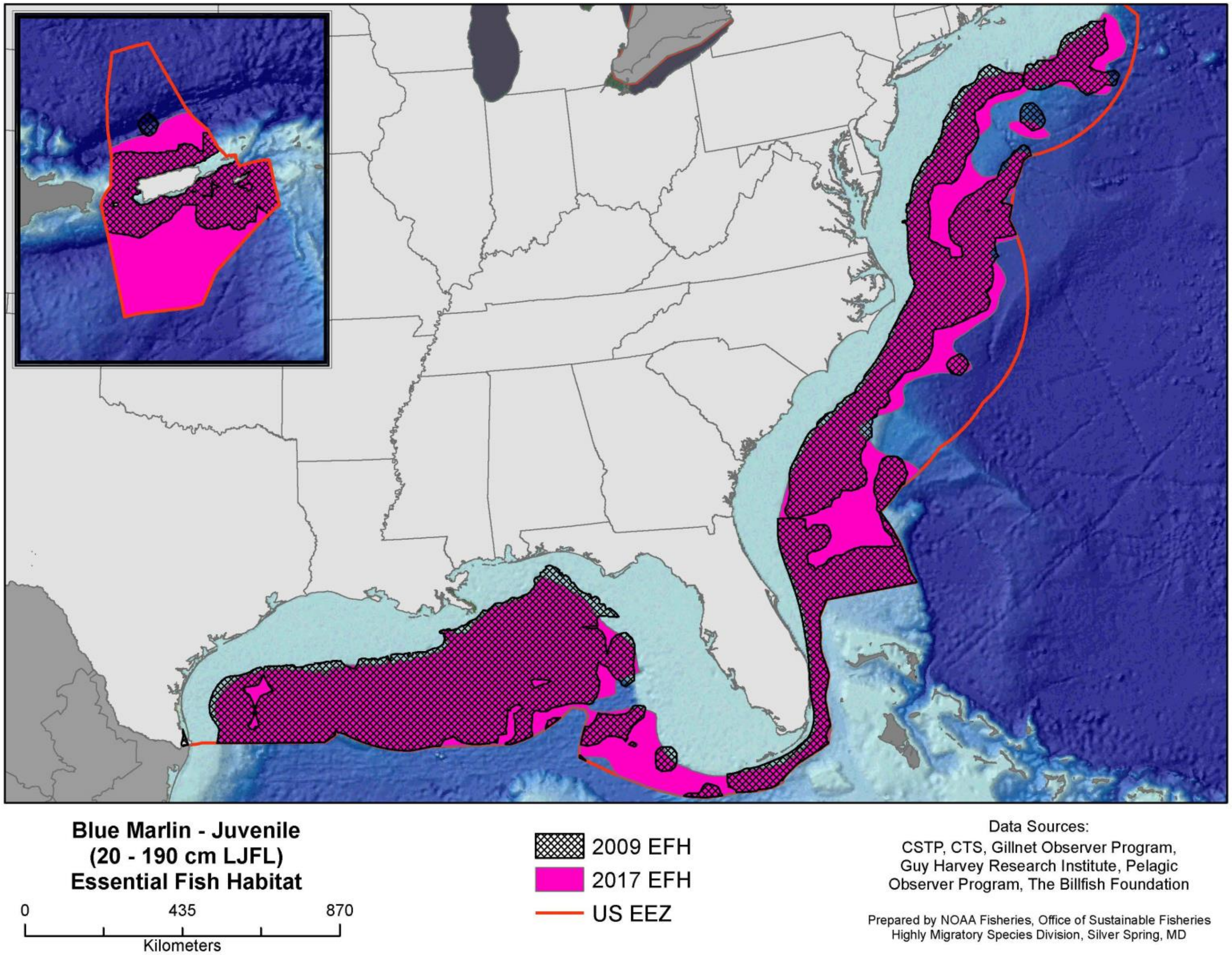


Figure G 18 **Blue Marlin - Juvenile**

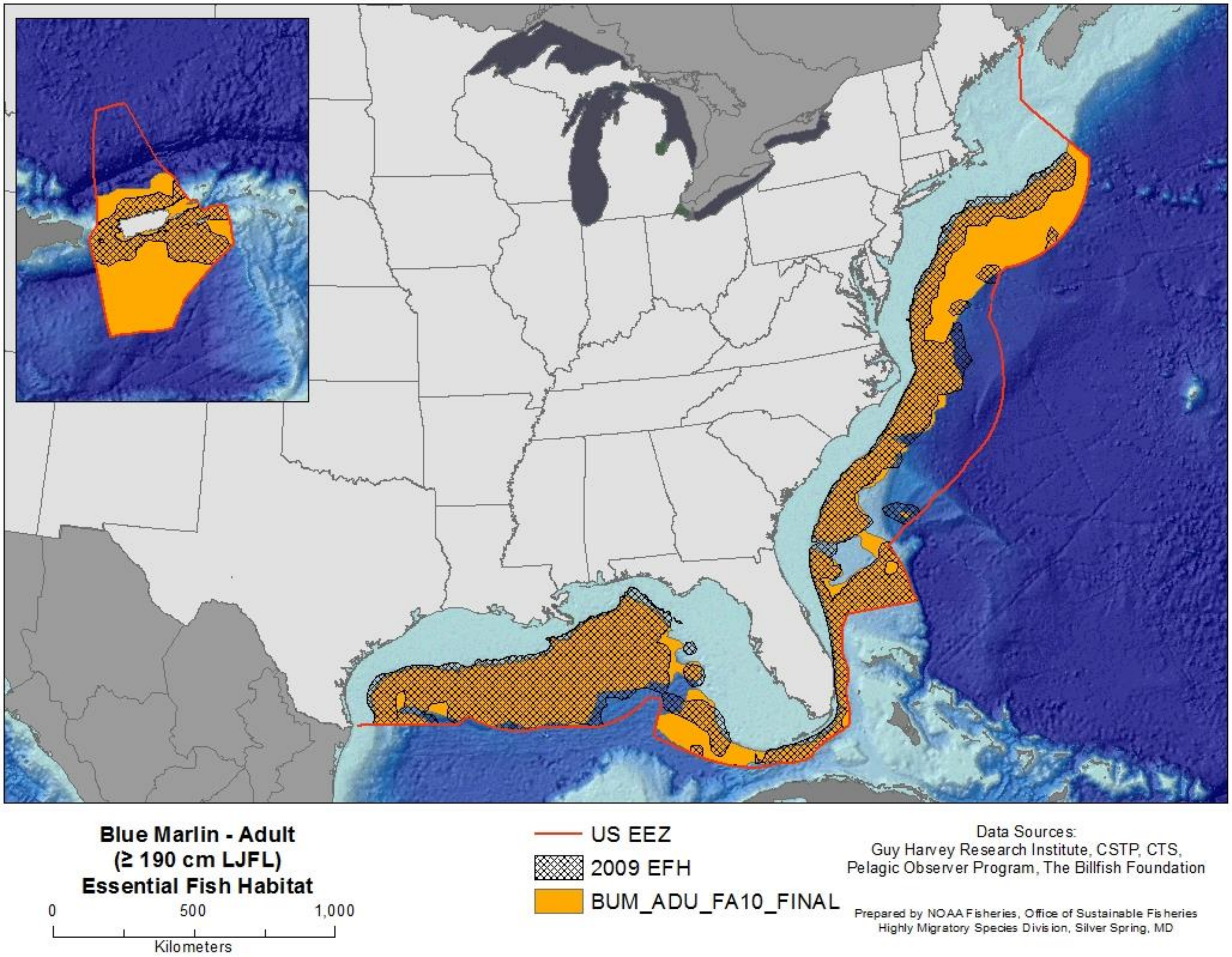


Figure G 19 **Blue Marlin - Adult**

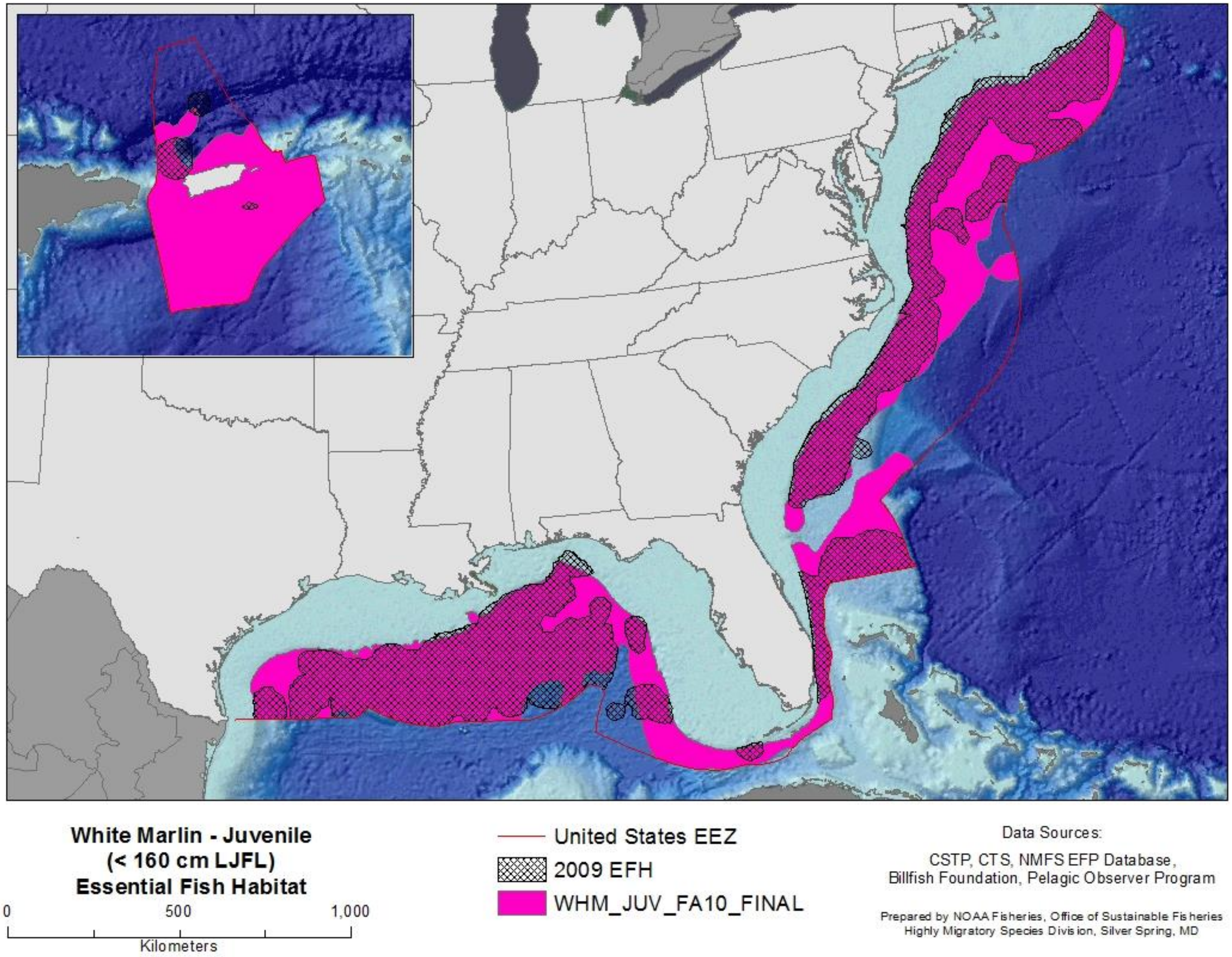


Figure G 20 **White Marlin - Juvenile**

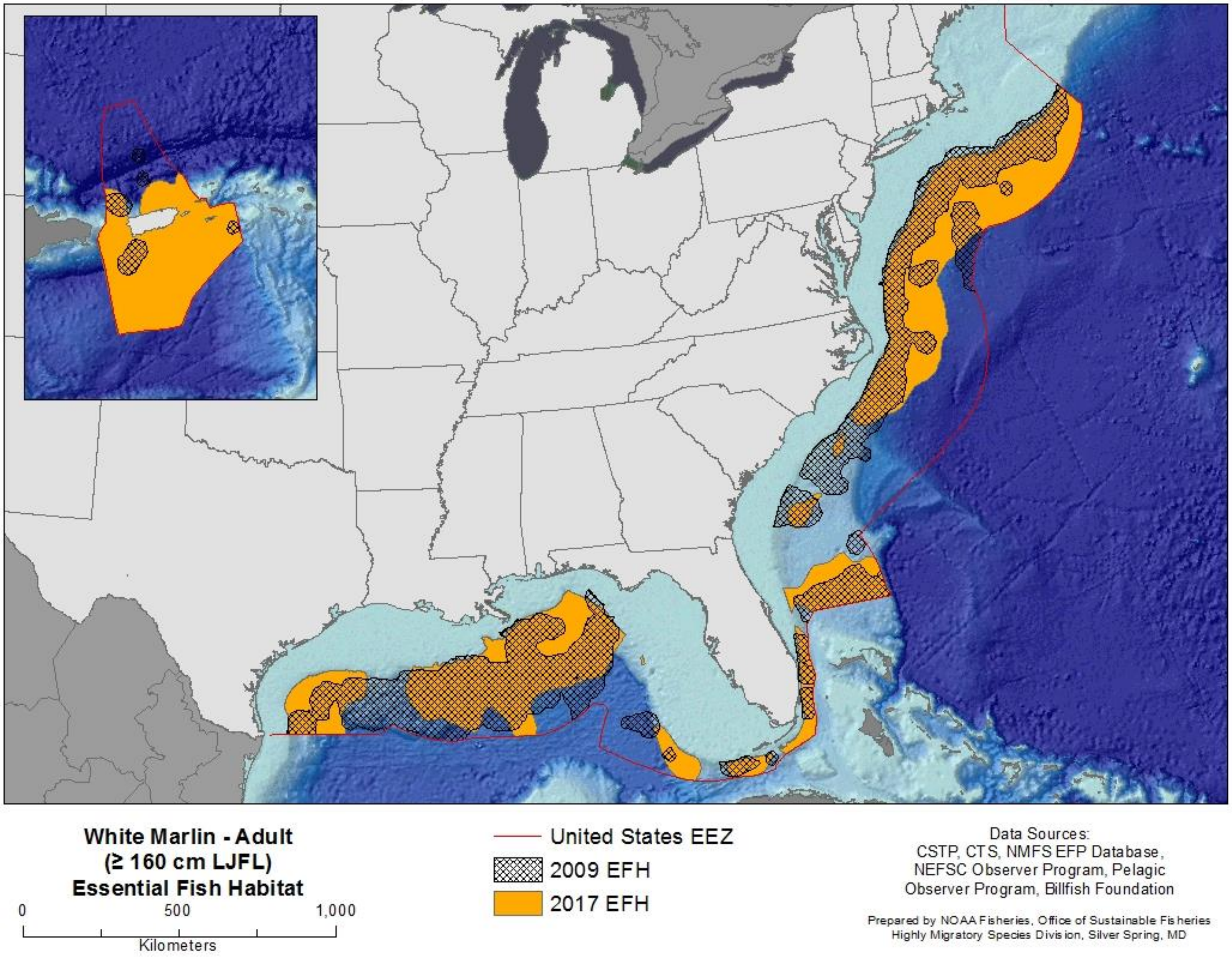


Figure G 21 **White Marlin - Adult**

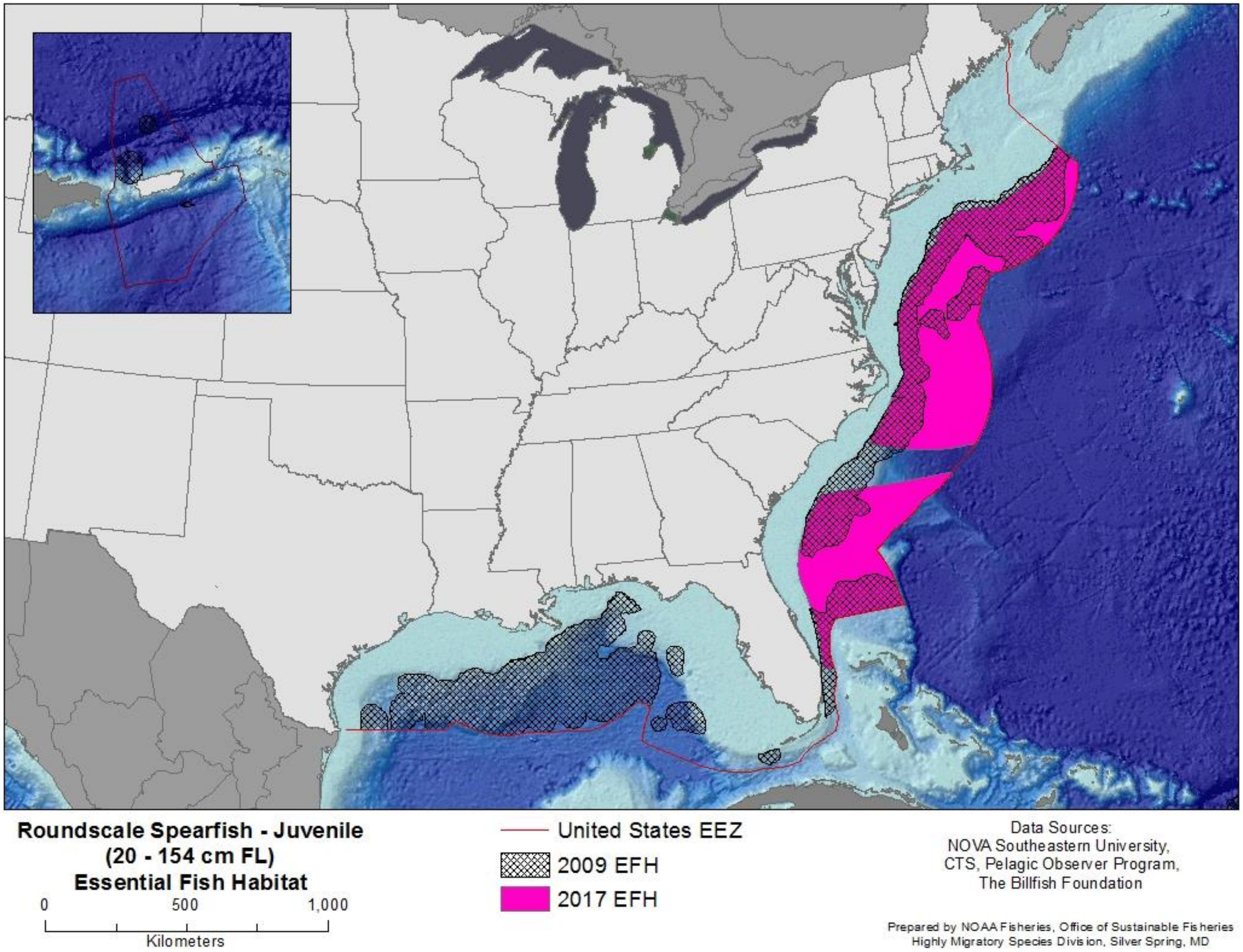


Figure G 22 **Roundscale Spearfish - Juvenile**

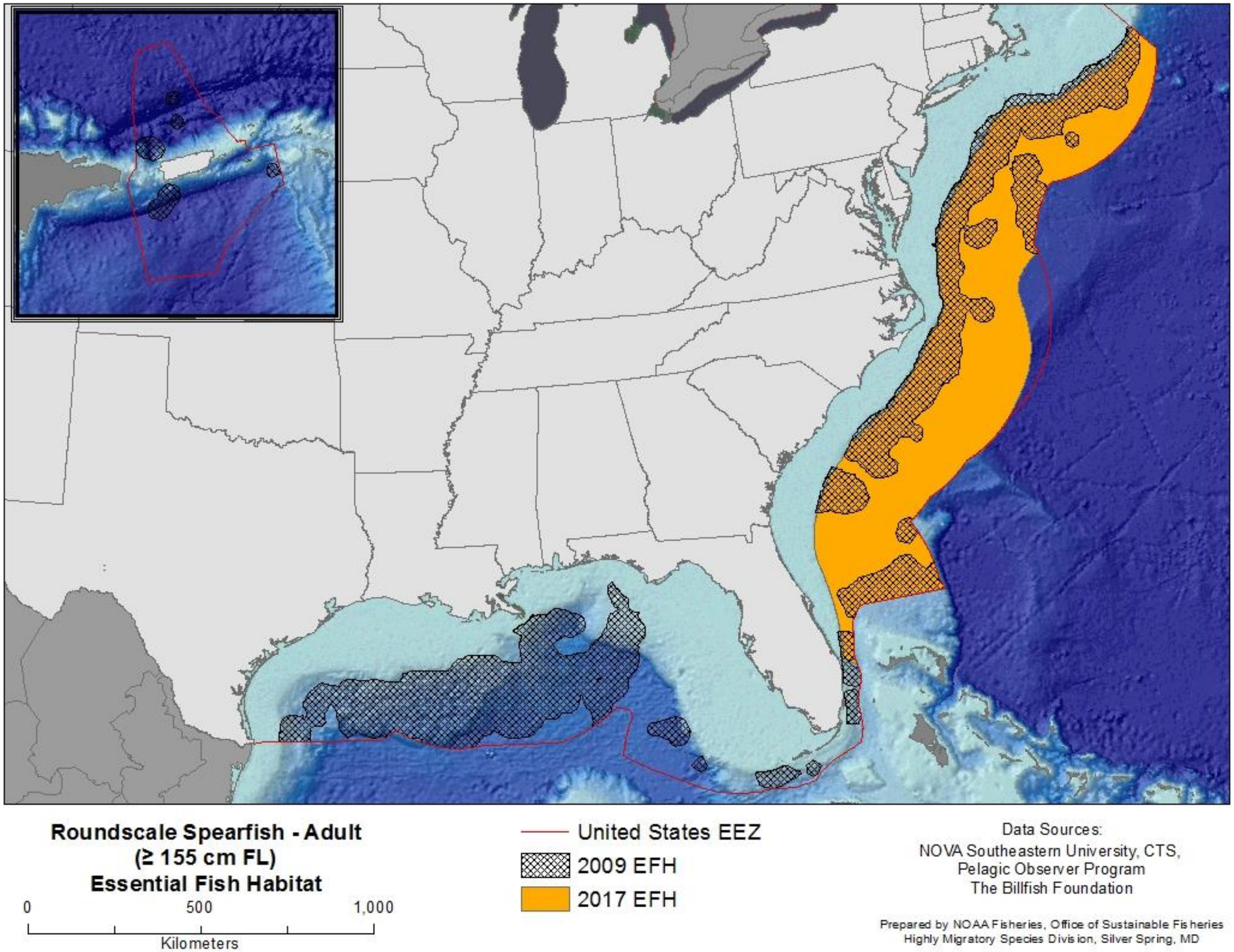


Figure G 23 **Roundscale Spearfish - Adult**

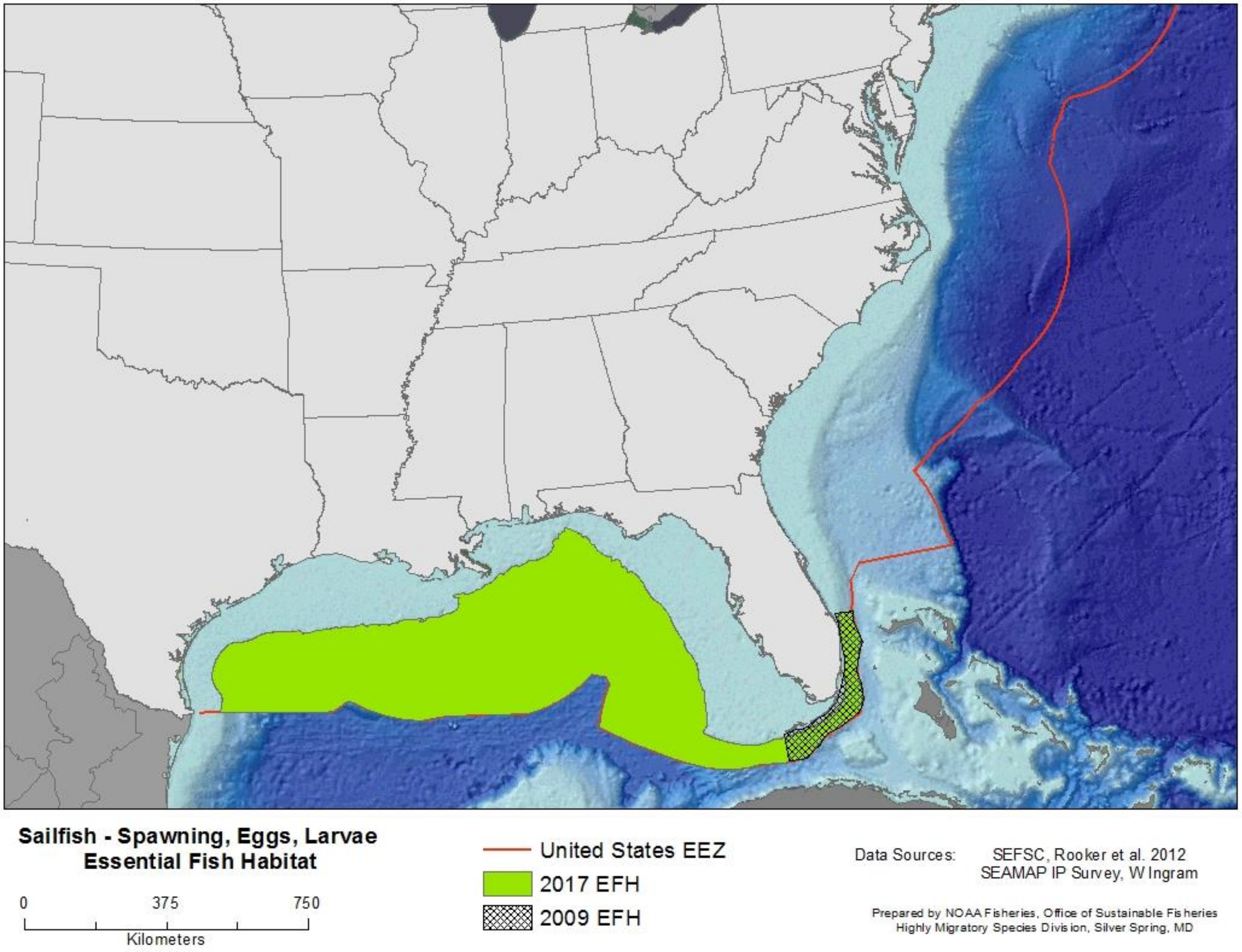


Figure G 24 **Sailfish - Spawning, Eggs, and Larvae**

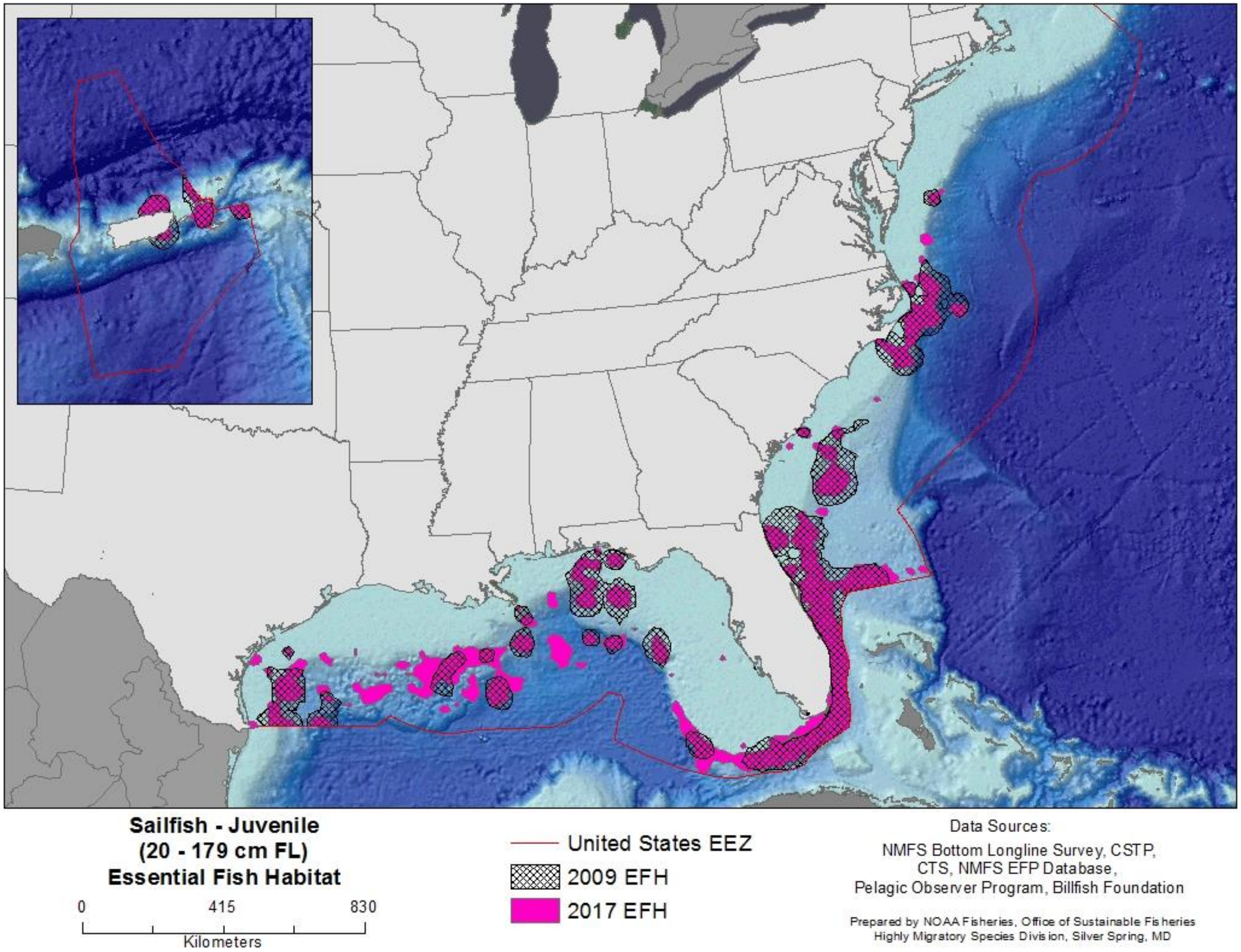
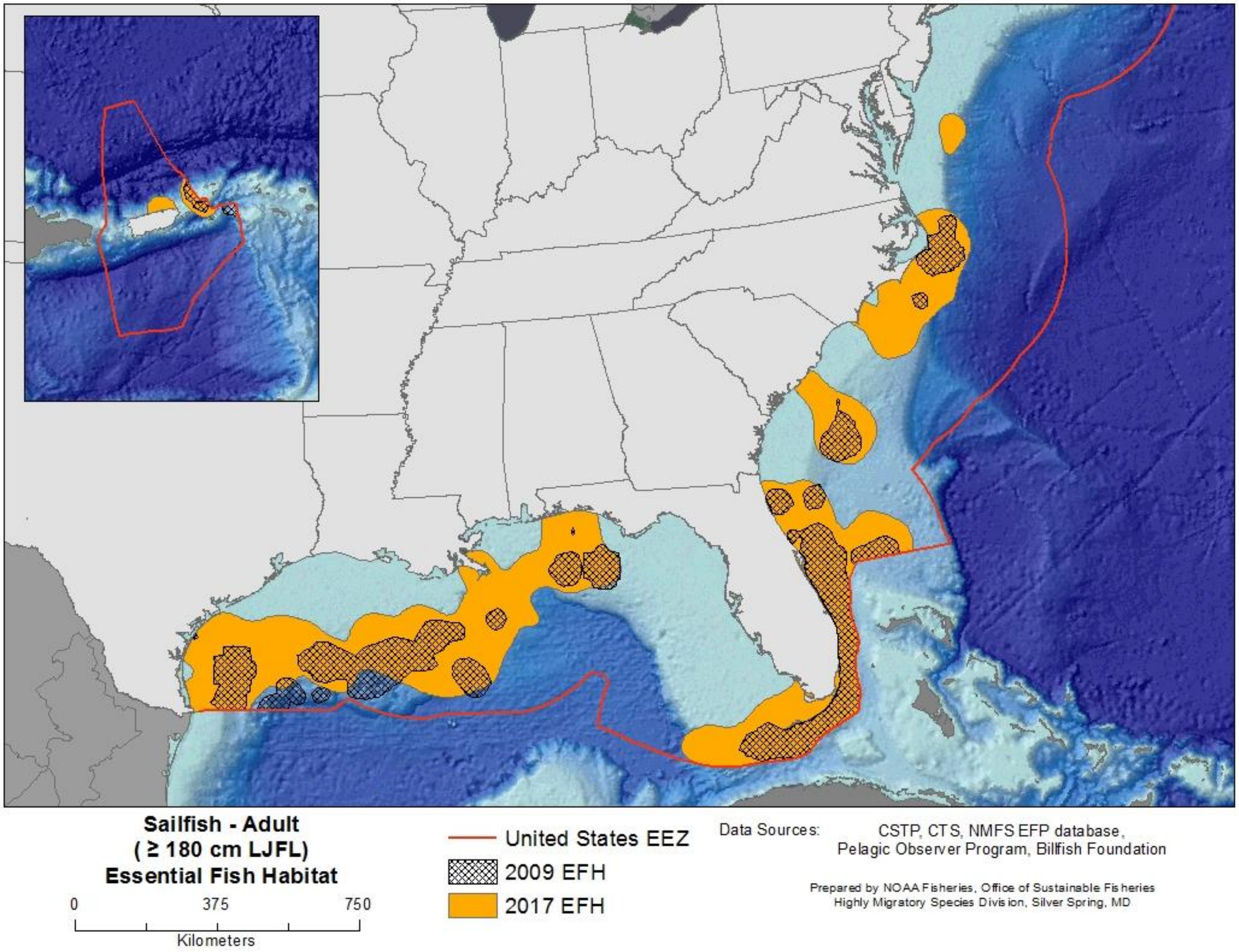


Figure G 25 **Sailfish - Juvenile**



Data Sources: CSTP, CTS, NMFS EFP database, Pelagic Observer Program, Billfish Foundation

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Figure G 26 **Sailfish – Adult**

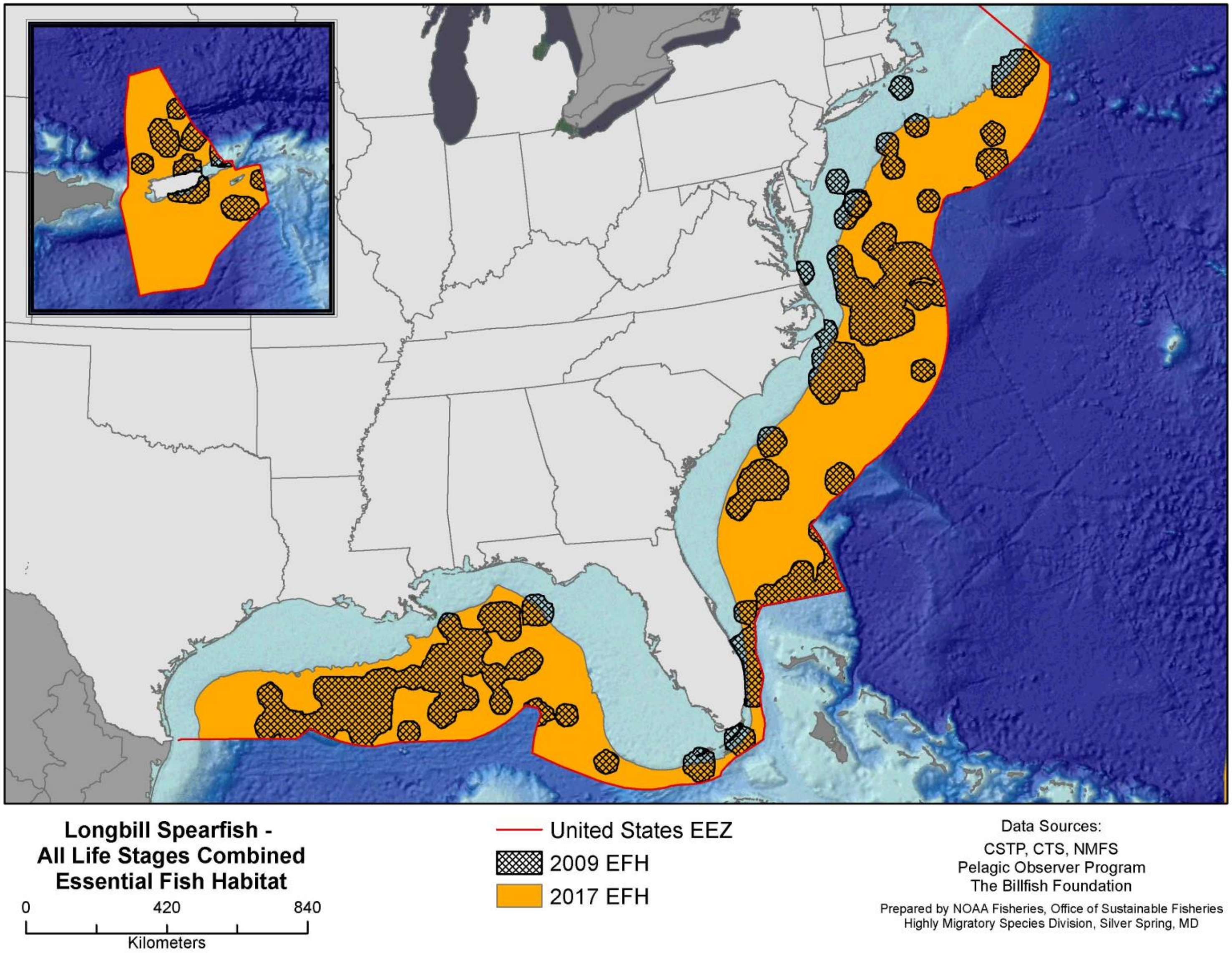


Figure G 27 **Longbill Spearfish – All Life Stages Combined**

Large Coastal Sharks

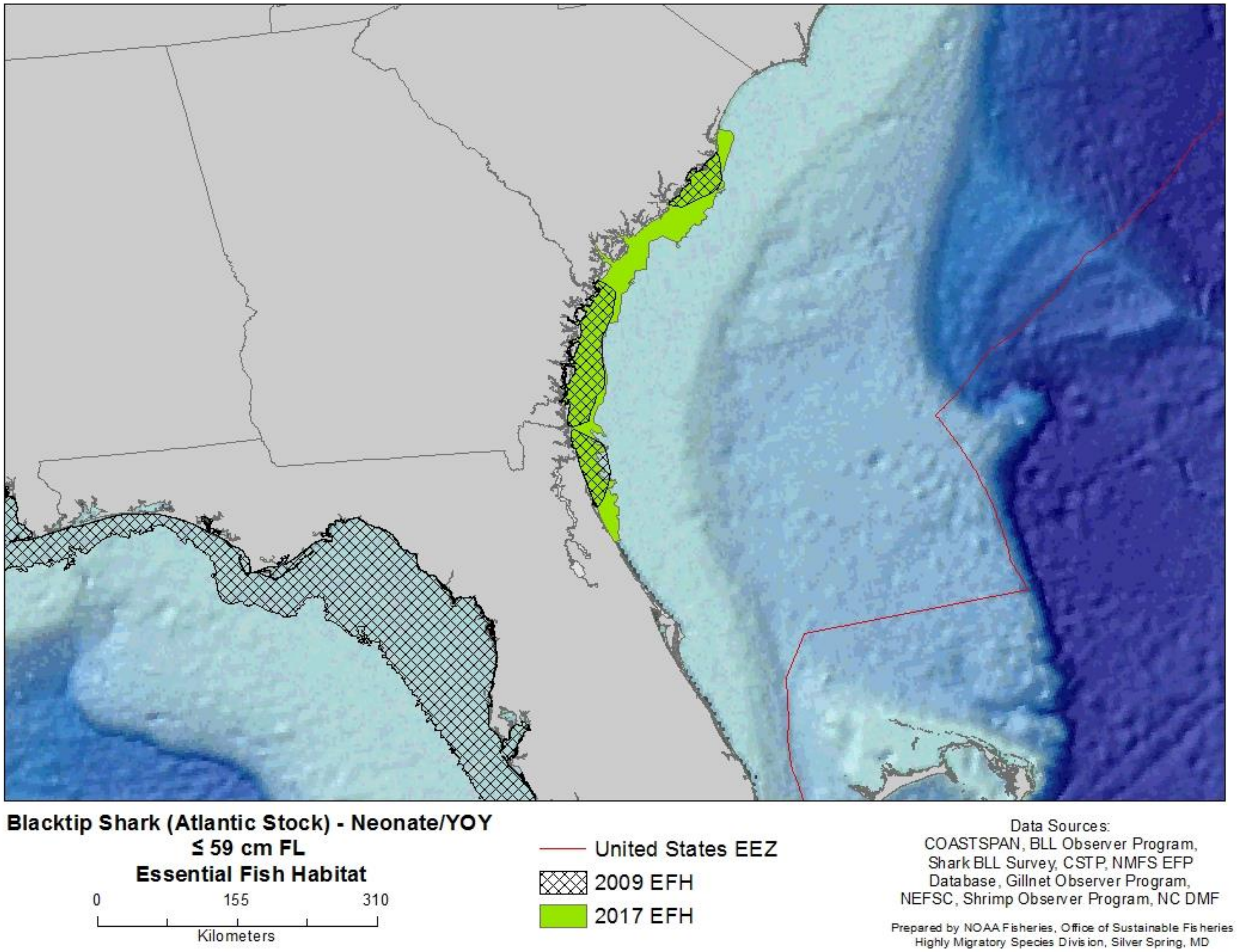


Figure G 28 **Blacktip Shark (Atlantic Stock) – Neonate/YOY**

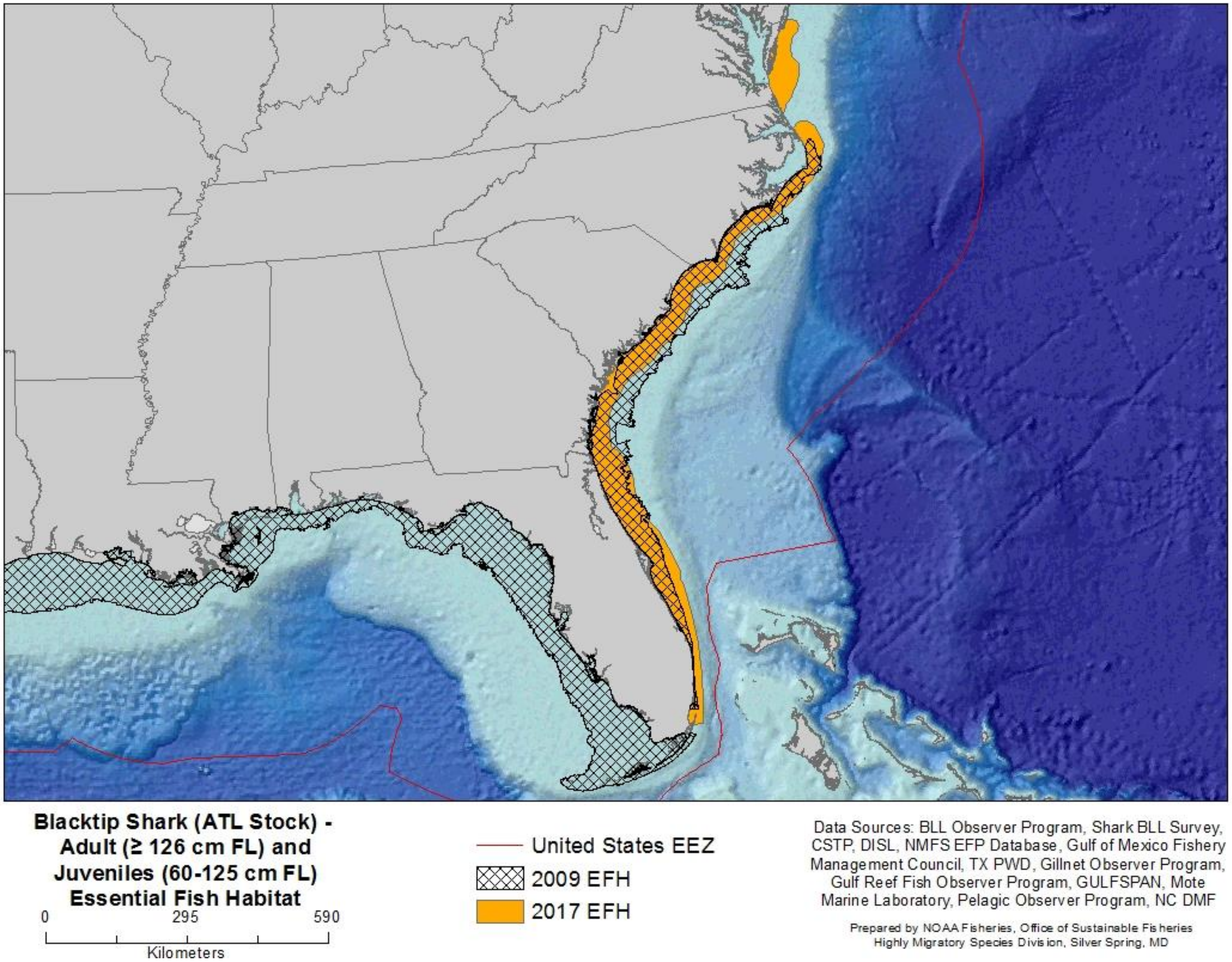
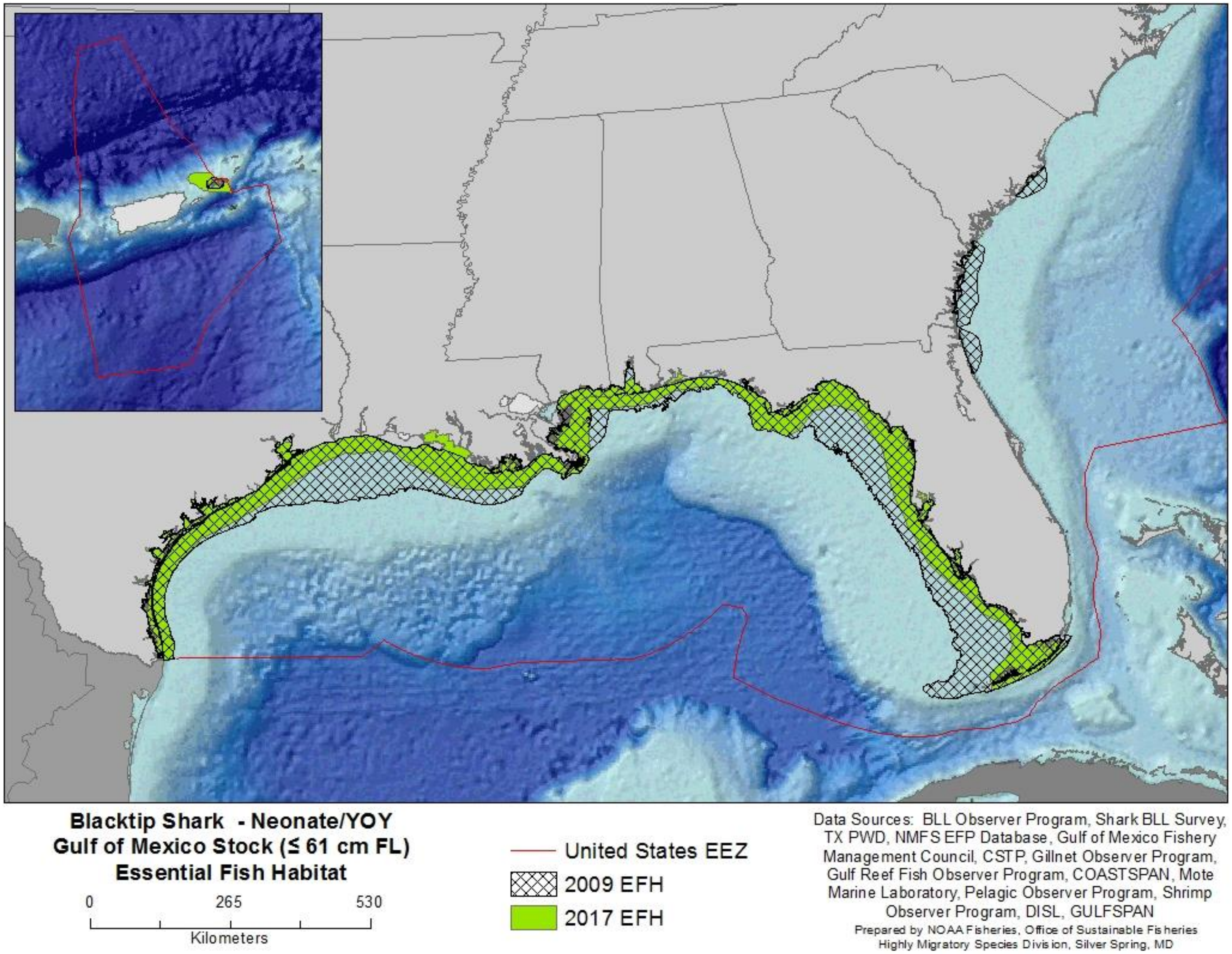


Figure G 29 **Blacktip Shark (Atlantic Stock) – Juvenile and Adult Combined**



Blacktip Shark - Neonate/YOY
Gulf of Mexico Stock (≤ 61 cm FL)
Essential Fish Habitat

Data Sources: BLL Observer Program, Shark BLL Survey, TX PWD, NMFS EFP Database, Gulf of Mexico Fishery Management Council, CSTP, Gillnet Observer Program, Gulf Reef Fish Observer Program, COASTSPAN, Mote Marine Laboratory, Pelagic Observer Program, Shrimp Observer Program, DISL, GULFSPAN

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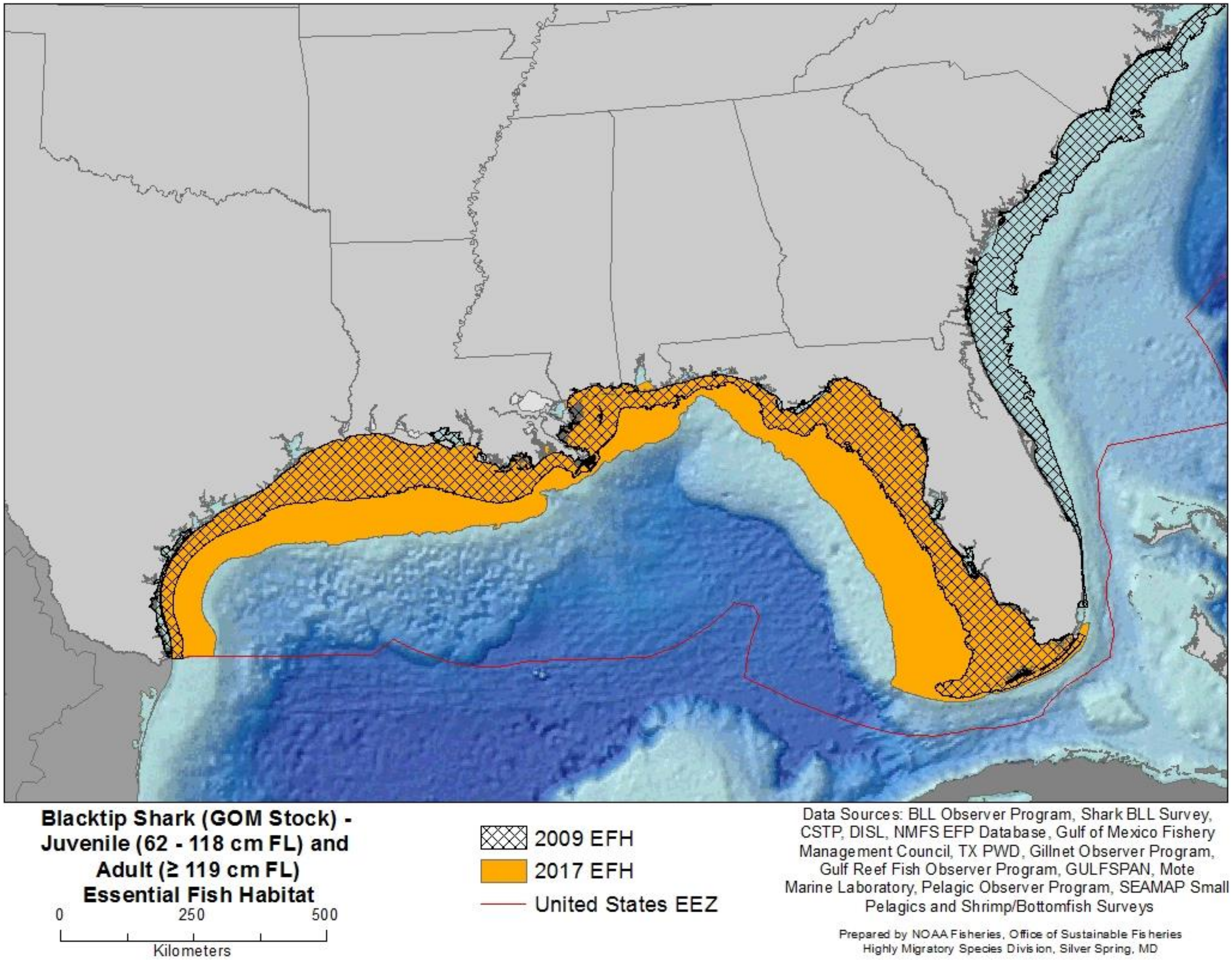
Figure G 30 **Blacktip Shark (Gulf of Mexico Stock) – Neonate/YOY**



Data Sources: BLL Observer Program, Shark BLL Survey, CSTP, DISL, NMFS EFP Database, Gulf of Mexico Fishery Management Council, TX PWD, Gillnet Observer Program, Gulf Reef Fish Observer Program, GULFSPAN, Mote Marine Laboratory, Pelagic Observer Program, SEAMAP Small Pelagics and Shrimp/Bottomfish Surveys

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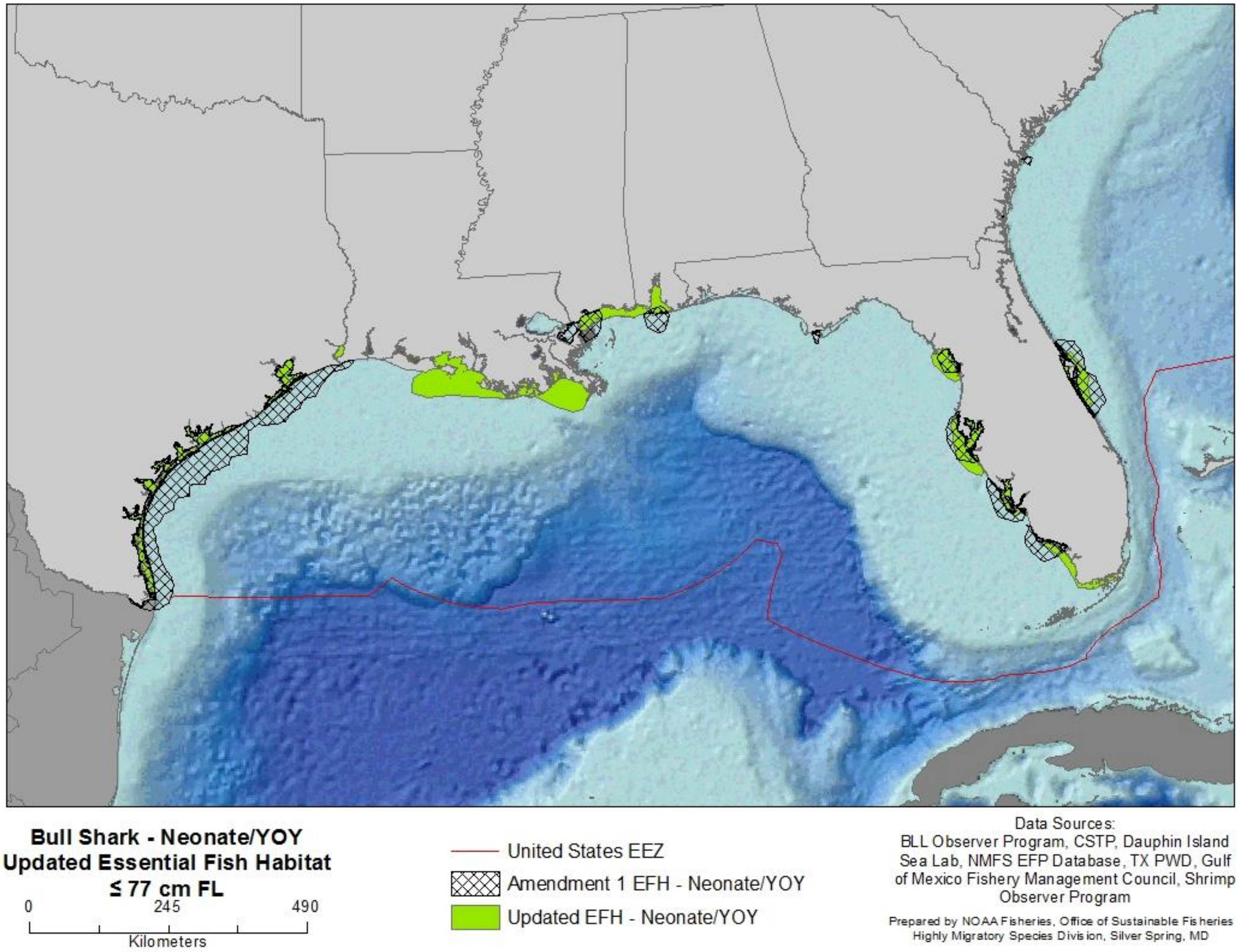
Highly Migratory Species Division, Silver Spring, MD

Figure G 31 **Blacktip Shark (Gulf of Mexico Stock) – Juvenile and Adult Combined**



Data Sources:
BLL Observer Program, CSTP, Dauphin Island Sea Lab, NMFS EFP Database, TX PWD, Gulf of Mexico Fishery Management Council, Shrimp Observer Program

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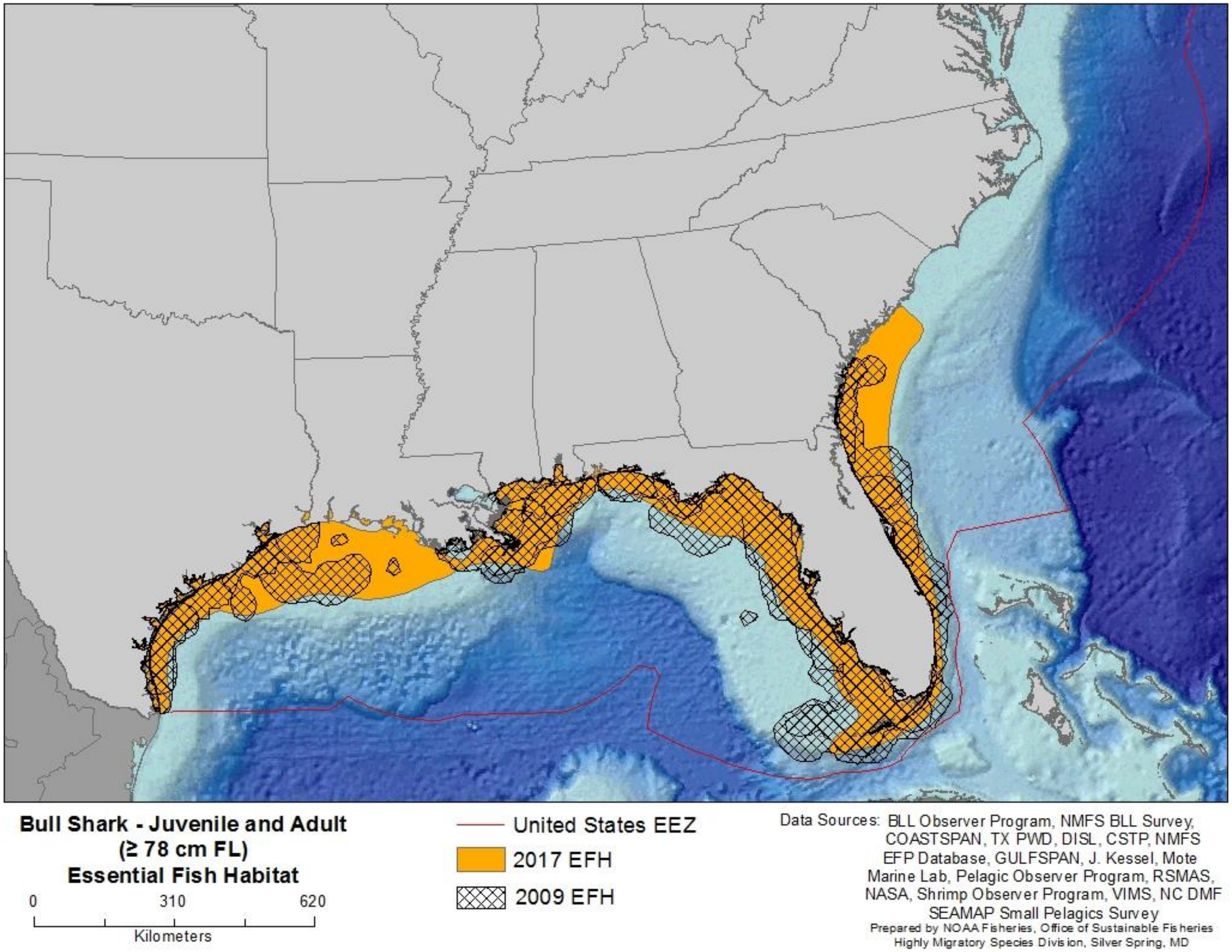
Highly Migratory Species Division, Silver Spring, MD

Figure G 32 **Bull Shark - Neonate/YOY**



Data Sources: BLL Observer Program, NMFS BLL Survey, COASTSPAN, TX PWD, DISL, CSTP, NMFS EFP Database, GULFSPAN, J. Kessel, Mote Marine Lab, Pelagic Observer Program, RSMAS, NASA, Shrimp Observer Program, VIMS, NC DMF SEAMAP Small Pelagics Survey

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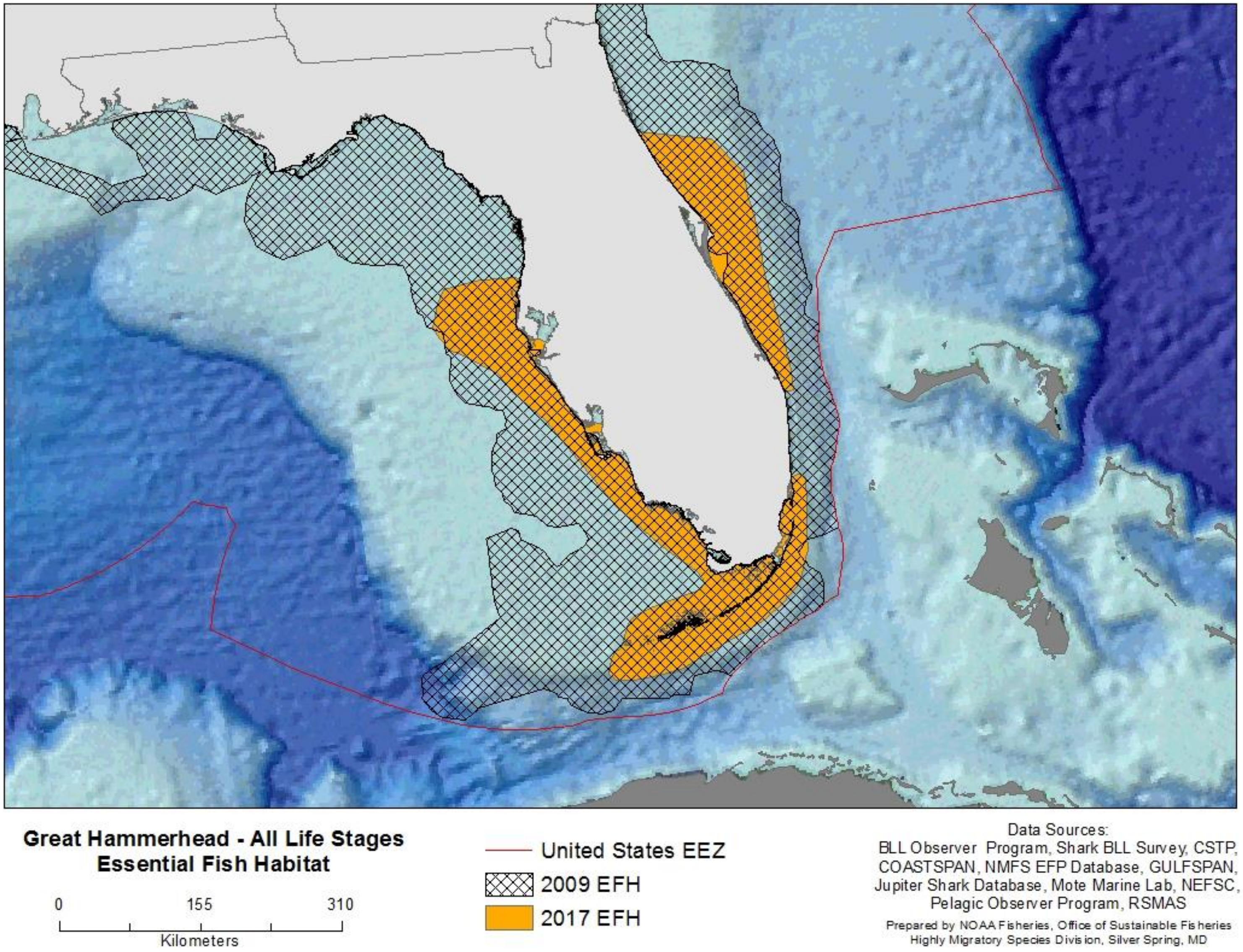
Figure G 33 **Bull Shark – Juvenile and Adult Combined**



Data Sources:
BLL Observer Program, Shark BLL Survey, CSTP, COASTSPAN, NMFS EFP Database, GULFSPAN, Jupiter Shark Database, Mote Marine Lab, NEFSC, Pelagic Observer Program, RSMAS

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Highly Migratory Species Division, Silver Spring, MD

Figure G 34 **Great Hammerhead Shark – All Life Stages Combined**

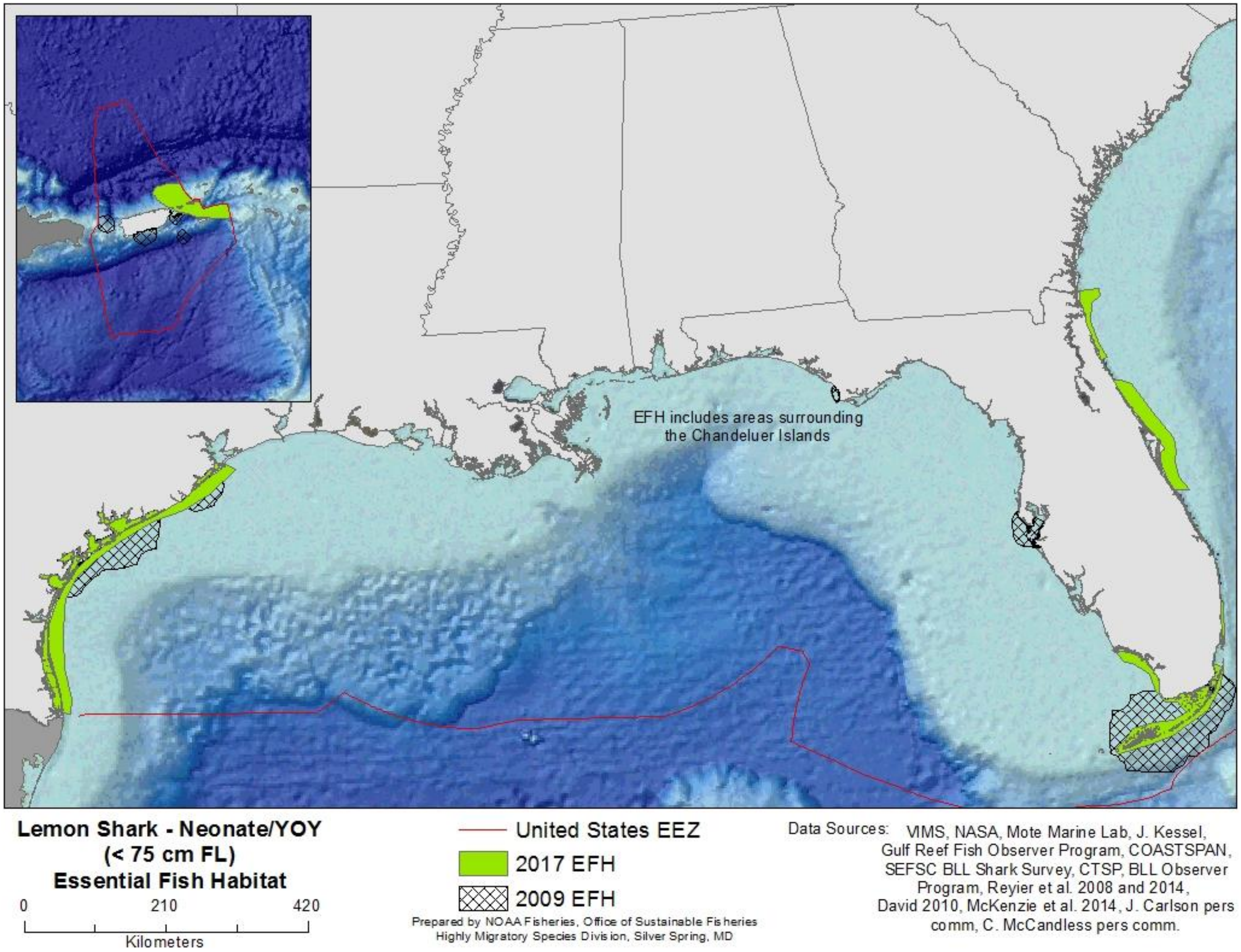
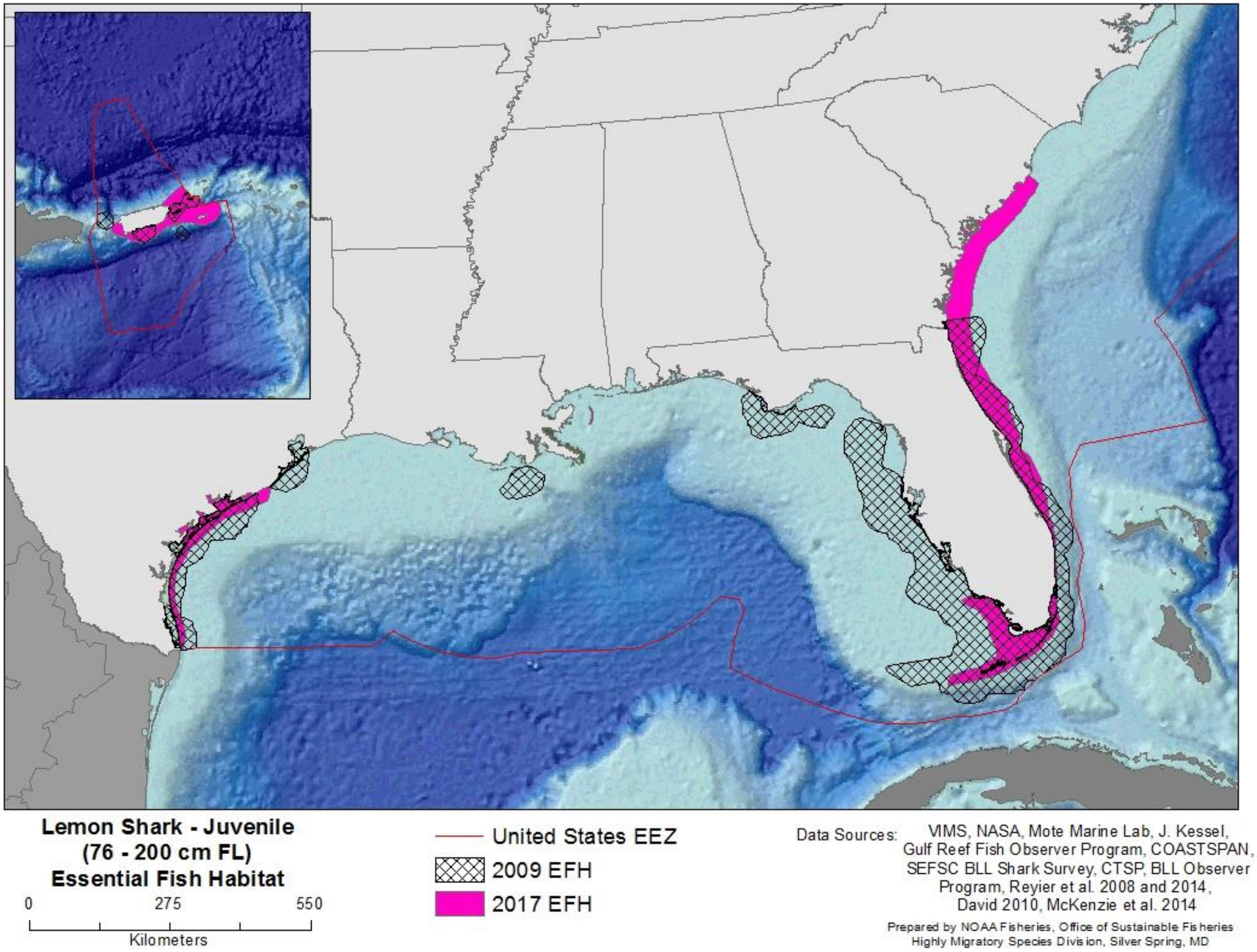


Figure G 35 **Lemon Shark – Neonate/YOY**



Data Sources: VIMS, NASA, Mote Marine Lab, J. Kessel, Gulf Reef Fish Observer Program, COASTSPAN, SEFSC BLL Shark Survey, CTSP, BLL Observer Program, Reyier et al. 2008 and 2014, David 2010, McKenzie et al. 2014

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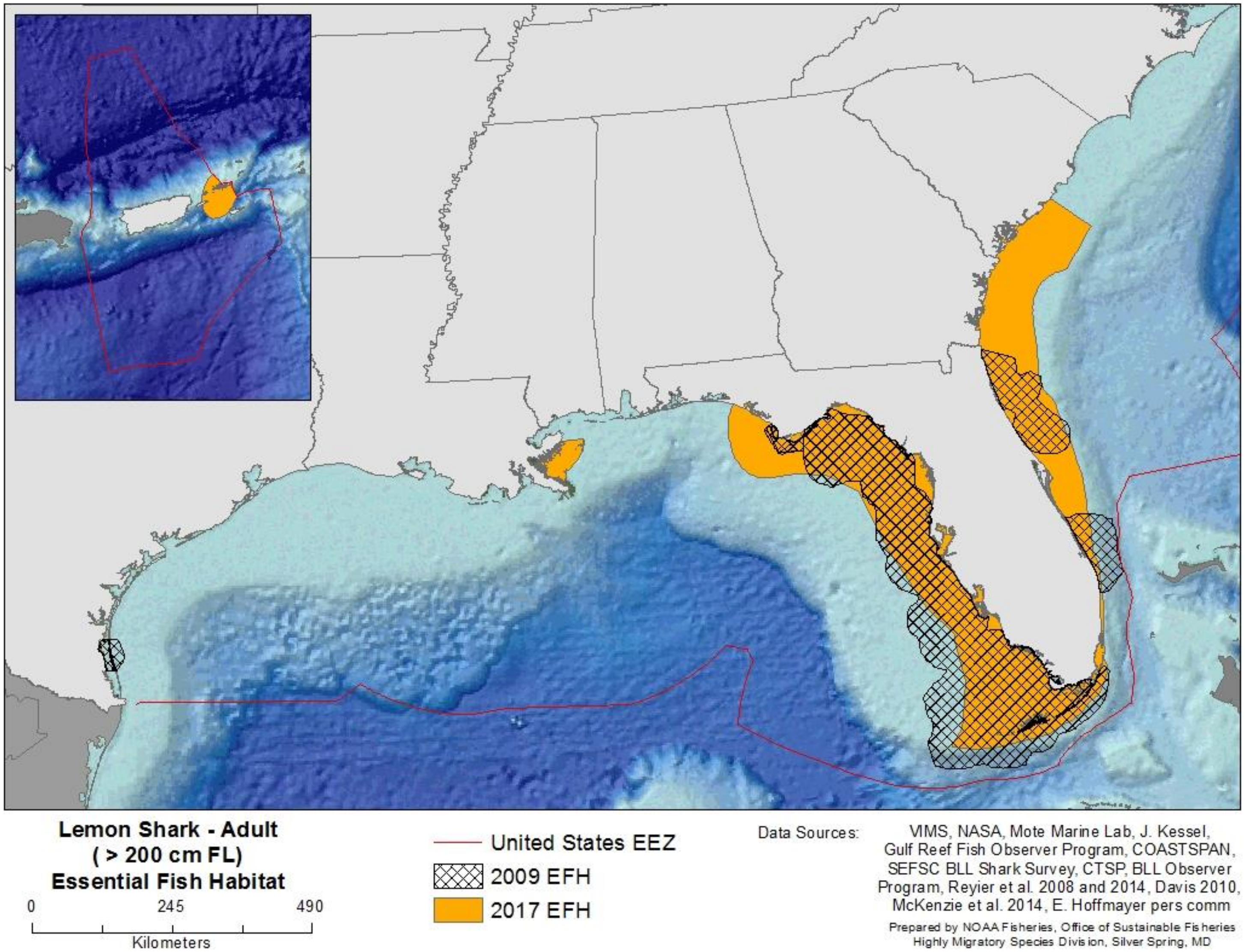
Figure G 36 **Lemon Shark – Juvenile**



Data Sources: VIMS, NASA, Mote Marine Lab, J. Kessel, Gulf Reef Fish Observer Program, COASTSPAN, SEFSC BLL Shark Survey, CTSP, BLL Observer Program, Reyier et al. 2008 and 2014, Davis 2010, McKenzie et al. 2014, E. Hoffmayer pers comm

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Figure G 37 **Lemon Shark – Adult**

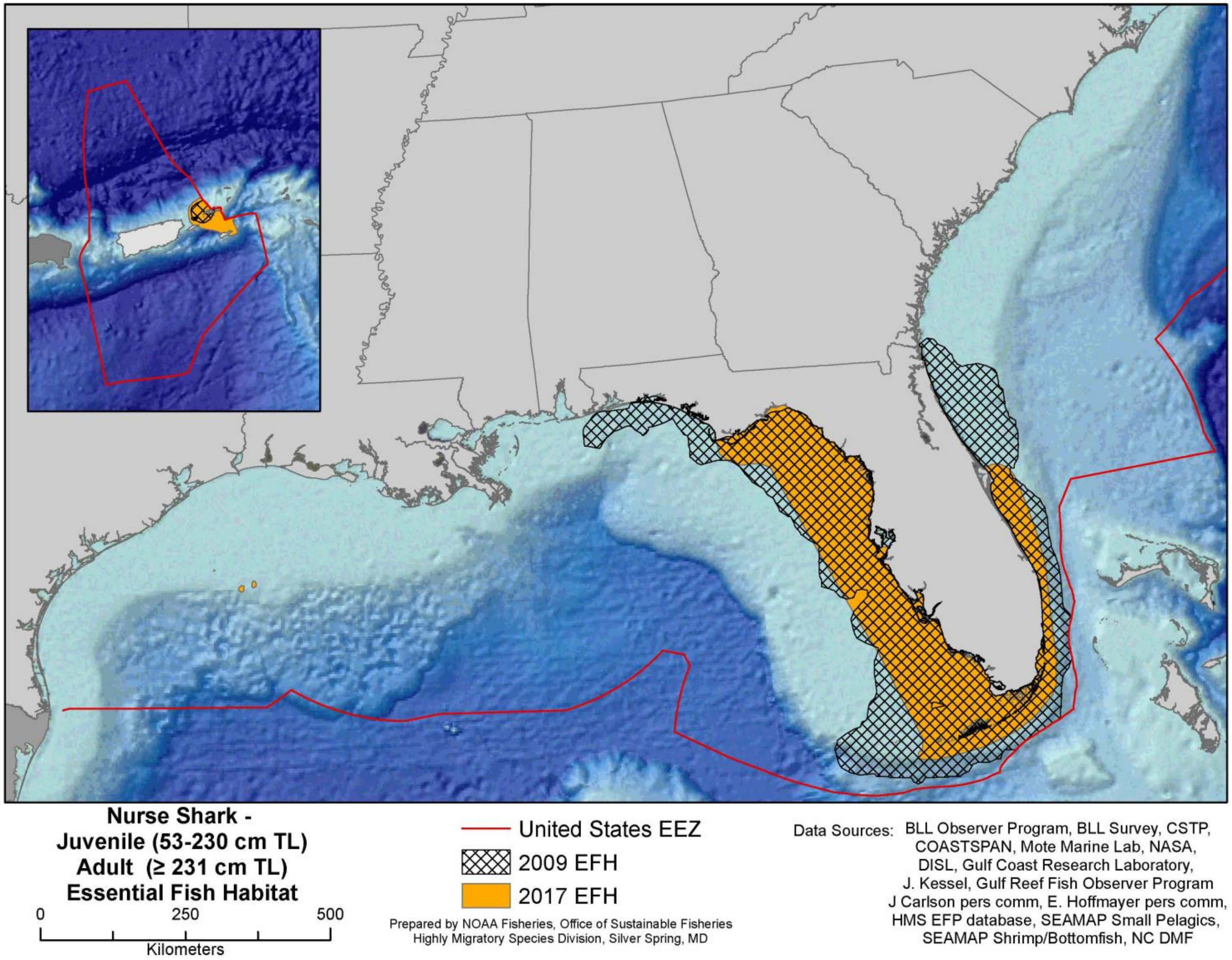


Figure G 38 **Nurse Shark – Juvenile and Adult**

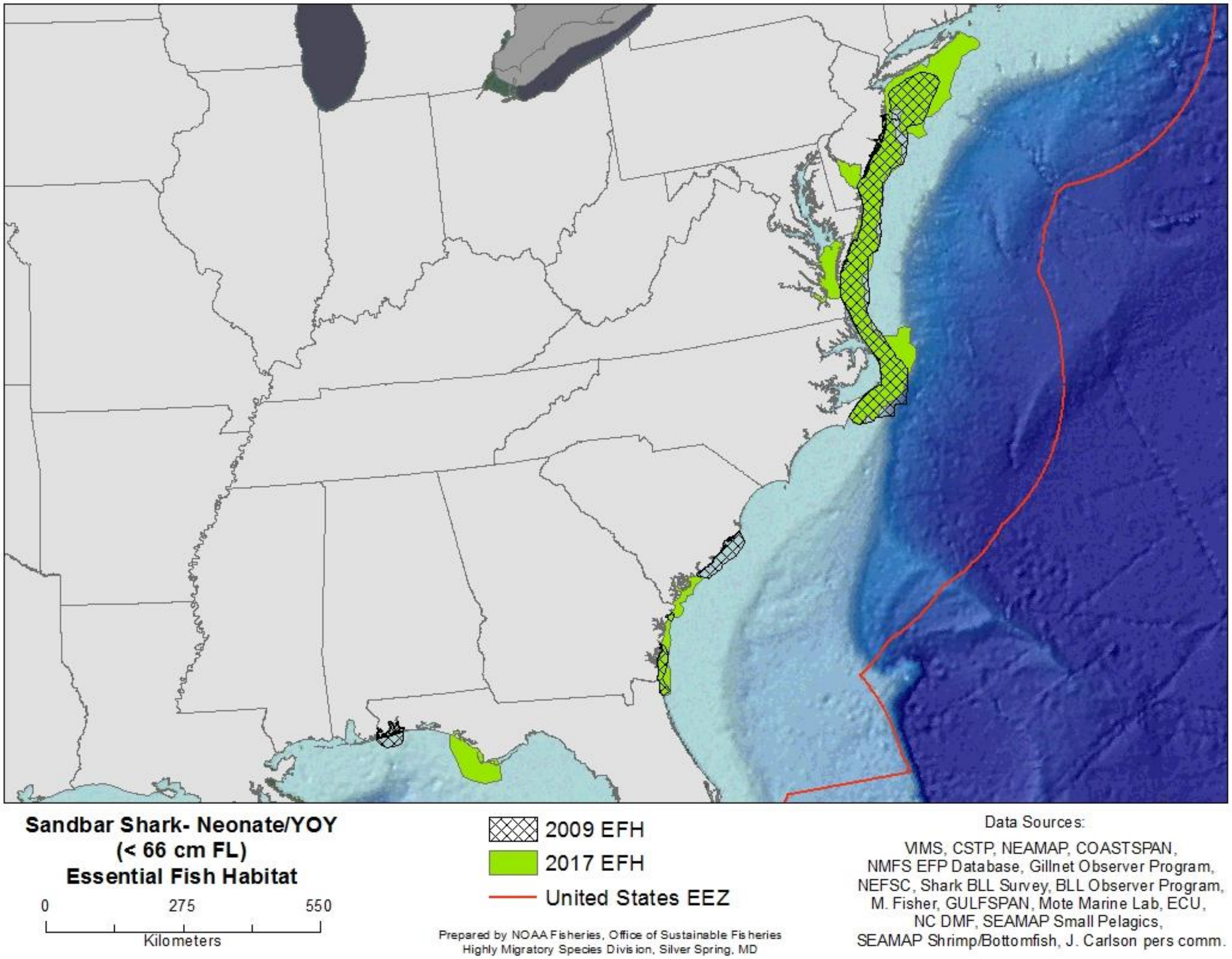


Figure G 39 **Sandbar Shark – Neonate/YOY**

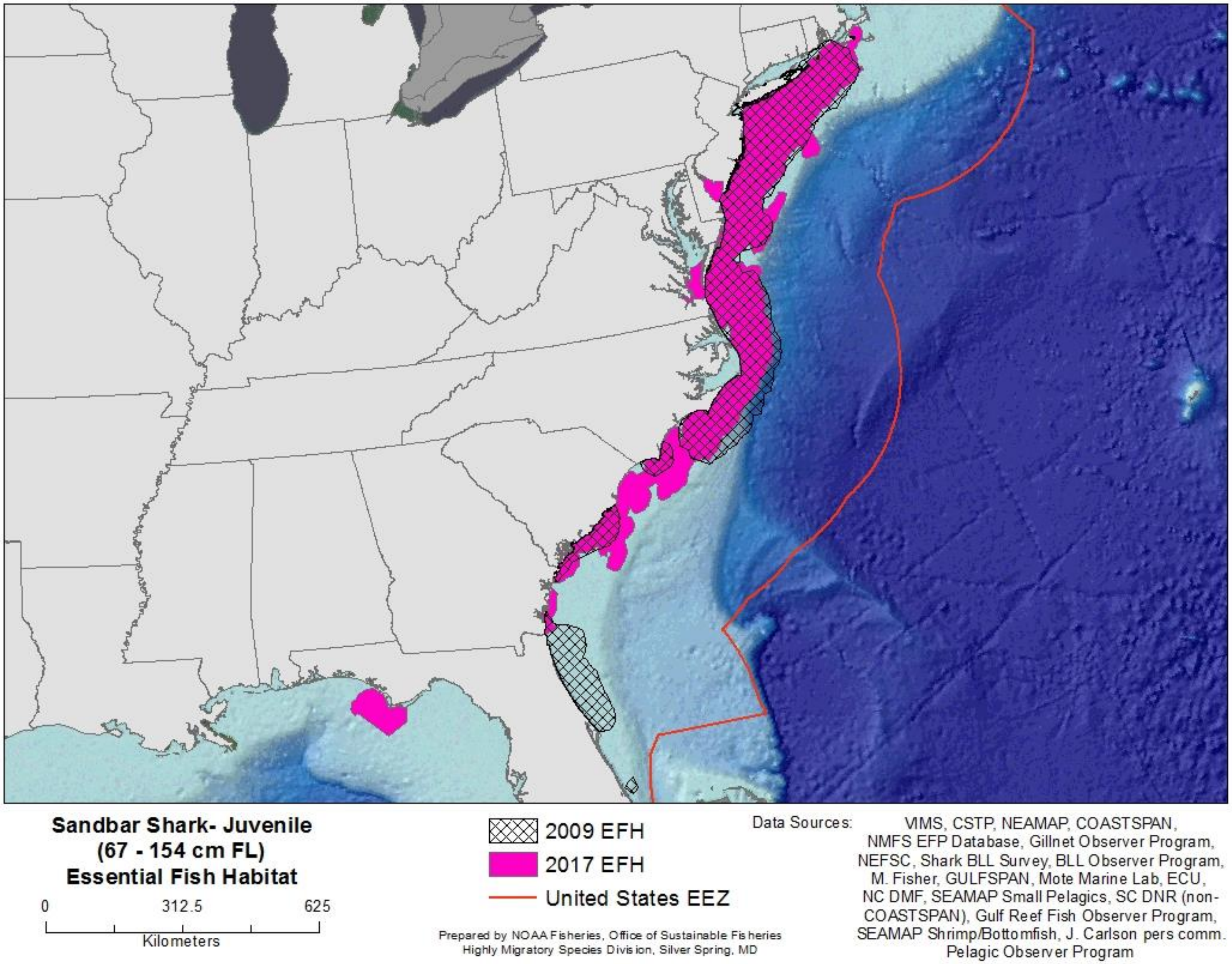
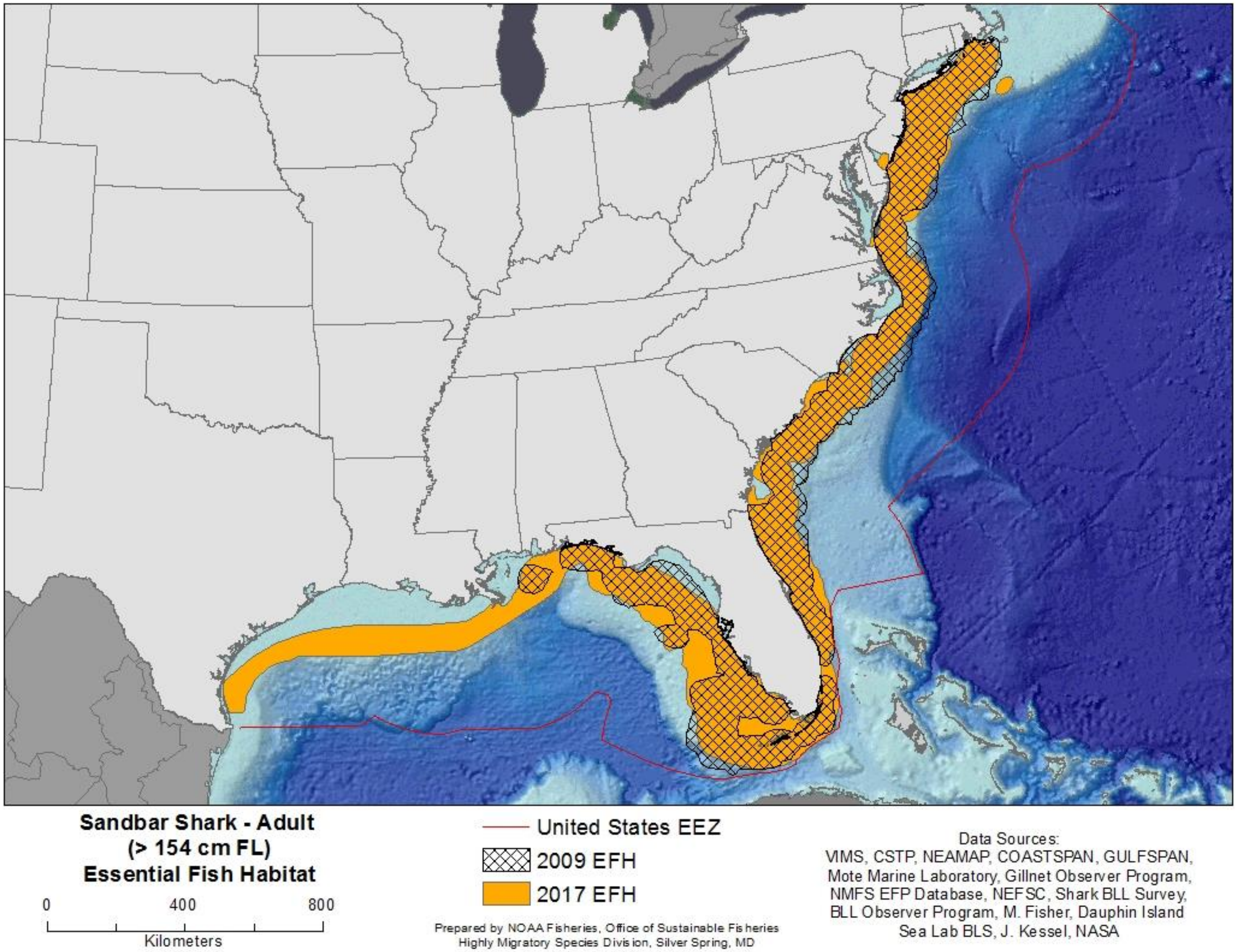


Figure G 40 **Sandbar Shark – Juvenile**



Sandbar Shark - Adult
(> 154 cm FL)
Essential Fish Habitat

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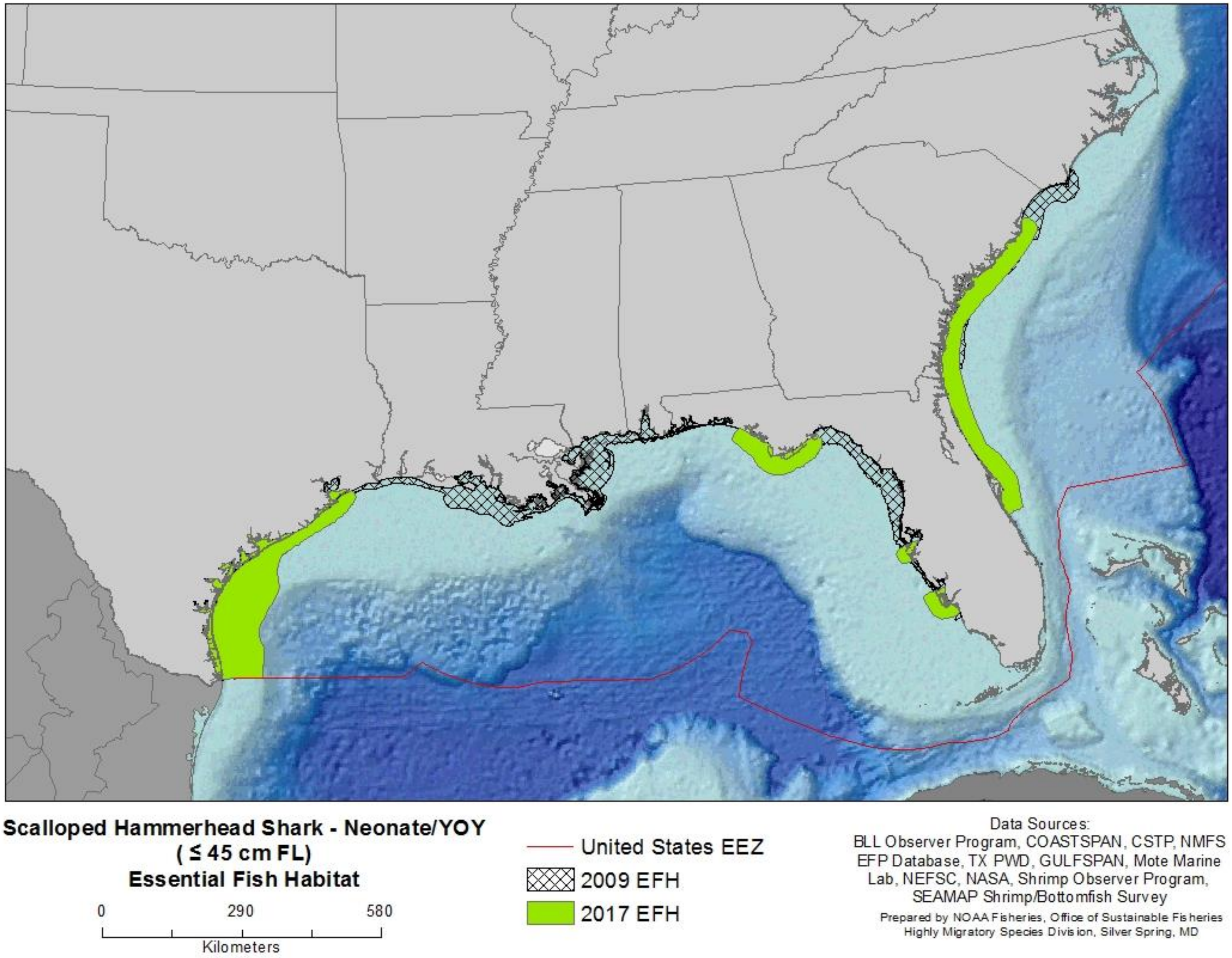
Highly Migratory Species Division, Silver Spring, MD

Data Sources:
VIMS, CSTP, NEAMAP, COASTSPAN, GULFSPAN,
Mote Marine Laboratory, Gillnet Observer Program,
NMFS EFP Database, NEFSC, Shark BLL Survey,
BLL Observer Program, M. Fisher, Dauphin Island
Sea Lab BLS, J. Kessel, NASA

Figure G 41 **Sandbar Shark - Adult**


Scalloped Hammerhead Shark - Neonate/YOY
(≤ 45 cm FL)
Essential Fish Habitat

Data Sources:
BLL Observer Program, COASTSPAN, CSTP, NMFS EFP Database, TX PWD, GULFSPAN, Mote Marine Lab, NEFSC, NASA, Shrimp Observer Program, SEAMAP Shrimp/Bottomfish Survey
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Figure G 42 **Scalloped Hammerhead Shark - Neonate**

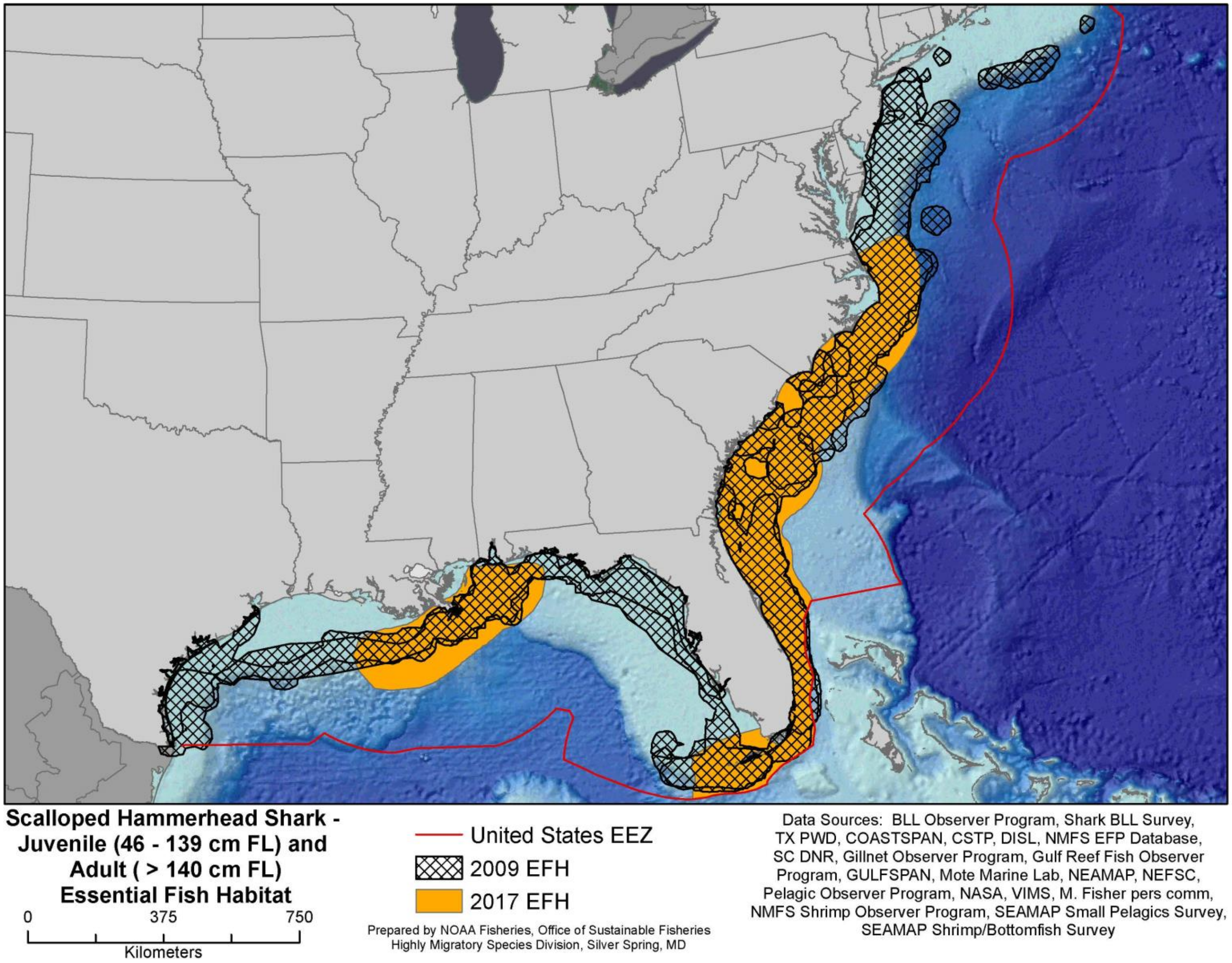
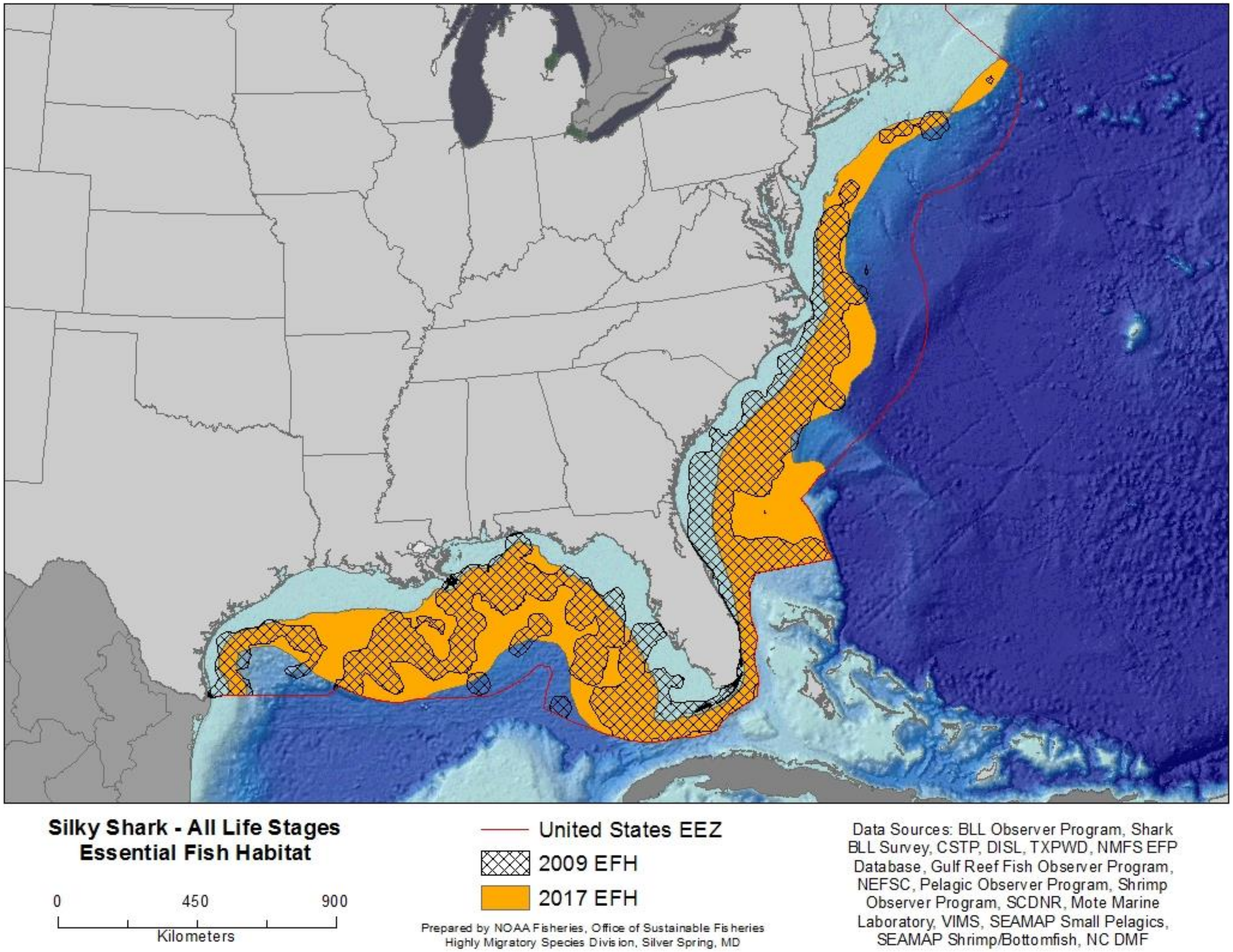


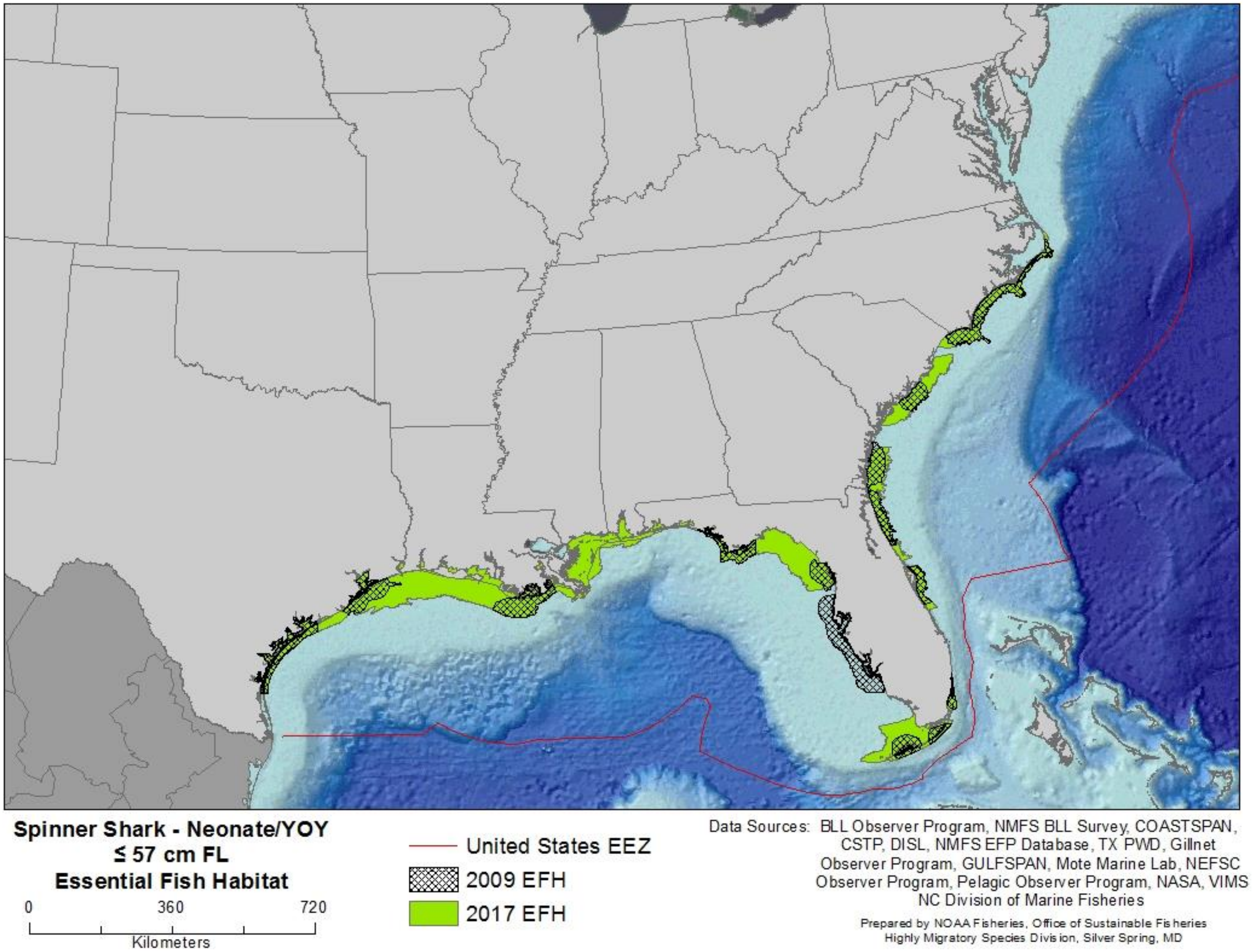
Figure G 43 Scalloped Hammerhead Shark – Juvenile and Adult Combined



Prepared by NOAA Fisheries, Office of Sustainable Fisheries
Highly Migratory Species Division, Silver Spring, MD

Data Sources: BLL Observer Program, Shark BLL Survey, CSTP, DISL, TXPWD, NMFS EFP Database, Gulf Reef Fish Observer Program, NEFSC, Pelagic Observer Program, Shrimp Observer Program, SCDNR, Mote Marine Laboratory, VIMS, SEAMAP Small Pelagics, SEAMAP Shrimp/Bottomfish, NC DMF

Figure G 44 **Silky Shark - All Life Stages Combined**



Data Sources: BLL Observer Program, NMFS BLL Survey, COASTSPAN, CSTP, DISL, NMFS EFP Database, TX PWD, Gillnet Observer Program, GULFSPAN, Mote Marine Lab, NEFSC Observer Program, Pelagic Observer Program, NASA, VIMS NC Division of Marine Fisheries

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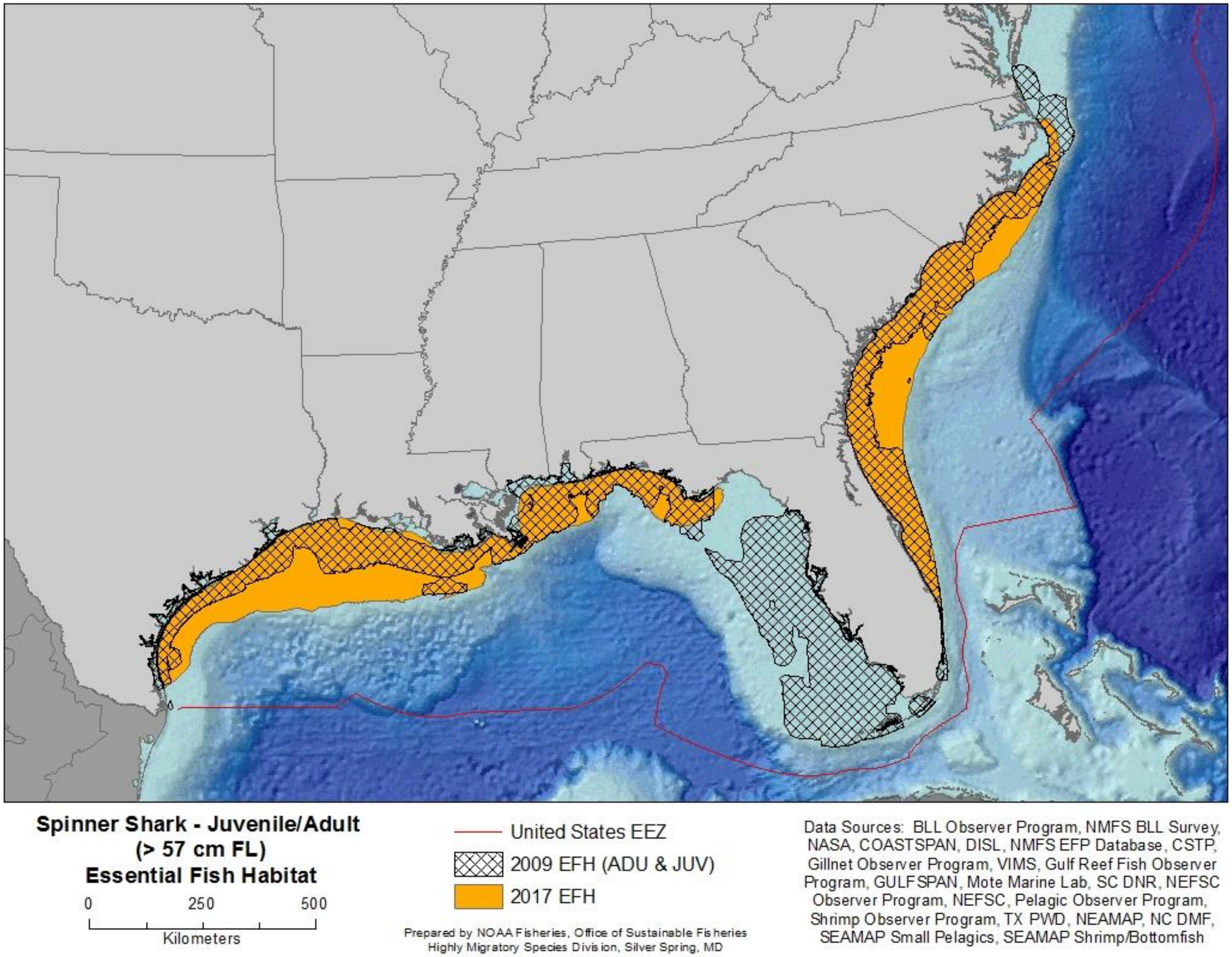
Figure G 45 **Spinner Shark - Neonate/YOY**

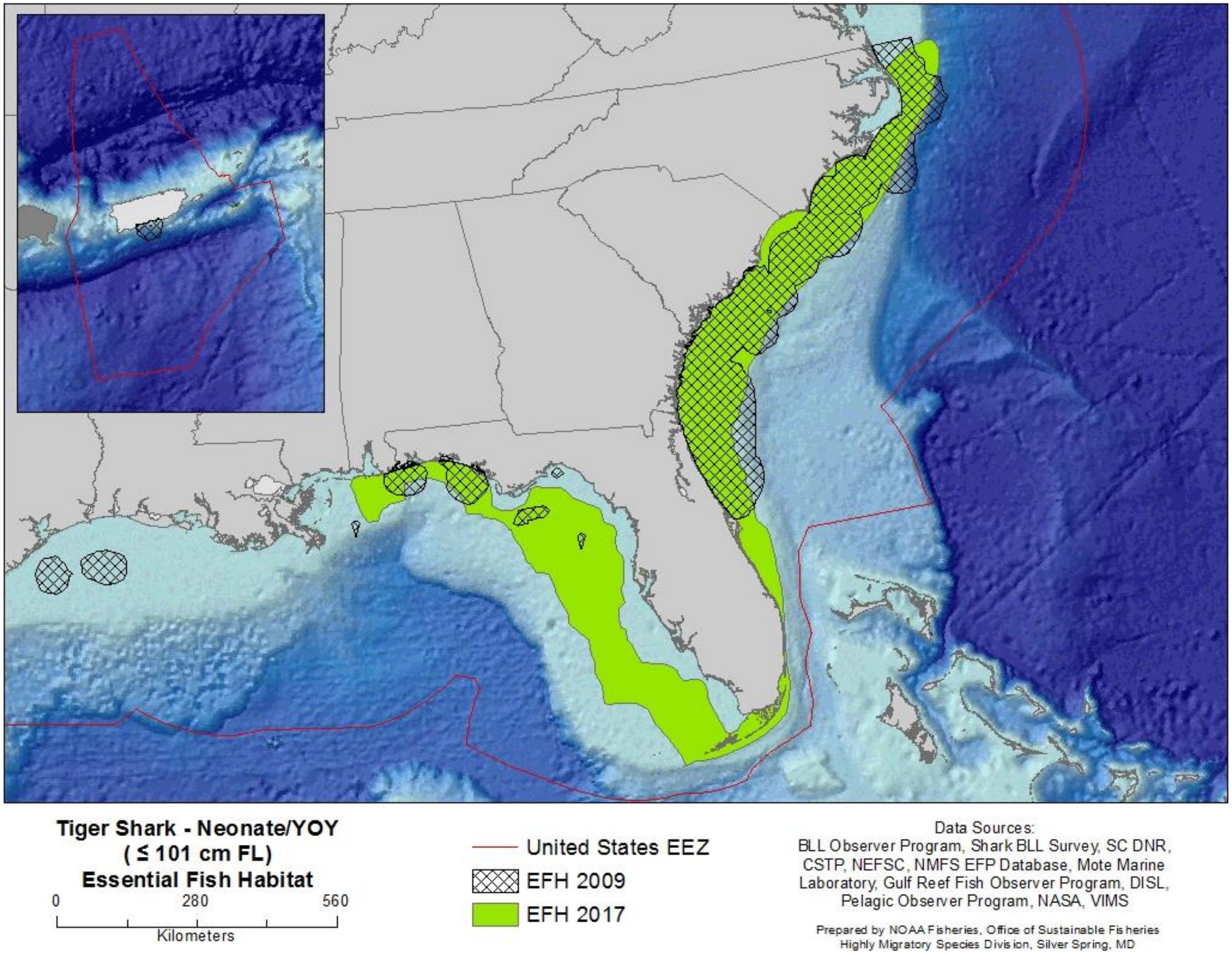


Spinner Shark - Juvenile/Adult (> 57 cm FL) Essential Fish Habitat

Prepared by NOAA Fisheries, Office of Sustainable Fisheries Highly Migratory Species Division, Silver Spring, MD

Data Sources: BLL Observer Program, NMFS BLL Survey, NASA, COASTSPAN, DISL, NMFS EFP Database, CSTP, Gillnet Observer Program, VIMS, Gulf Reef Fish Observer Program, GULFSPAN, Mote Marine Lab, SC DNR, NEFSC Observer Program, NEFSC, Pelagic Observer Program, Shrimp Observer Program, TX PWD, NEAMAP, NC DMF, SEAMAP Small Pelagics, SEAMAP Shrimp/Bottomfish

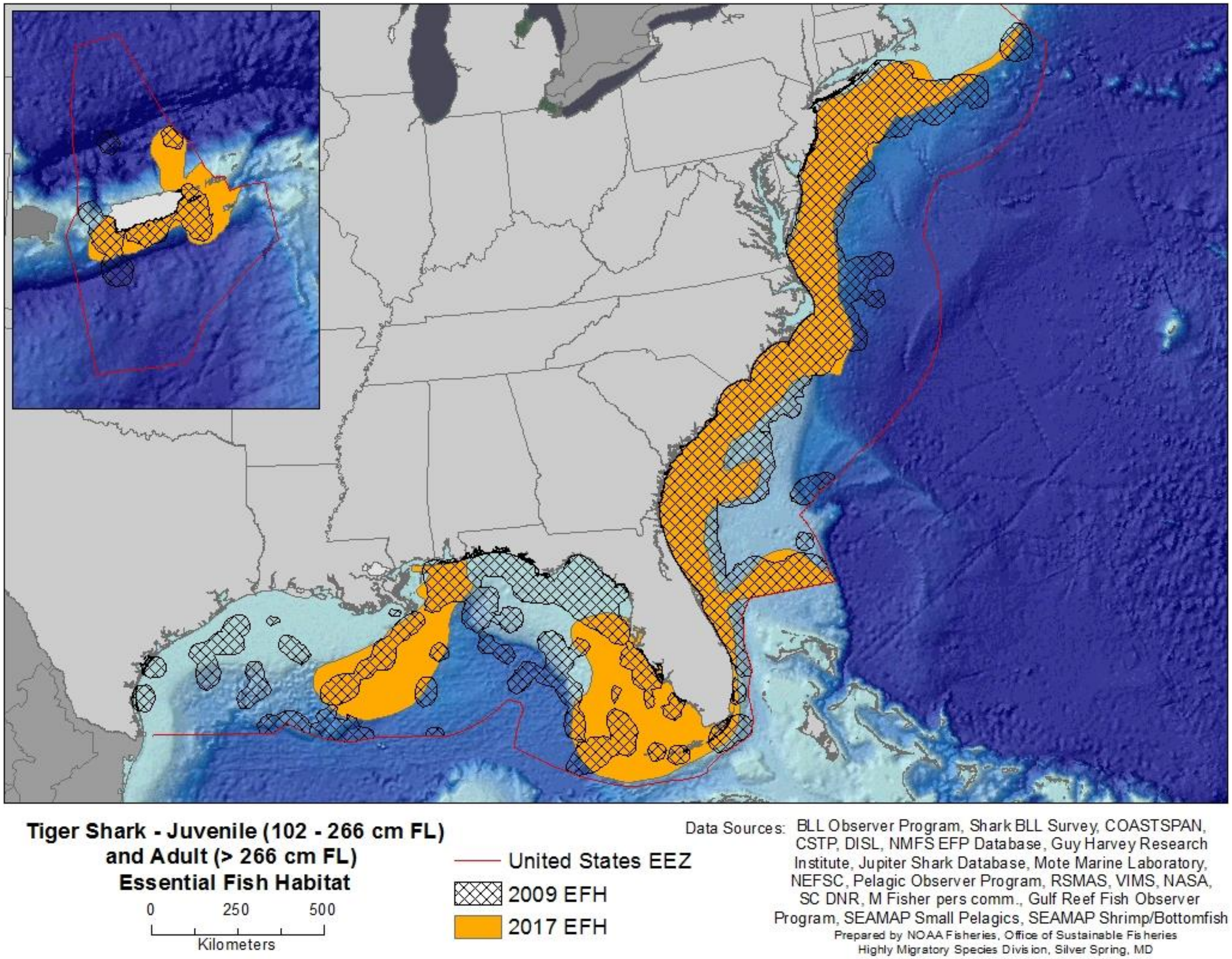
Figure G 46 **Spinner Shark – Juvenile and Adult Combined**



Data Sources:
BLL Observer Program, Shark BLL Survey, SC DNR, CSTP, NEFSC, NMFS EFP Database, Mote Marine Laboratory, Gulf Reef Fish Observer Program, DISL, Pelagic Observer Program, NASA, VIMS

Prepared by NOAA Fisheries, Office of Sustainable Fisheries
Highly Migratory Species Division, Silver Spring, MD

Figure G 47 **Tiger Shark - Neonate**


Tiger Shark - Juvenile (102 - 266 cm FL) and Adult (> 266 cm FL) Essential Fish Habitat

Data Sources: BLL Observer Program, Shark BLL Survey, COASTSPAN, CSTP, DISL, NMFS EFP Database, Guy Harvey Research Institute, Jupiter Shark Database, Mote Marine Laboratory, NEFSC, Pelagic Observer Program, RSMAS, VIMS, NASA, SC DNR, M Fisher pers comm., Gulf Reef Fish Observer Program, SEAMAP Small Pelagics, SEAMAP Shrimp/Bottomfish

Prepared by NOAA Fisheries, Office of Sustainable Fisheries
Highly Migratory Species Division, Silver Spring, MD

Figure G 48 **Tiger Shark – Juvenile and Adult Combined**

Small Coastal Sharks

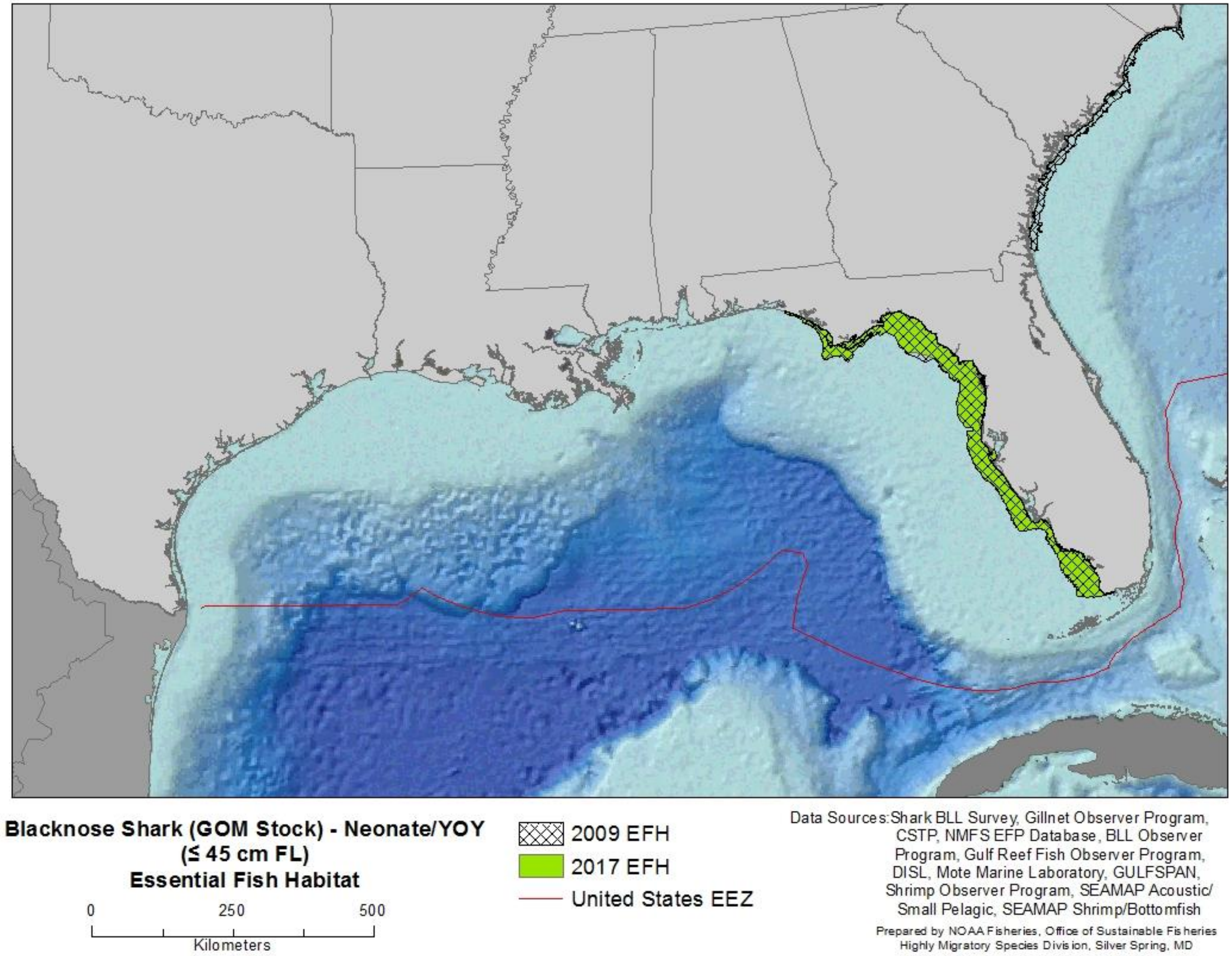


Figure G 49 Blacknose Shark (Gulf of Mexico Stock) – Neonate/YOY

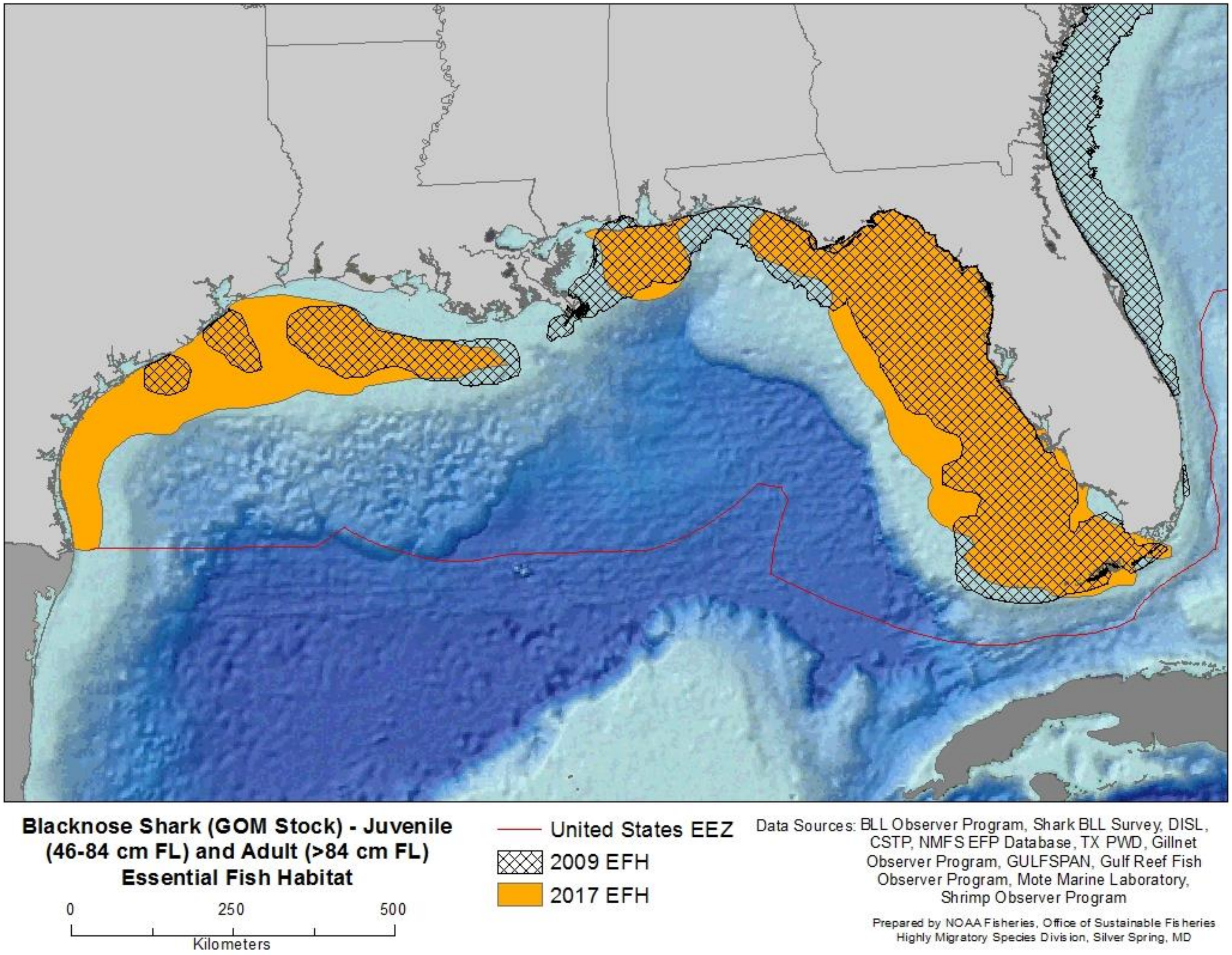


Figure G 50 **Blacknose Shark (Gulf of Mexico Stock) – Juvenile and Adult Combined**

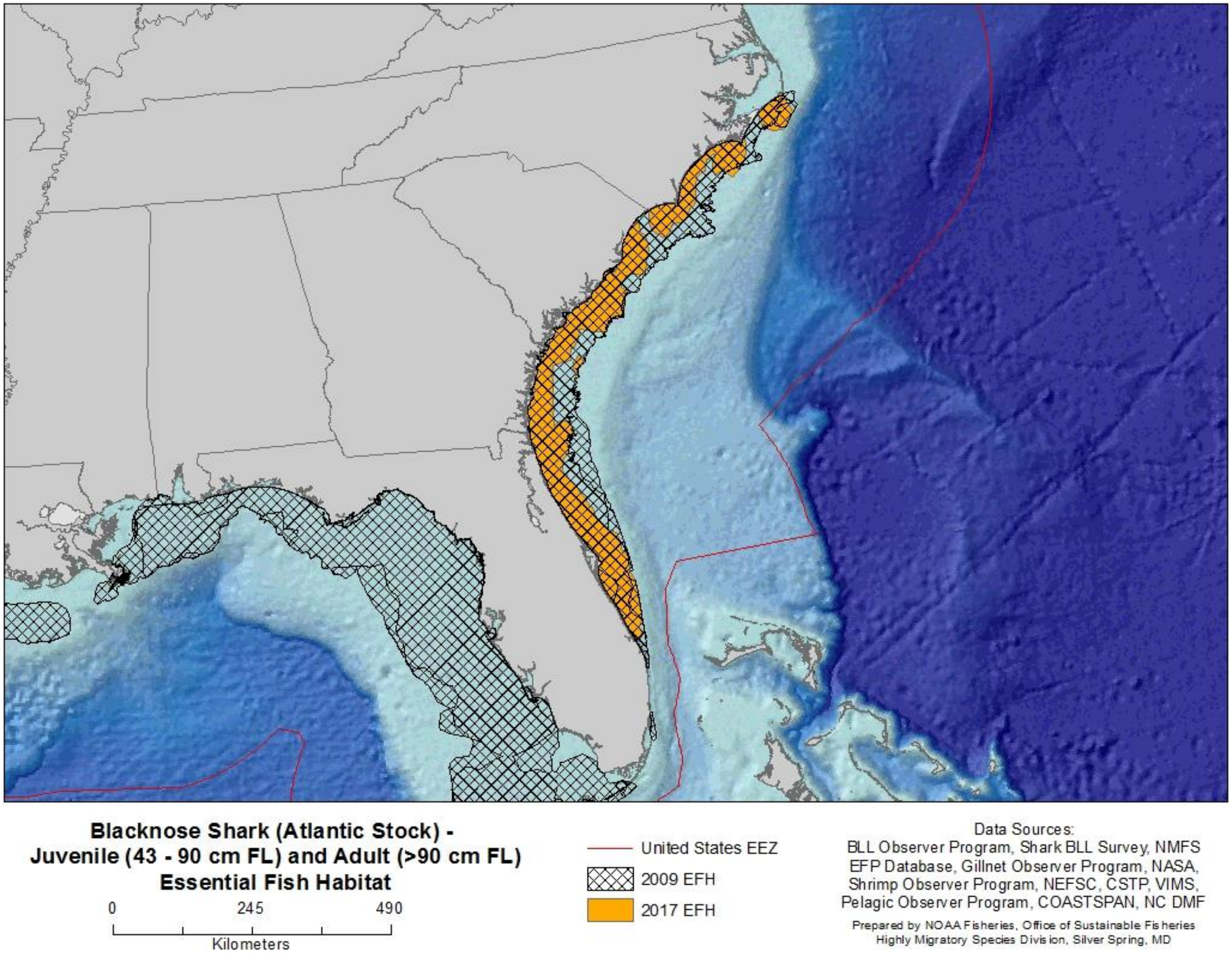


Figure G 51 **Blacknose Shark (Atlantic Stock) - Juvenile and Adult Combined**

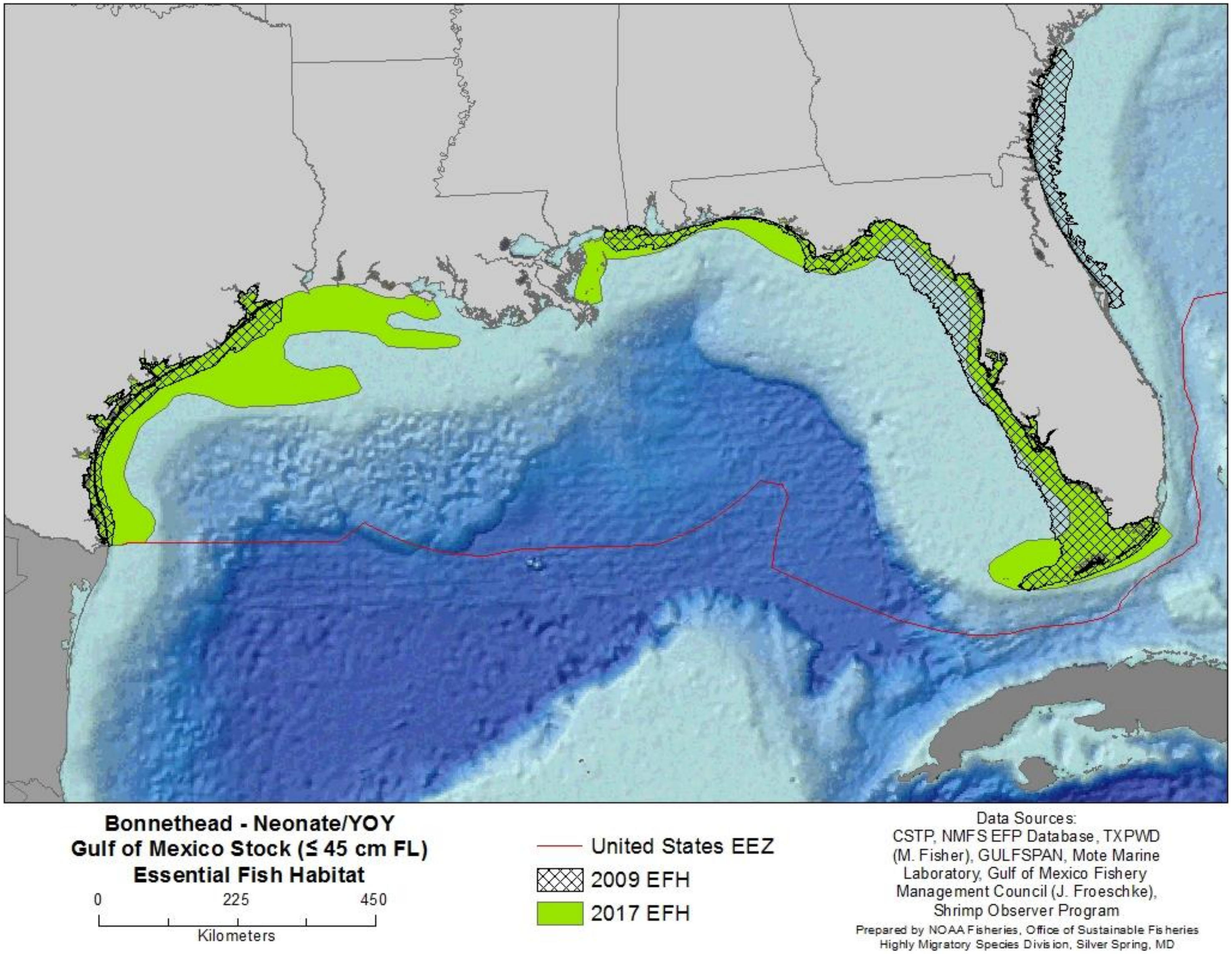


Figure G 52 Bonnethead Shark (Gulf of Mexico Stock) – Neonate/YOY

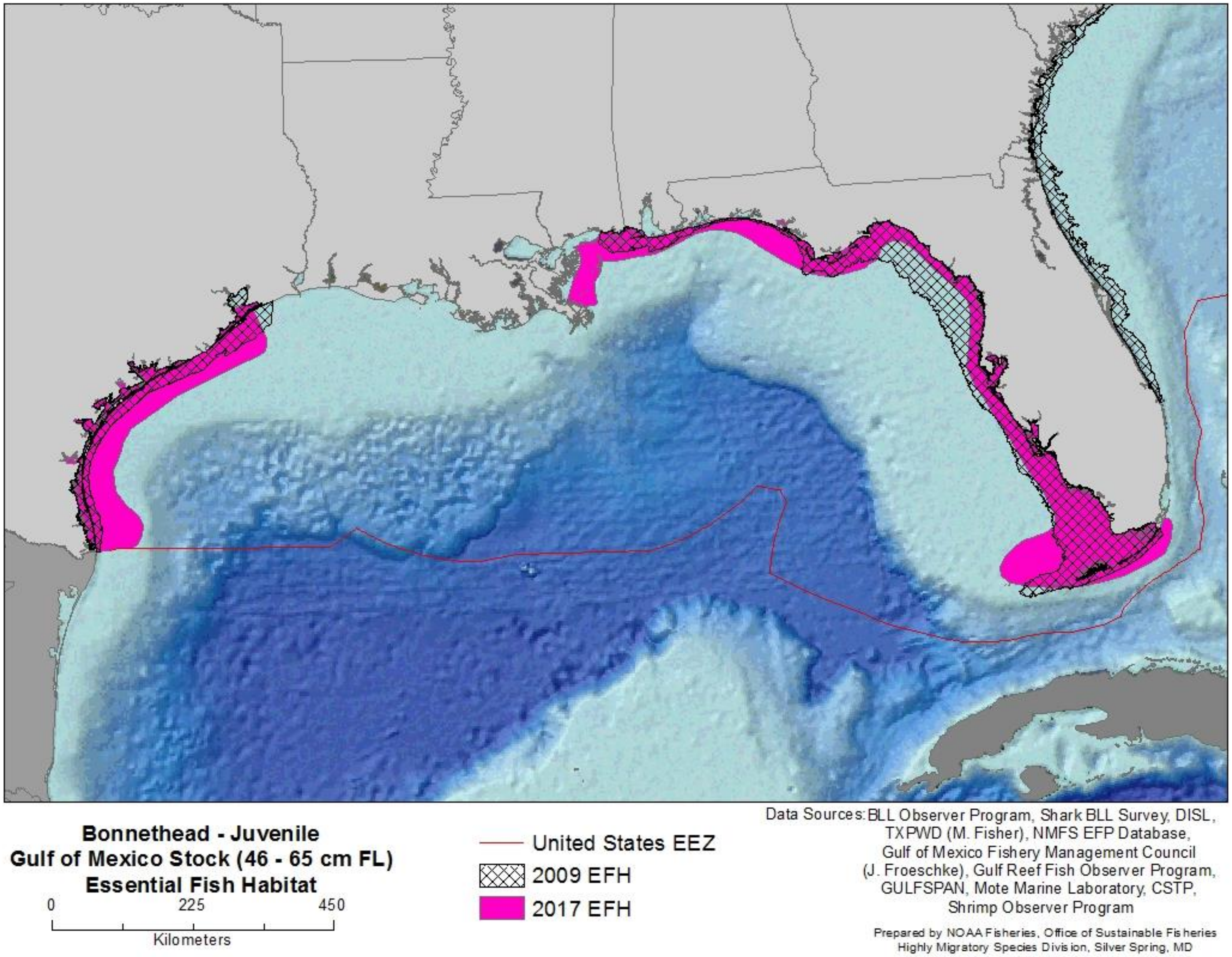


Figure G 53 **Bonnethead Shark (Gulf of Mexico Stock) – Juvenile**

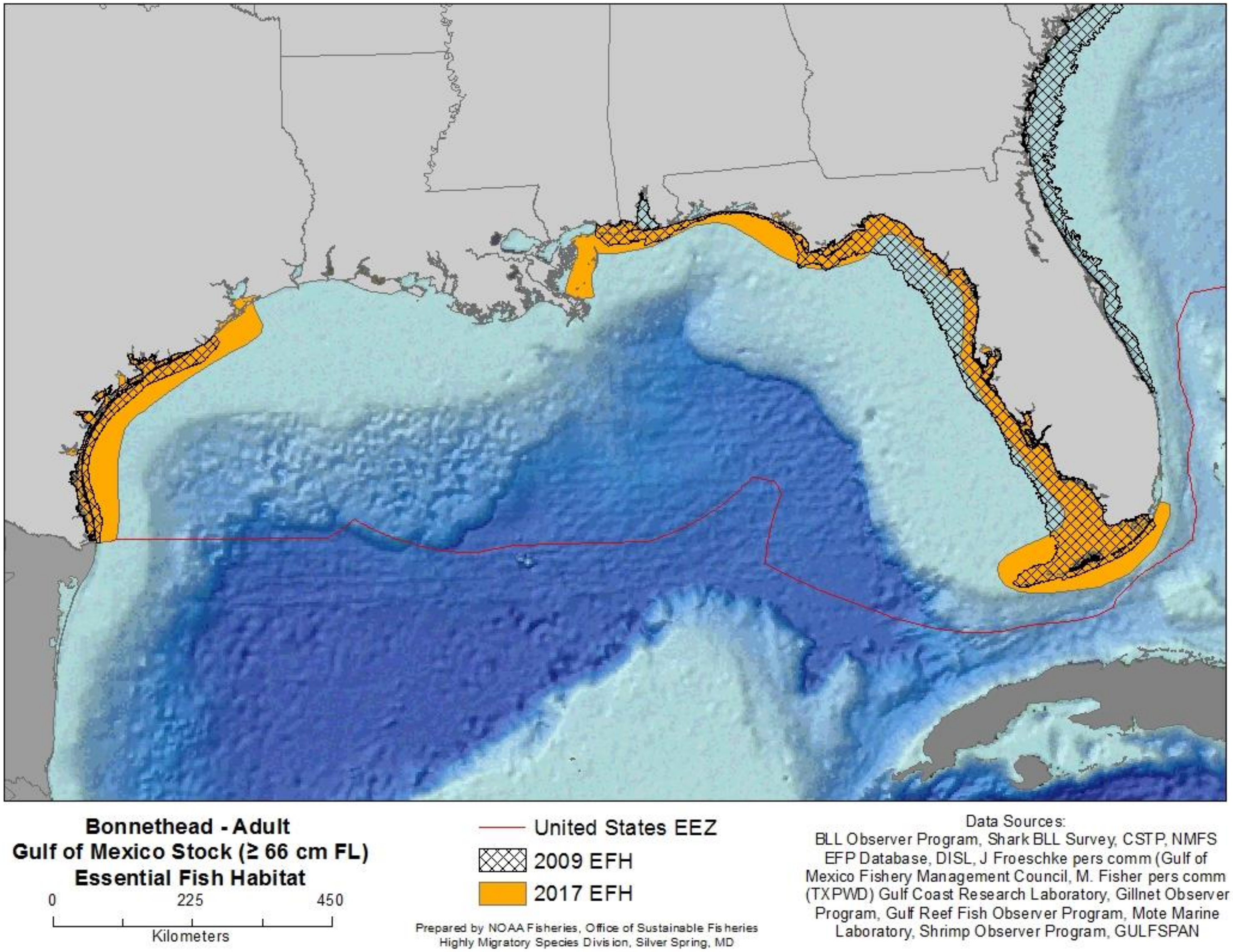


Figure G 54 Bonnethead Shark (Gulf of Mexico Stock) – Adult

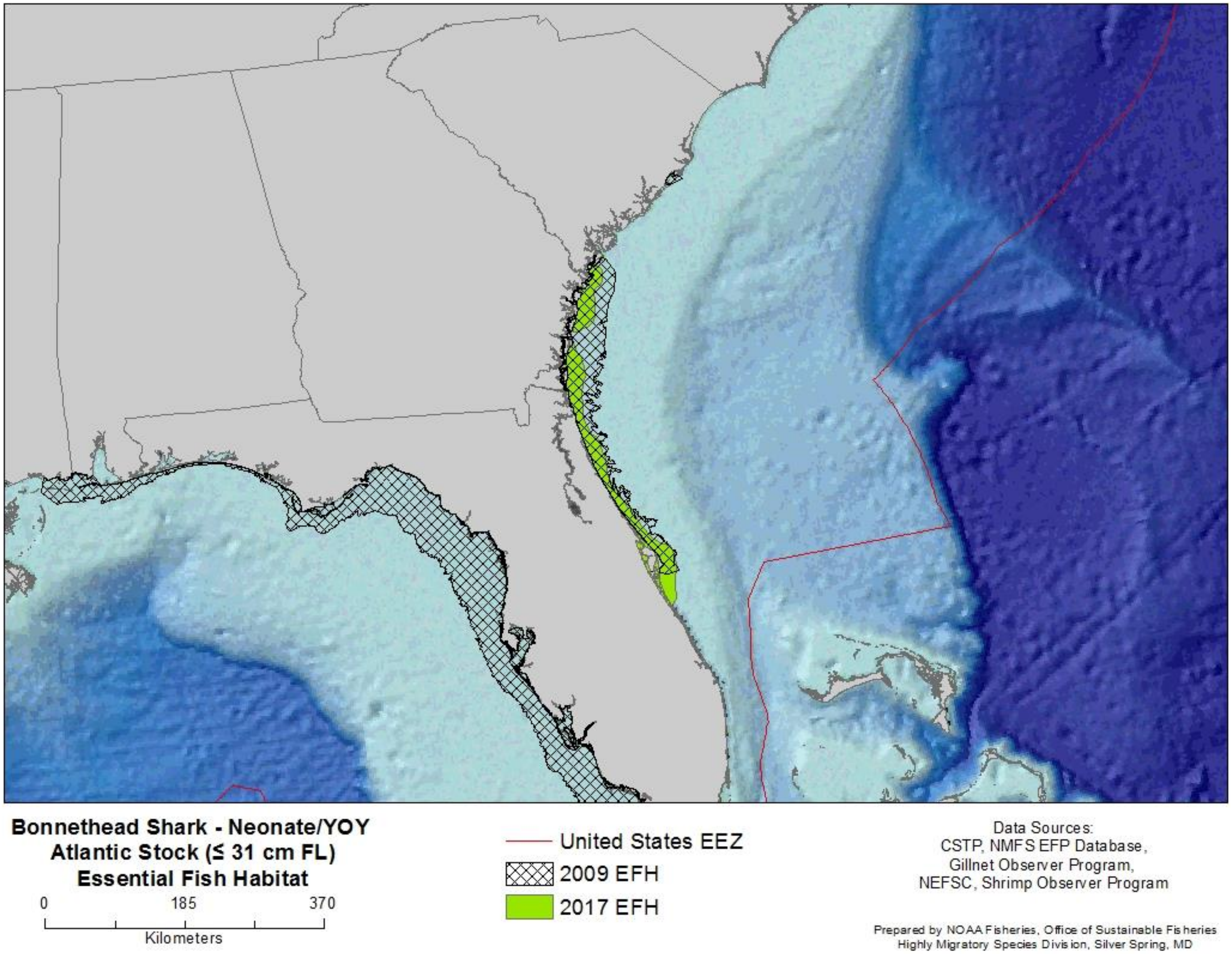


Figure G 55 Bonnethead Shark (Atlantic Stock) – Neonate/YOY

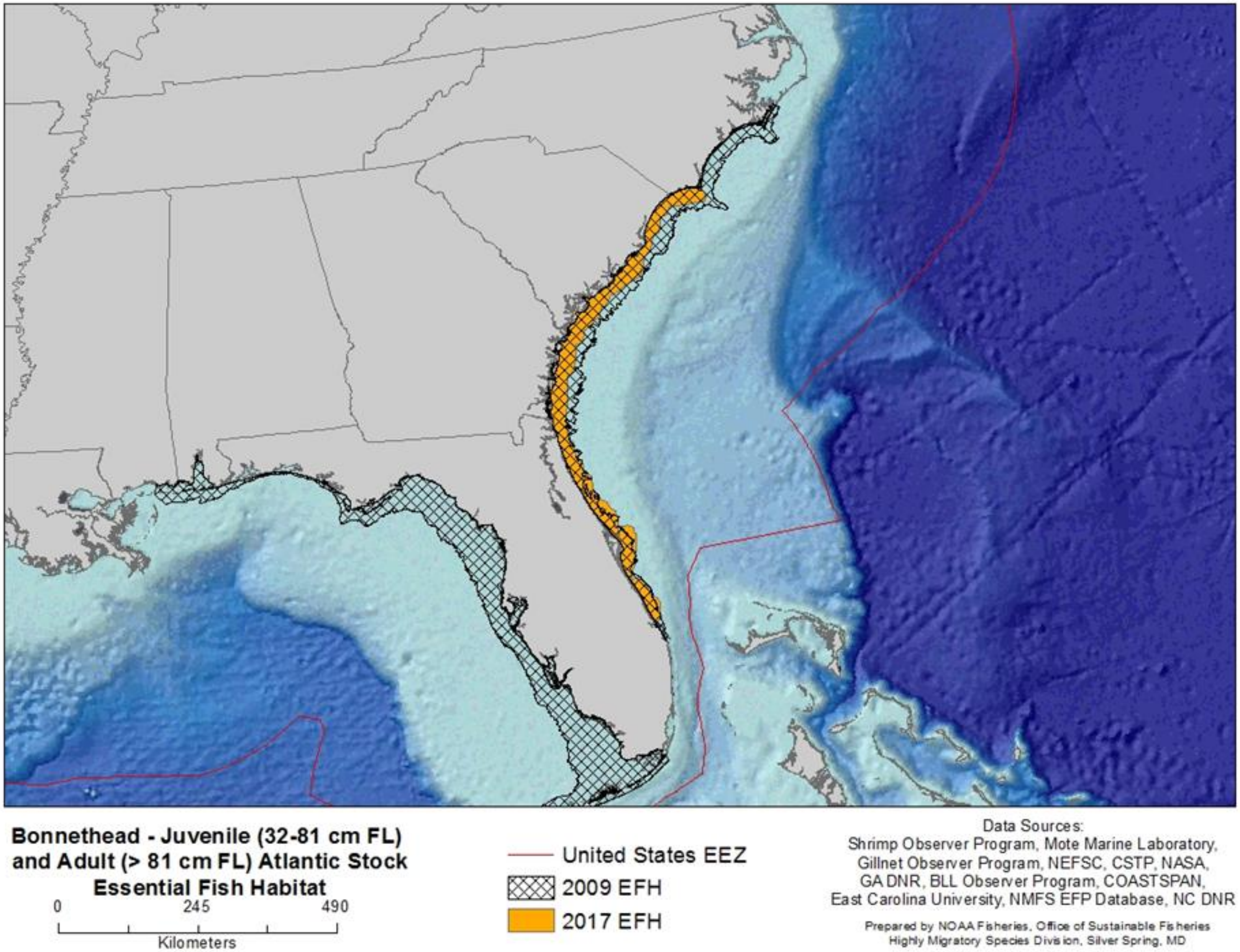
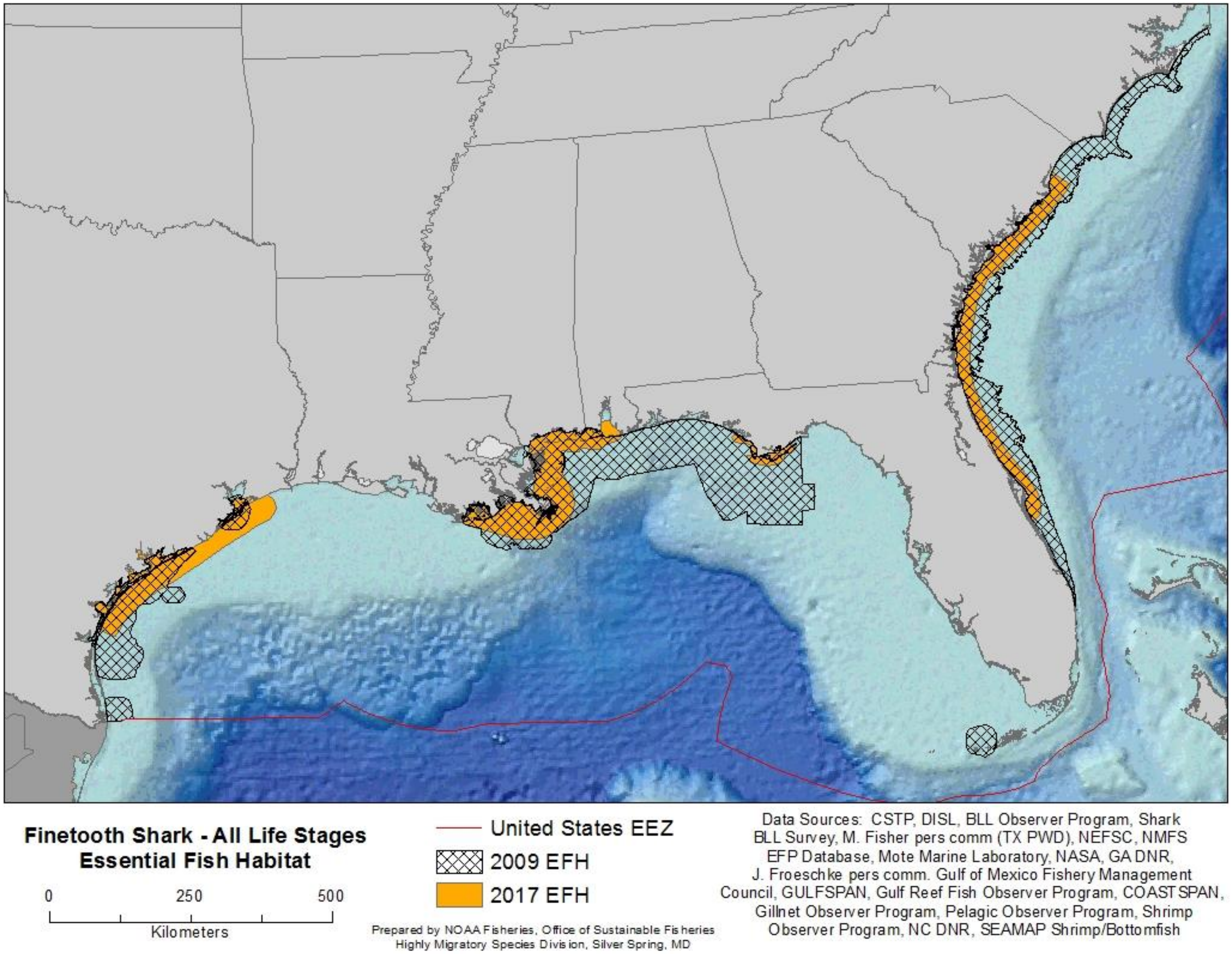


Figure G 56 **Bonnethead Shark (Atlantic Stock) –Juvenile and Adult**



Finetooth Shark - All Life Stages
Essential Fish Habitat

Data Sources: CSTP, DISL, BLL Observer Program, Shark BLL Survey, M. Fisher pers comm (TX PWD), NEFSC, NMFS EFP Database, Mote Marine Laboratory, NASA, GA DNR, J. Froeschke pers comm. Gulf of Mexico Fishery Management Council, GULFSPAN, Gulf Reef Fish Observer Program, COASTSPAN, Gillnet Observer Program, Pelagic Observer Program, Shrimp Observer Program, NC DNR, SEAMAP Shrimp/Bottomfish

Prepared by NOAA Fisheries, Office of Sustainable Fisheries
Highly Migratory Species Division, Silver Spring, MD

Figure G 57 **Finetooth Shark – All Life Stages Combined**

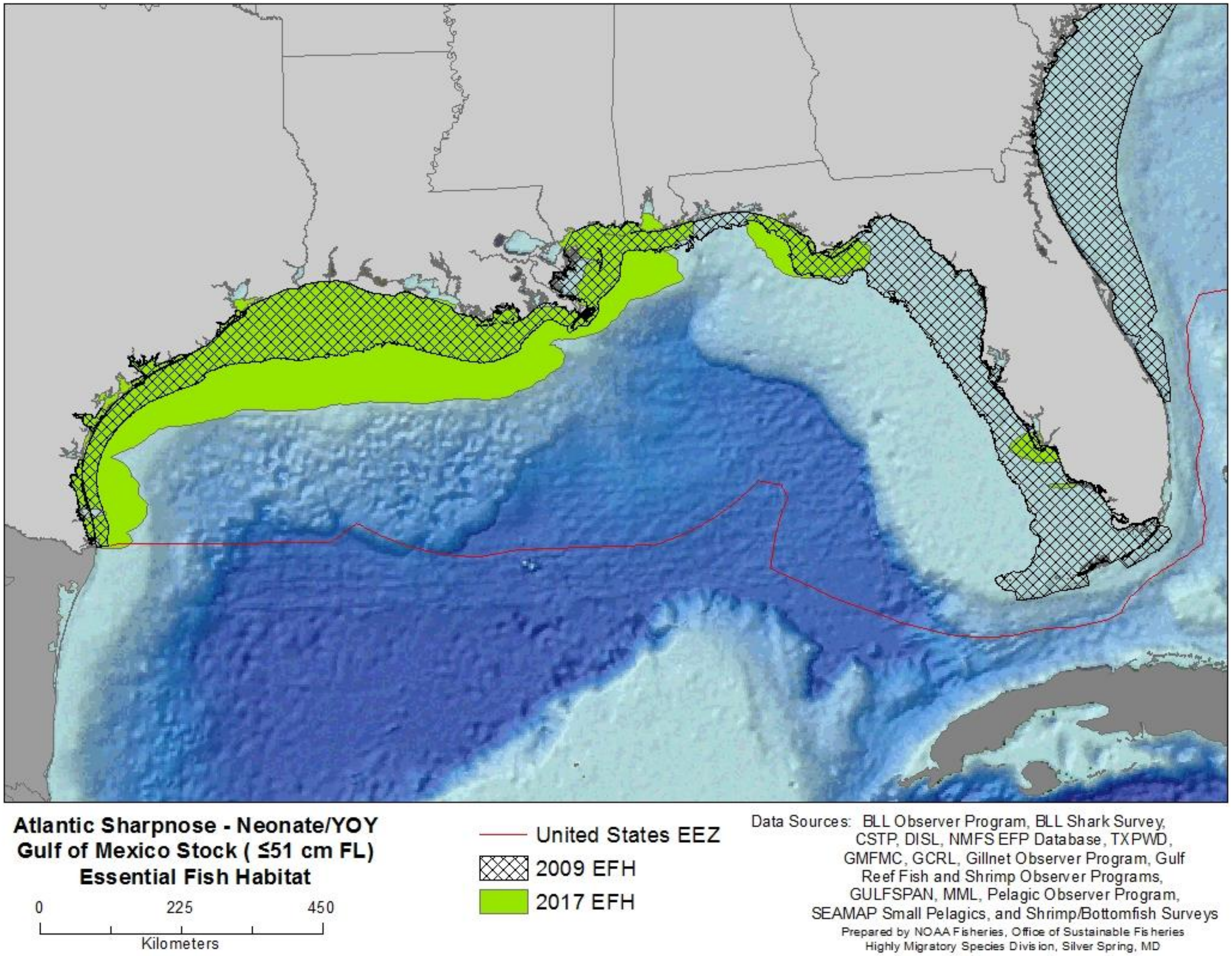
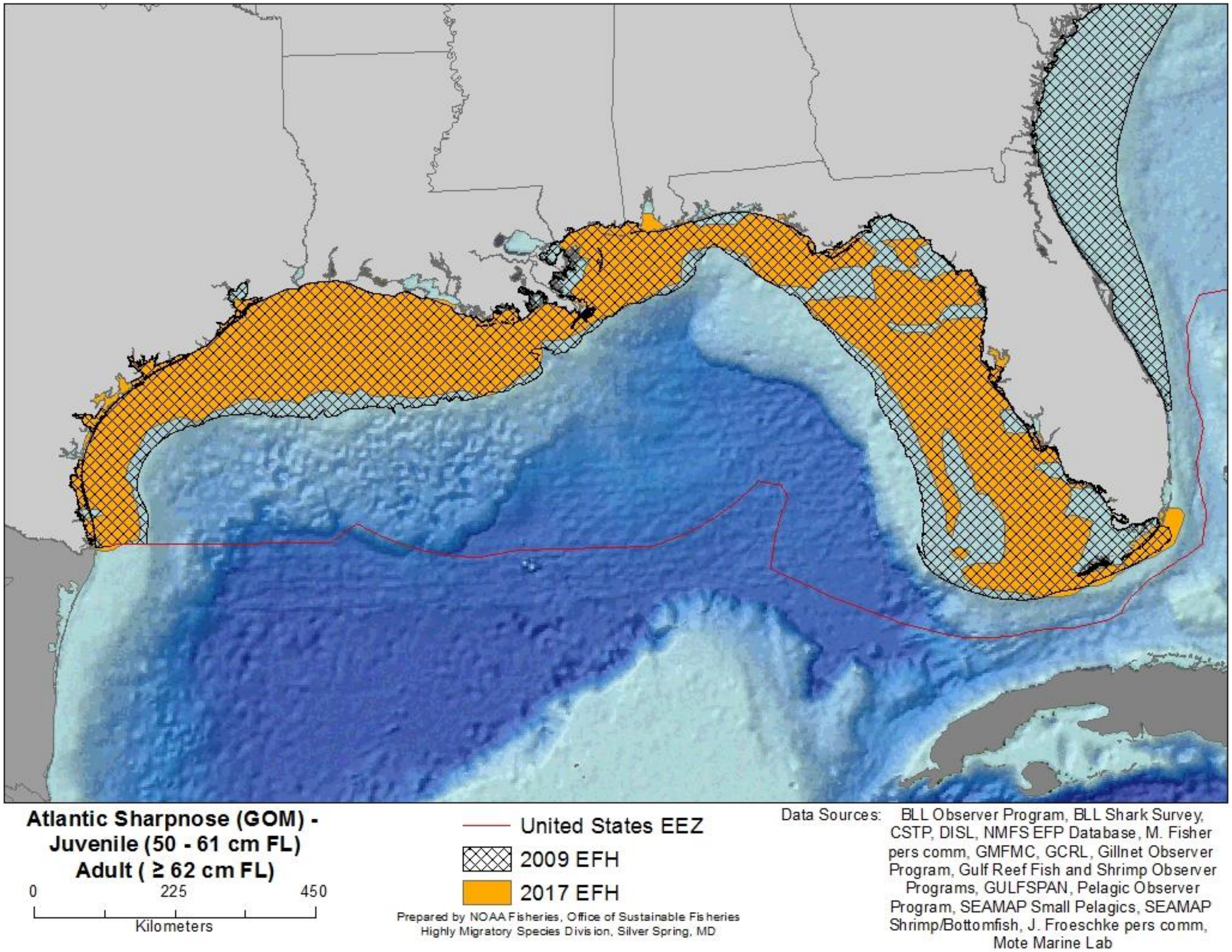


Figure G 58 **Sharpnose Shark (Gulf of Mexico Stock) – Neonate/YOY**



**Atlantic Sharpnose (GOM) -
Juvenile (50 - 61 cm FL)
Adult (≥ 62 cm FL)**

Prepared by NOAA Fisheries, Office of Sustainable Fisheries
Highly Migratory Species Division, Silver Spring, MD

Data Sources: BLL Observer Program, BLL Shark Survey, CSTP, DISL, NMFS EFP Database, M. Fisher pers comm, GMFMC, GCRL, Gillnet Observer Program, Gulf Reef Fish and Shrimp Observer Programs, GULFSPAN, Pelagic Observer Program, SEAMAP Small Pelagics, SEAMAP Shrimp/Bottomfish, J. Froeschke pers comm, Mote Marine Lab

Figure G 59 **Sharpnose Shark (Gulf of Mexico Stock) – Juvenile and Adult**

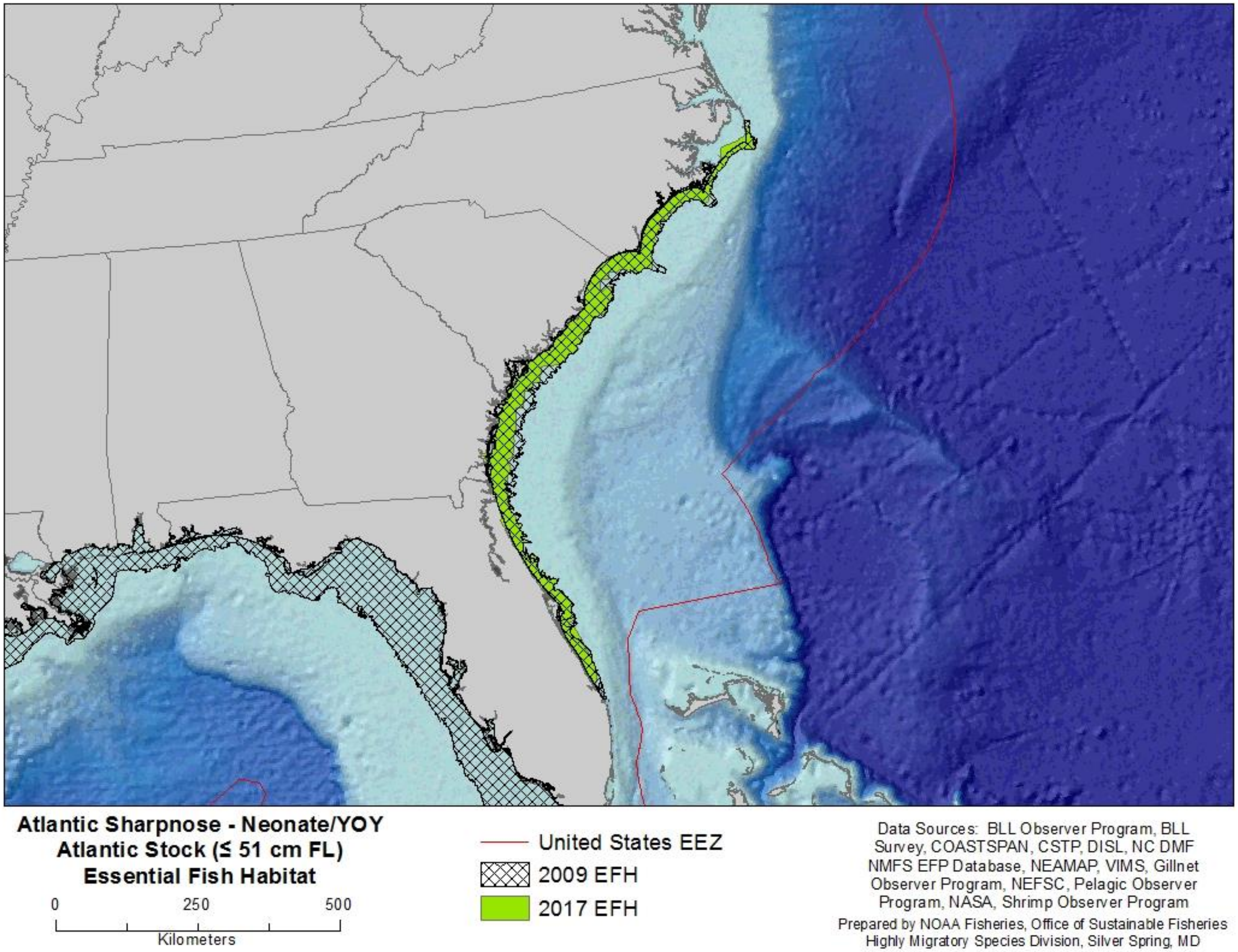


Figure G 60 **Sharpnose Shark (Atlantic Stock) – Neonate/YOY**

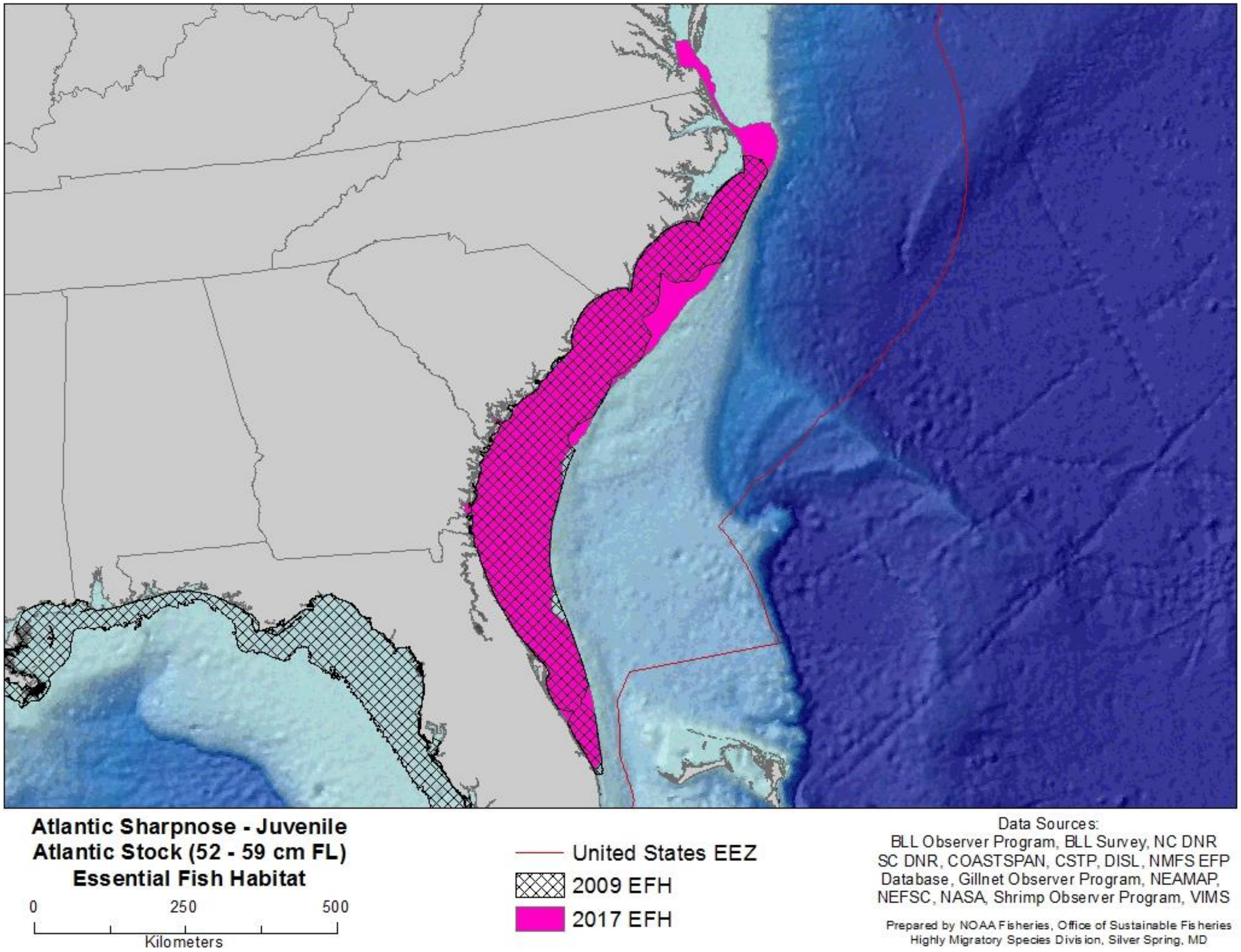
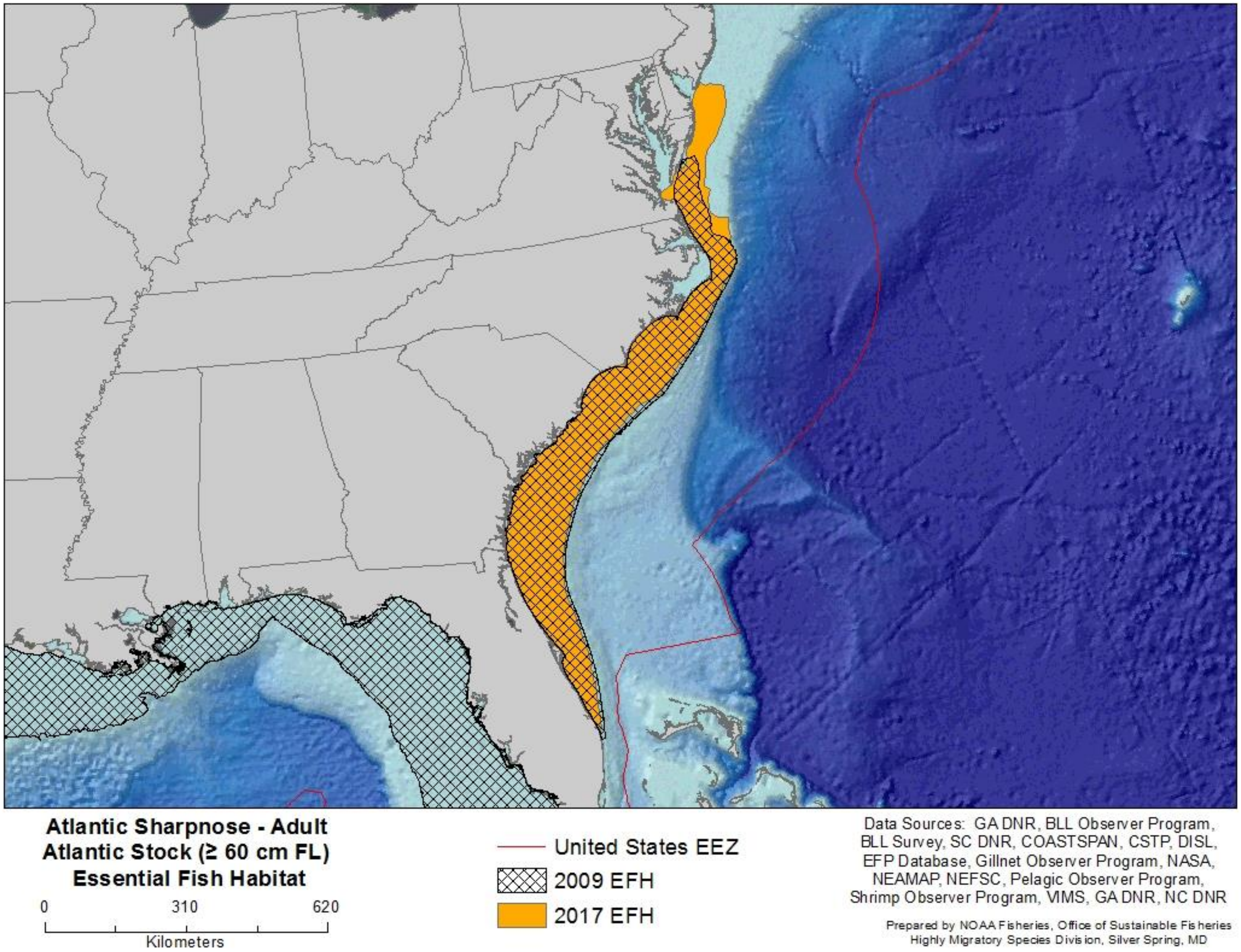


Figure G 61 Sharpnose Shark (Atlantic Stock) - Juvenile



Data Sources: GA DNR, BLL Observer Program, BLL Survey, SC DNR, COASTSPAN, CSTP, DISL, EFP Database, Gillnet Observer Program, NASA, NEAMAP, NEFSC, Pelagic Observer Program, Shrimp Observer Program, VIMS, GA DNR, NC DNR

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Figure G 62 **Sharpnose Sharks (Atlantic Stock) - Adult**

Pelagic Sharks

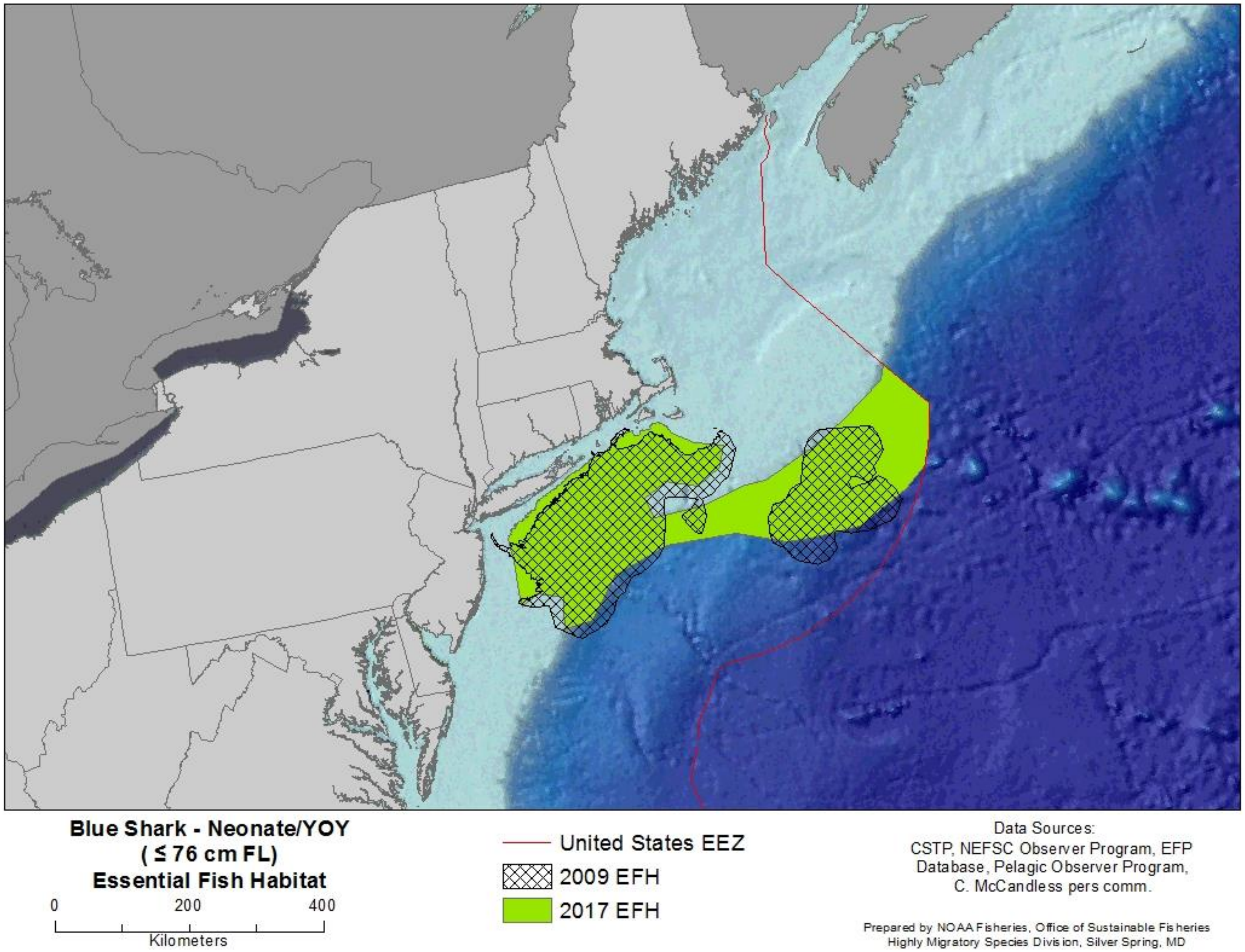
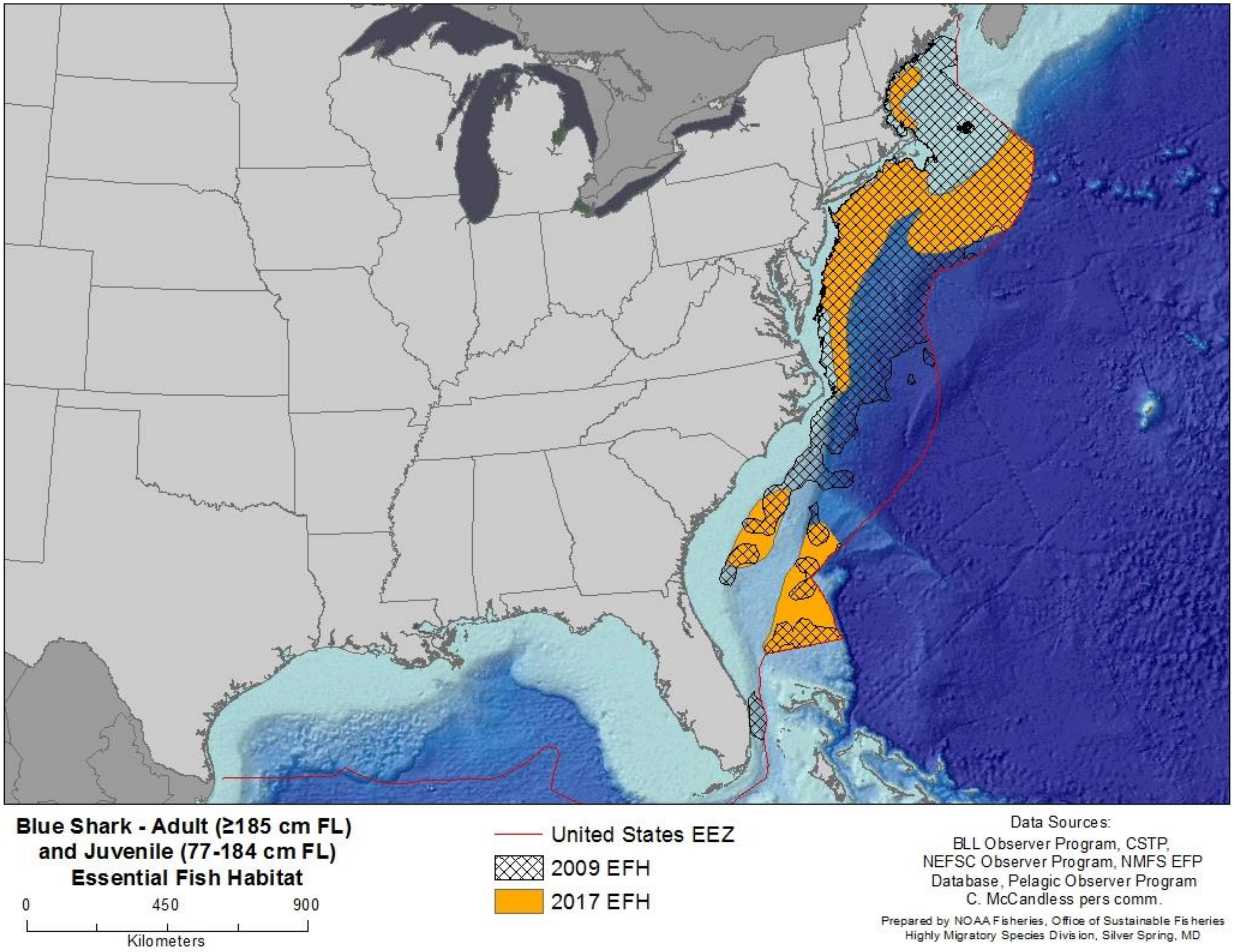


Figure G 63 **Blue Shark – Neonate/YOY**



Data Sources:
BLL Observer Program, CSTP,
NEFSC Observer Program, NMFS EFP
Database, Pelagic Observer Program
C. McCandless pers comm.

Prepared by NOAA Fisheries, Office of Sustainable Fisheries
Highly Migratory Species Division, Silver Spring, MD

Figure G 64 **Blue Shark – Juvenile and Adult Combined**

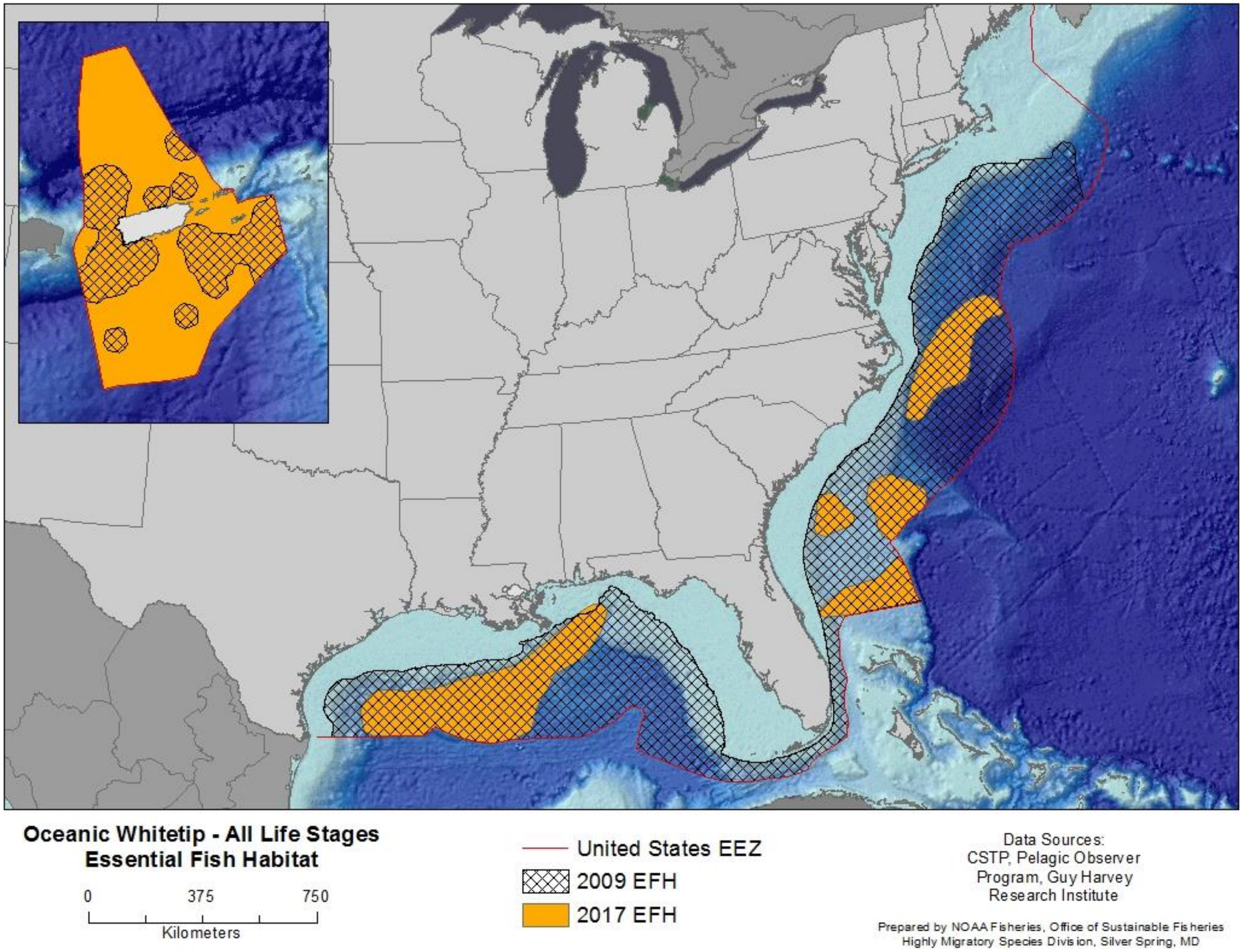


Figure G 65 **Oceanic Whitetip Shark – All Life Stages Combined**

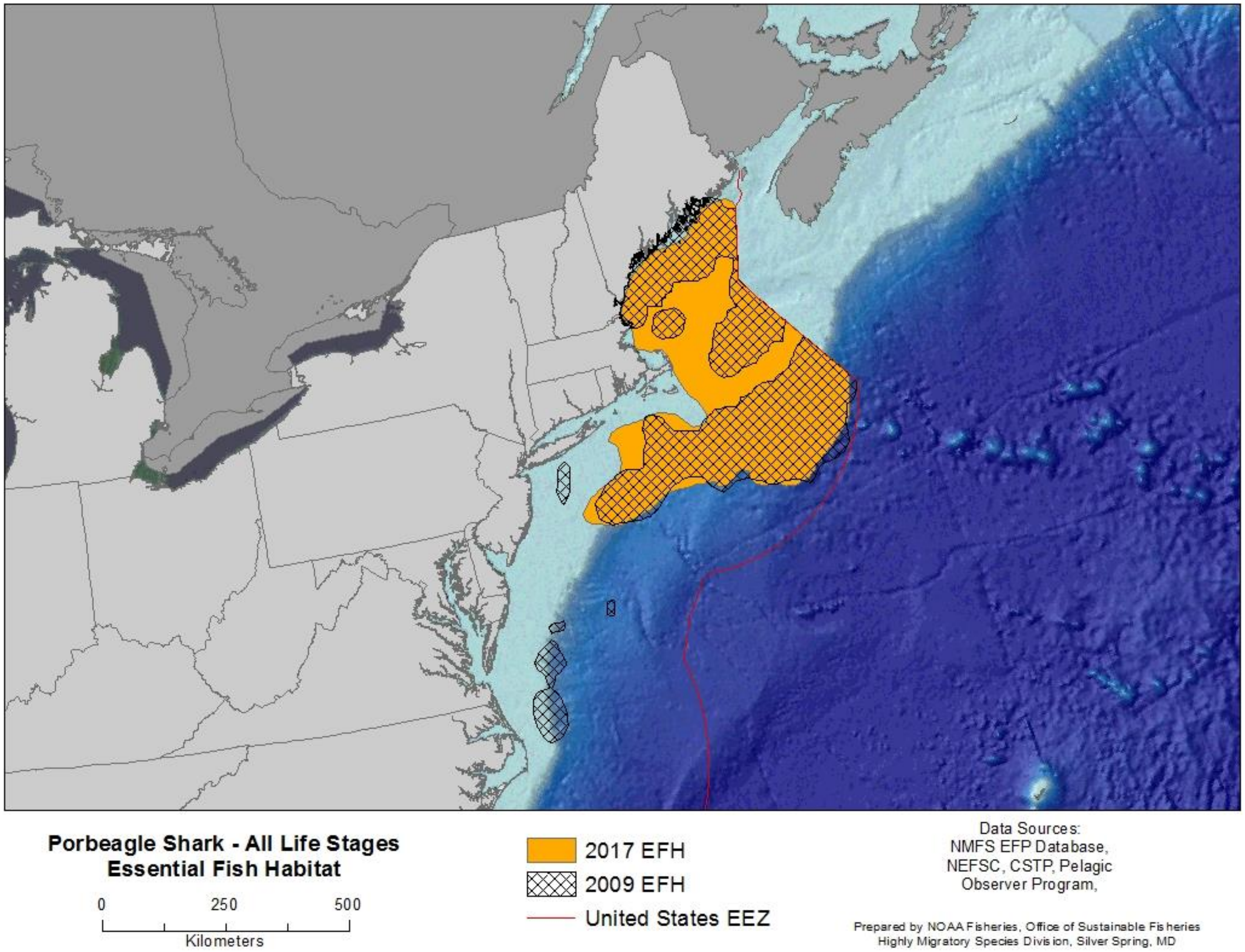


Figure G 66 **Porbeagle Shark - All Life Stages Combined**

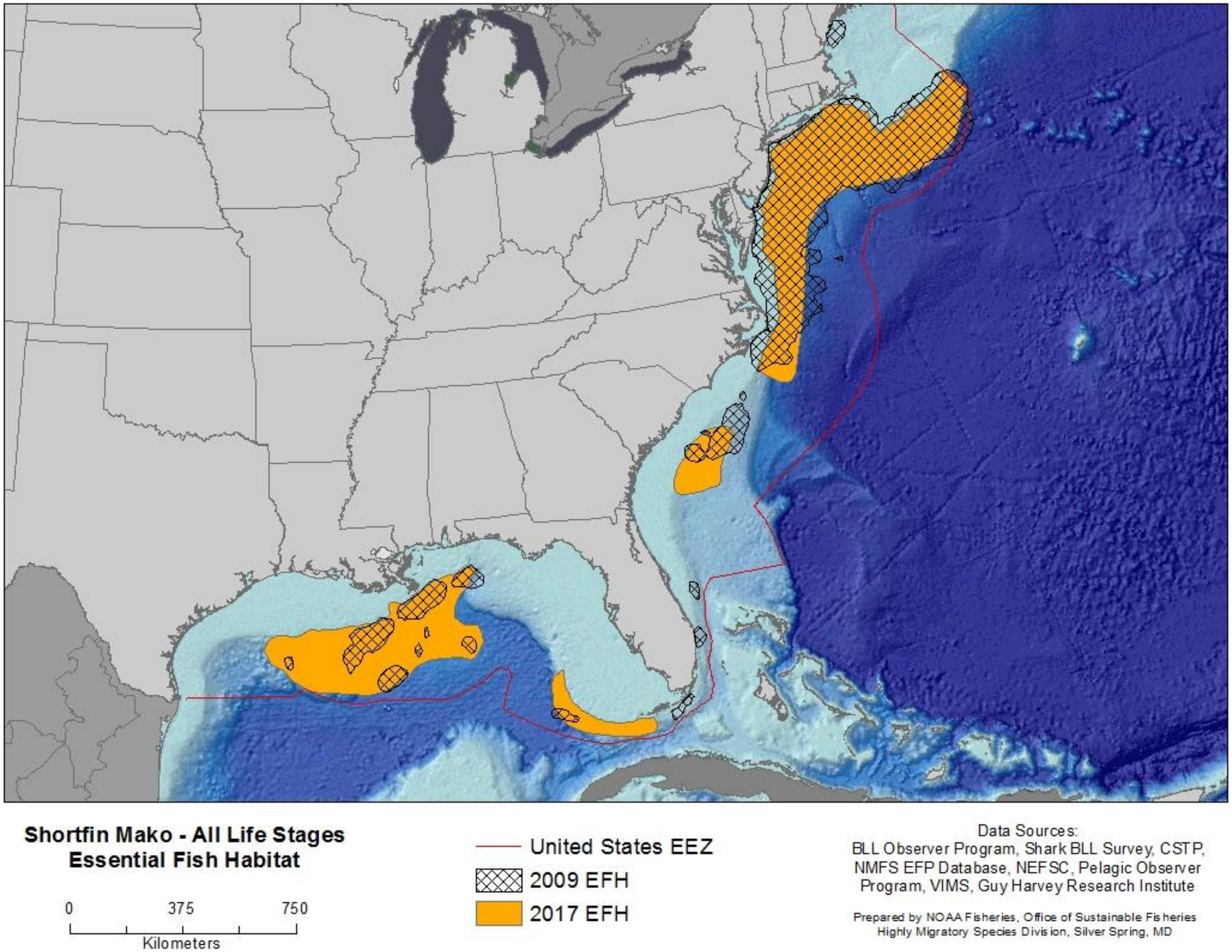


Figure G 67 Shortfin Mako Shark – All Life Stages Combined

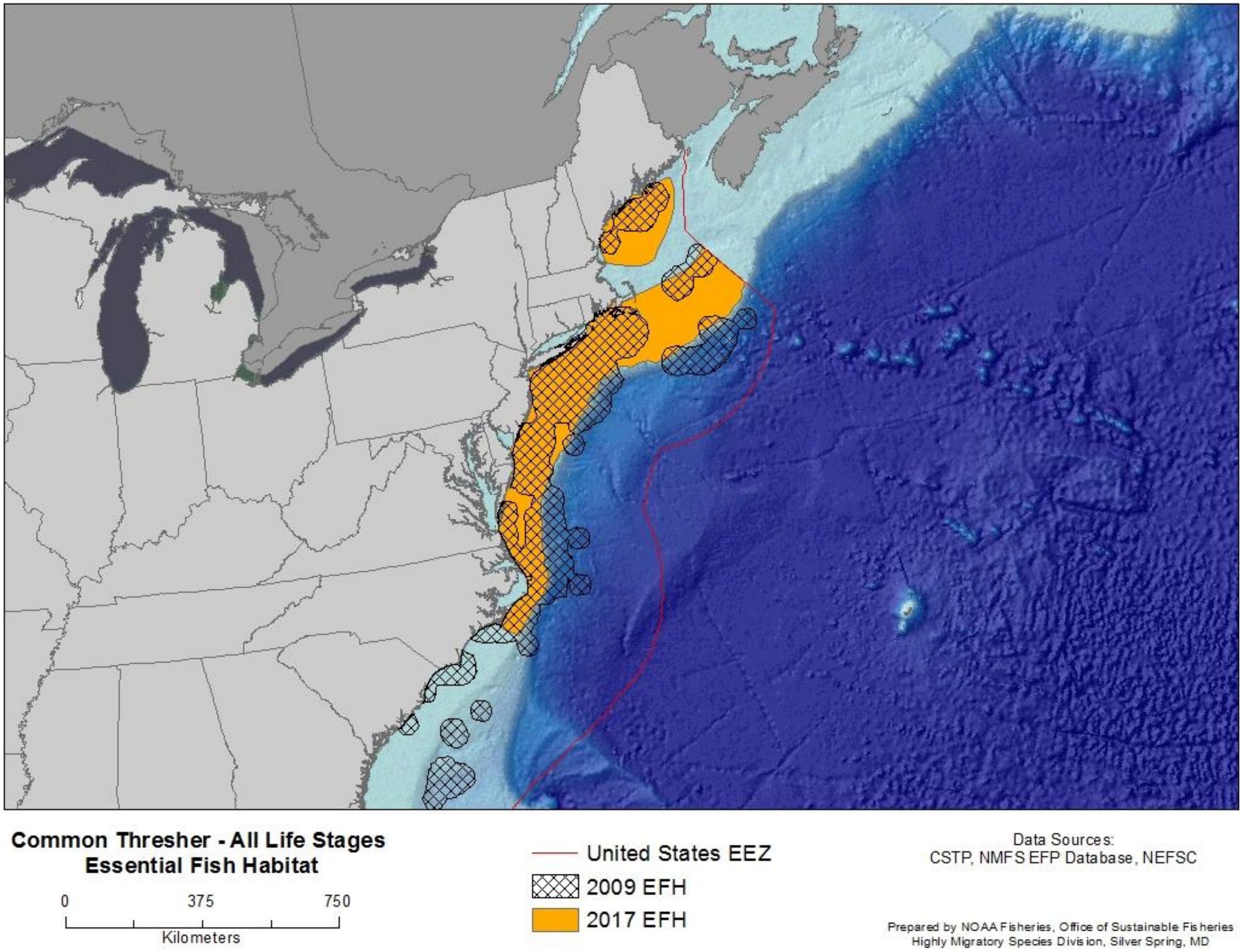


Figure G 68 Common Thresher Shark - All Life Stages Combined

Smoothhound Shark Complex

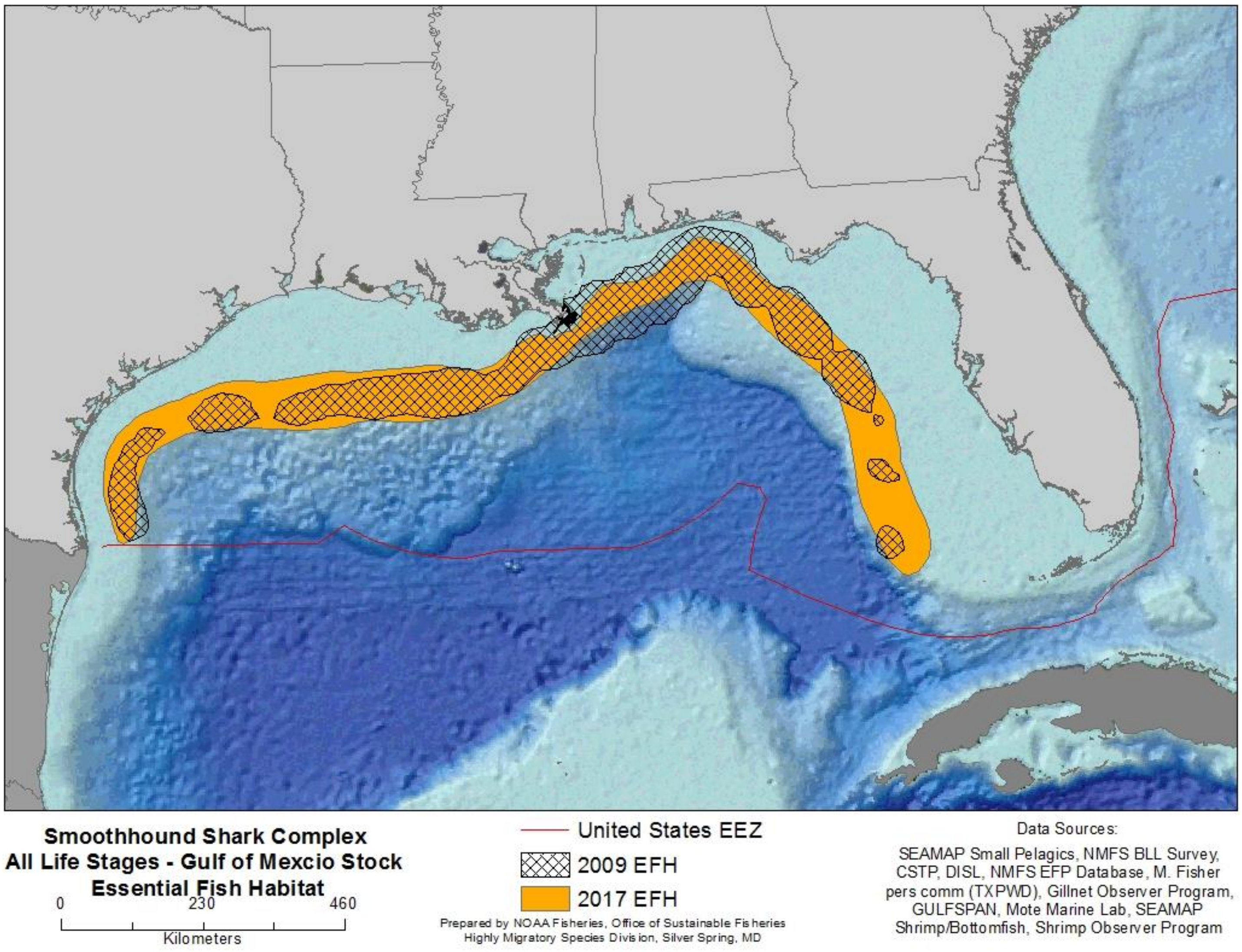


Figure G 69 Smoothhound Shark Complex (Gulf of Mexico Stock) – All Life Stages Combined

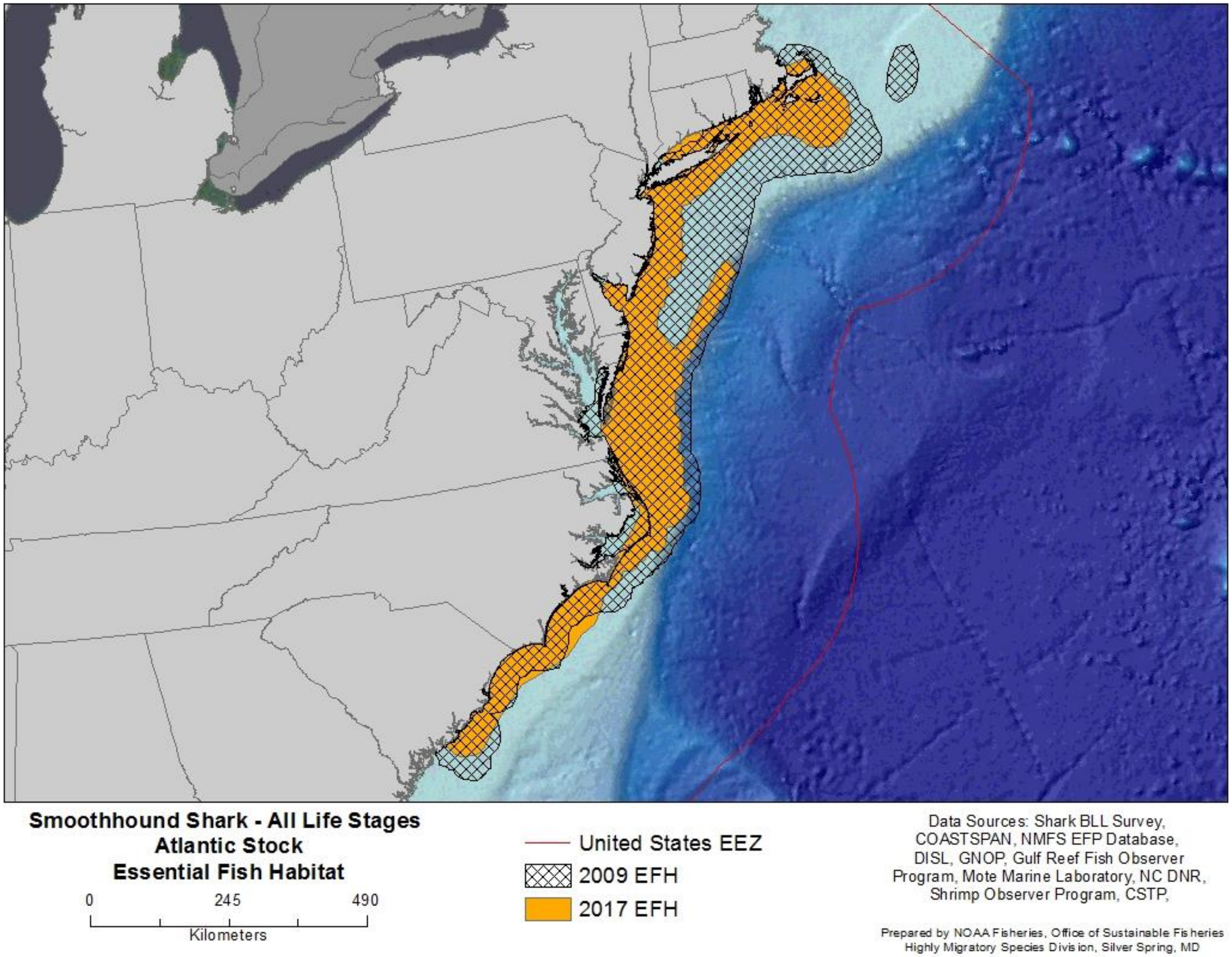


Figure G 70 **Smoothhound Shark (Atlantic Stock) – All Lifestages Combined**

Prohibited Sharks

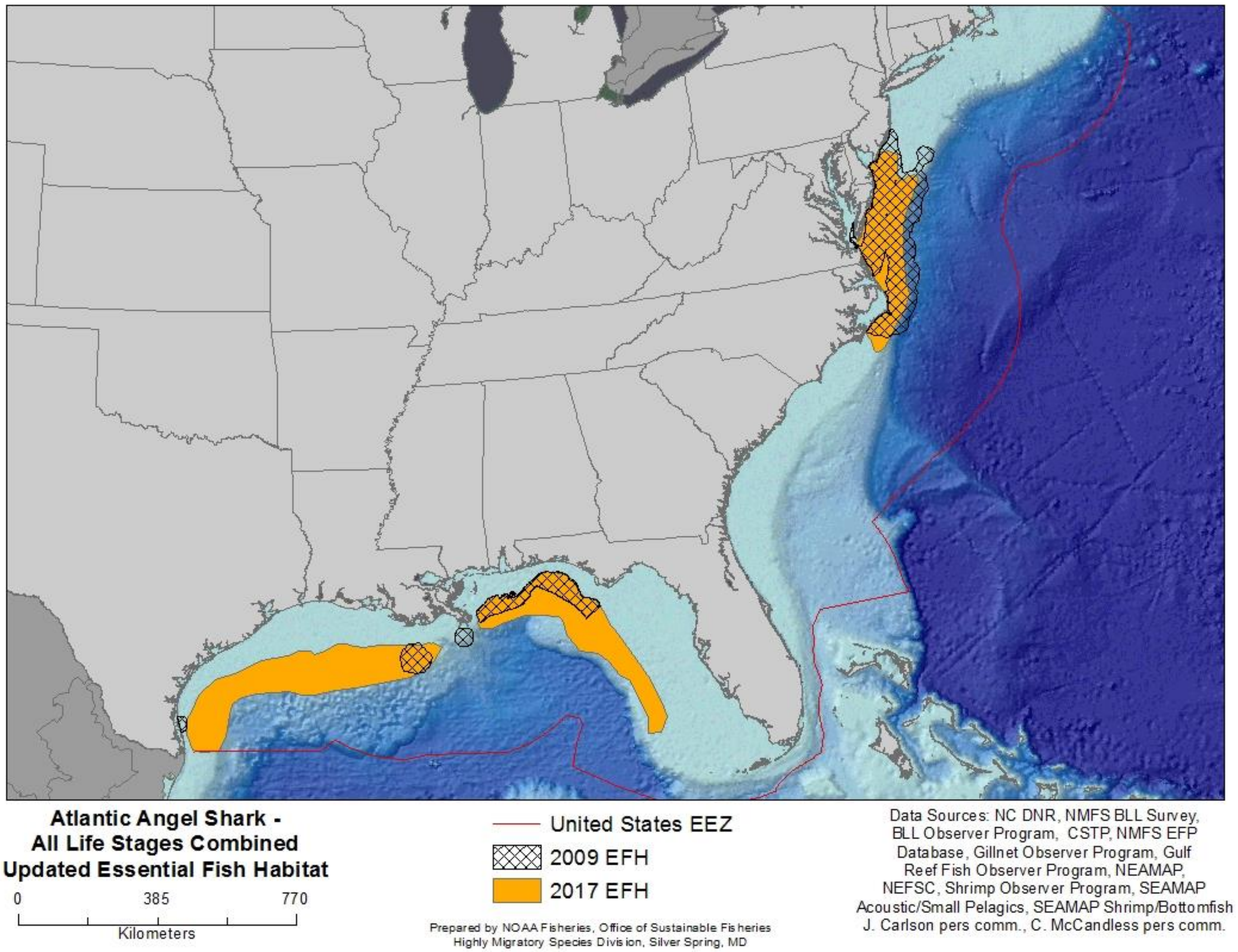


Figure G 71 **Atlantic Angel Shark - All Life Stages Combined**

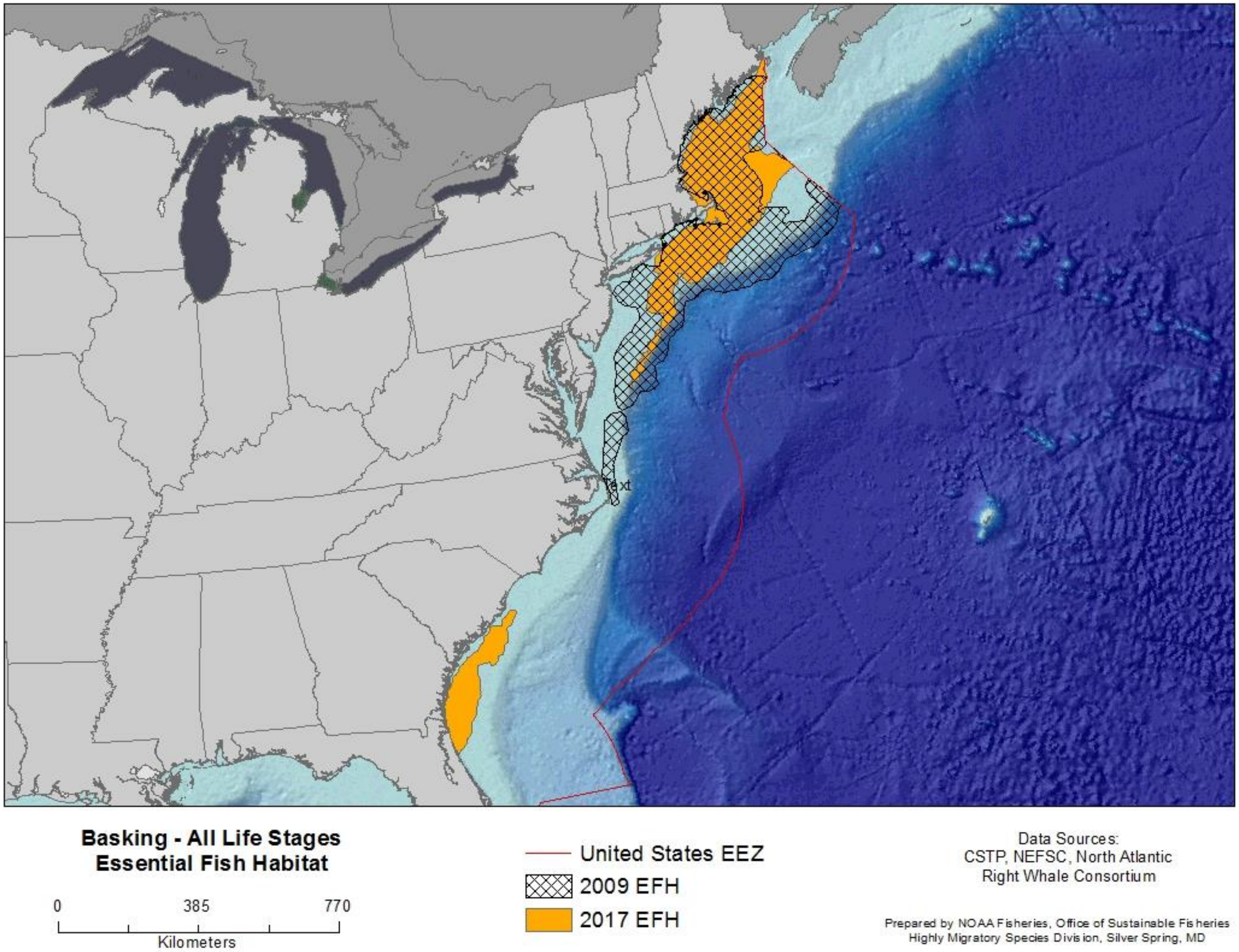


Figure G 72 **Basking Shark – All Life Stages Combined**

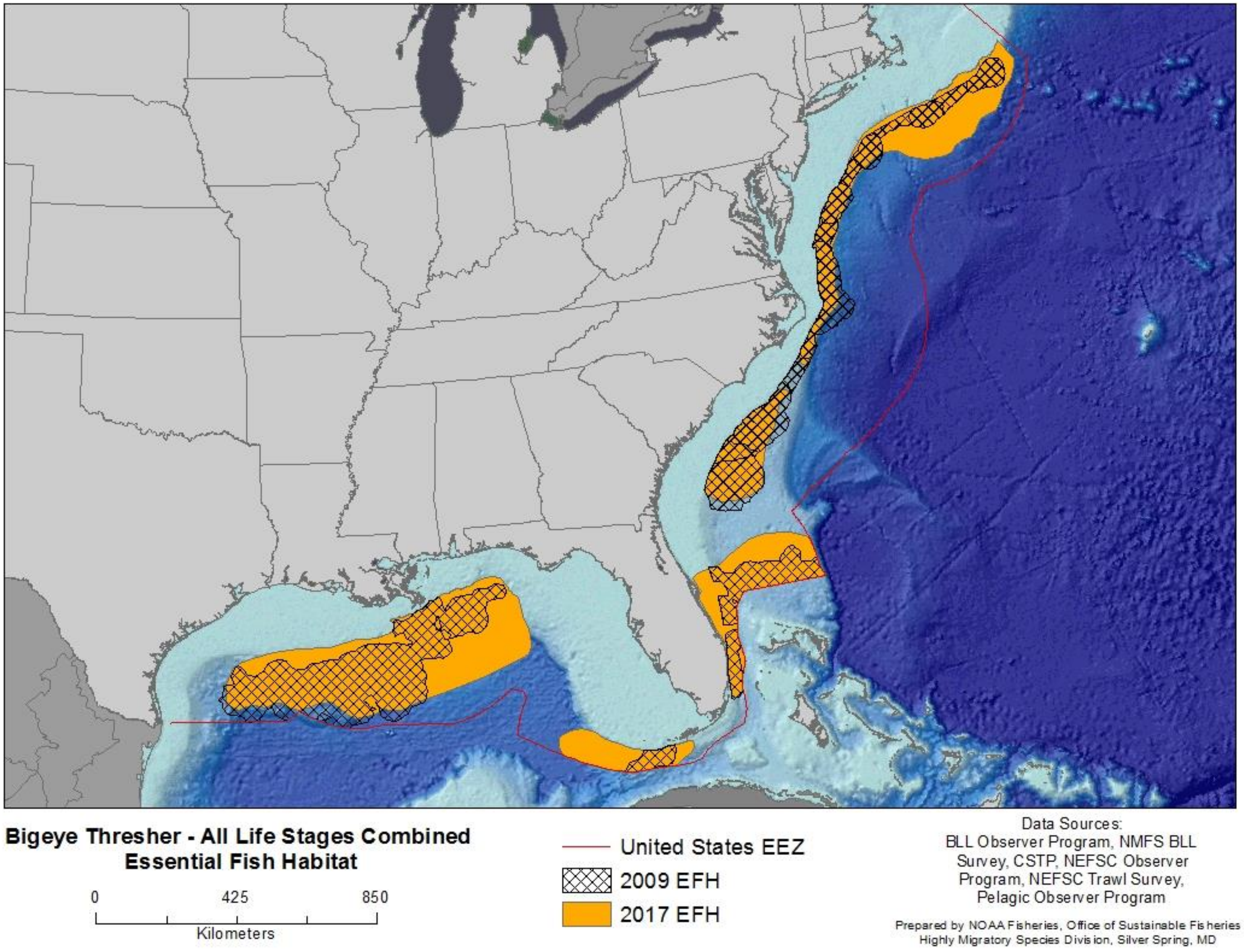
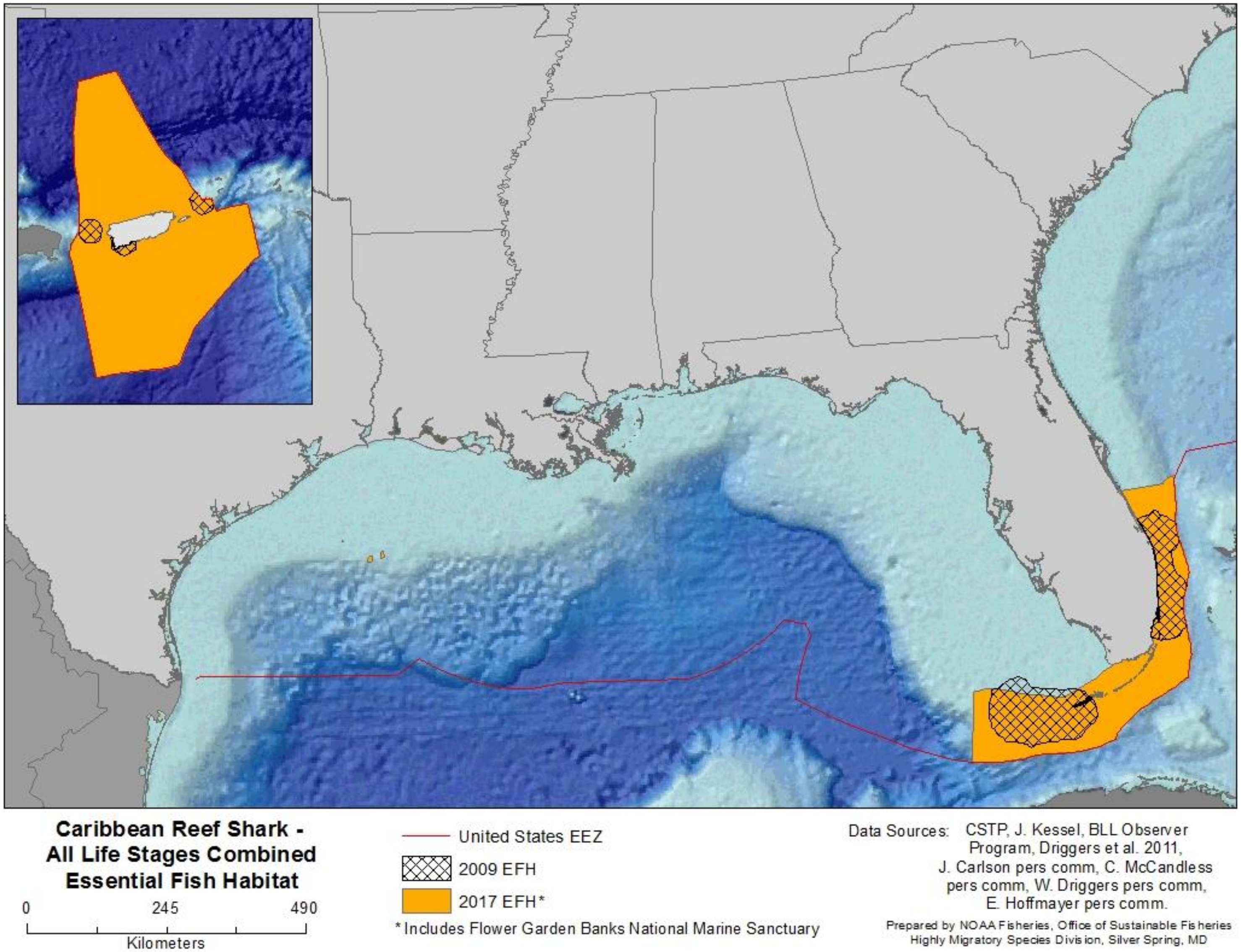


Figure G 73 **Bigeye Thresher - All Life Stages Combined**



Data Sources: CSTP, J. Kessel, BLL Observer Program, Driggers et al. 2011, J. Carlson pers comm, C. McCandless pers comm, W. Driggers pers comm, E. Hoffmayer pers comm.

Prepared by NOAA Fisheries, Office of Sustainable Fisheries Highly Migratory Species Division, Silver Spring, MD

Figure G 74 Caribbean Reef Shark - All Life Stages Combined

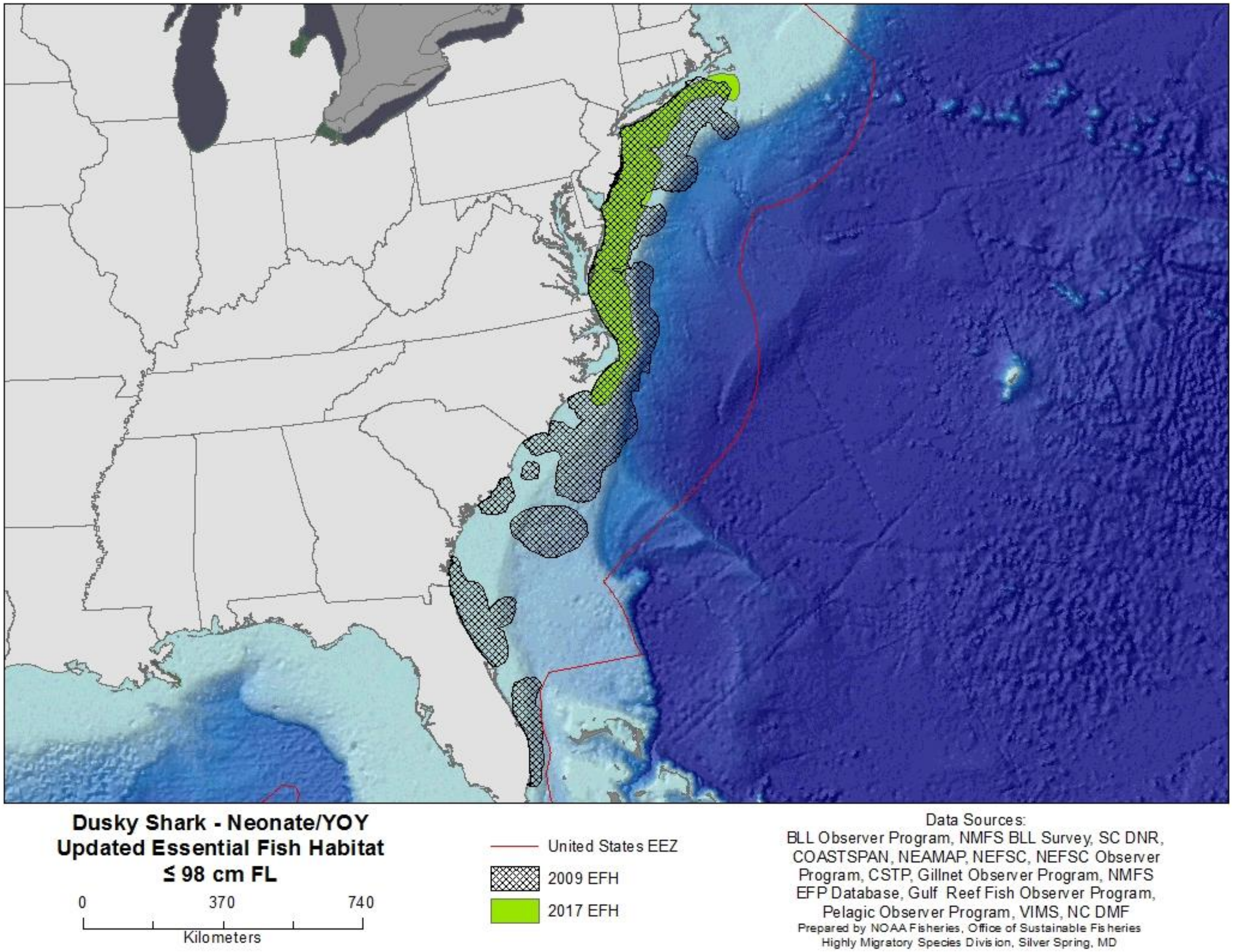


Figure G 75 **Dusky Shark – Neonate/YOY**

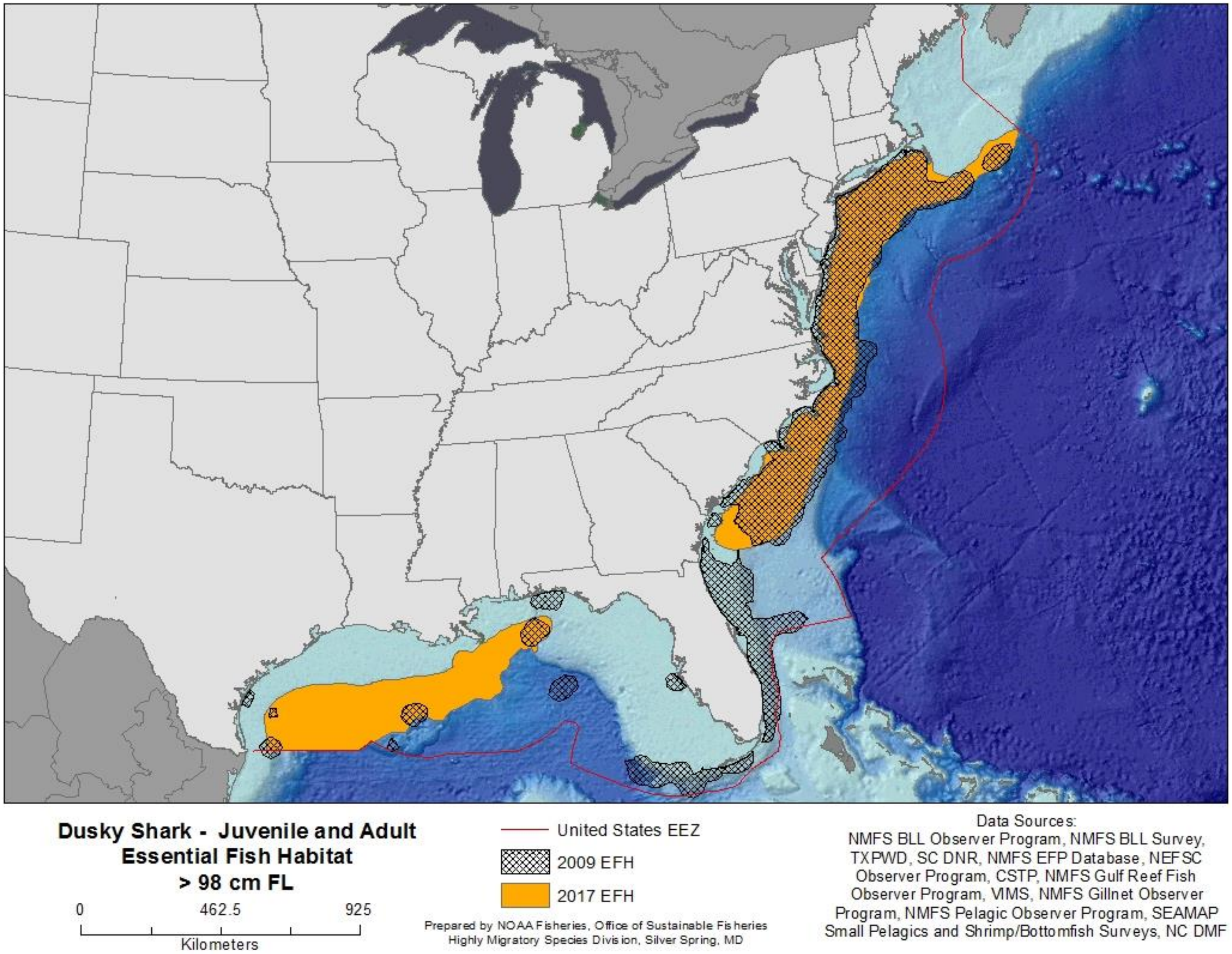
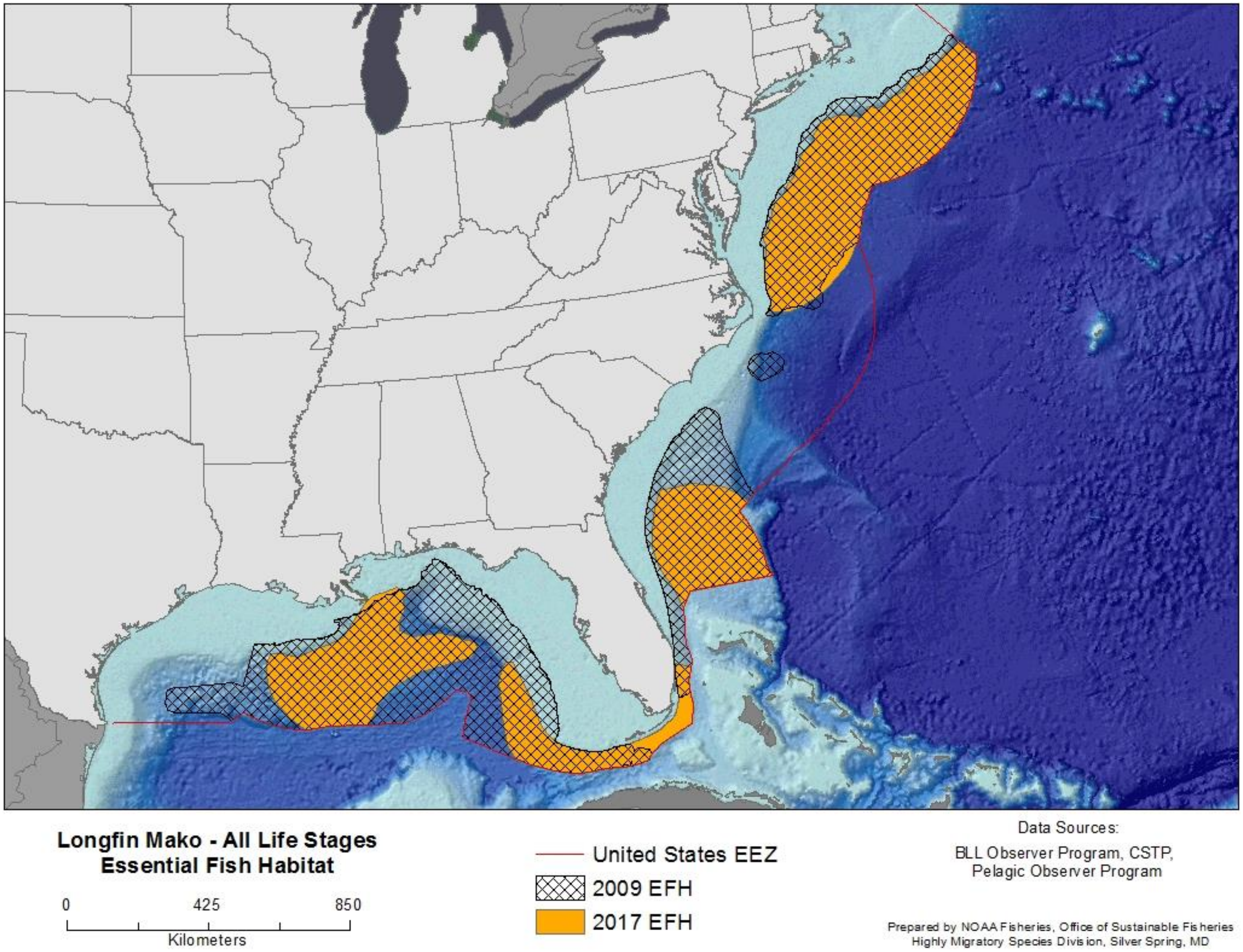


Figure G 76 **Dusky Shark – Juvenile and Adult Combined**



Data Sources:
BLL Observer Program, CSTP,
Pelagic Observer Program

Prepared by NOAA Fisheries, Office of Sustainable Fisheries
Highly Migratory Species Division, Silver Spring, MD

Figure G 77 Longfin Mako Shark - All Lifestages Combined

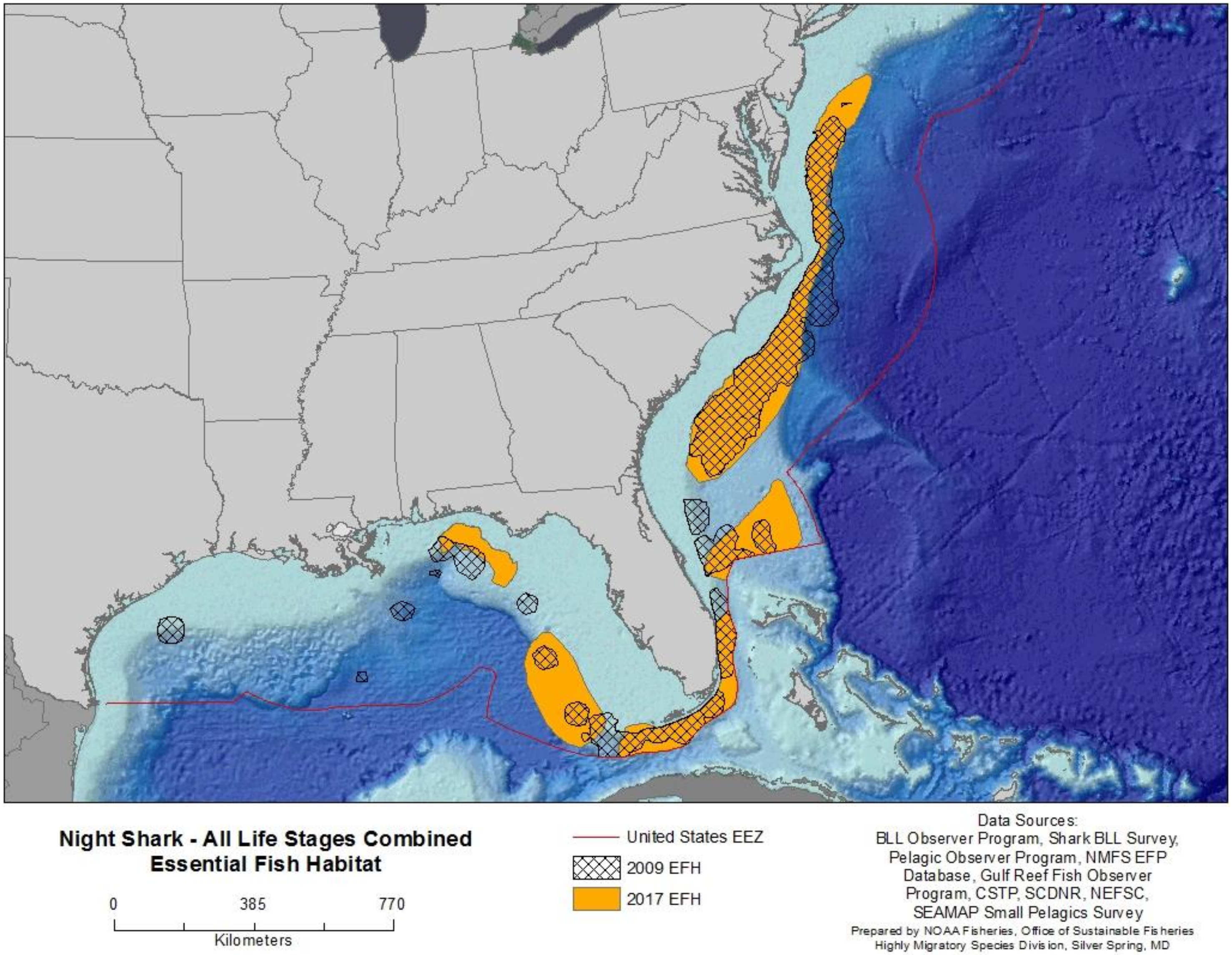
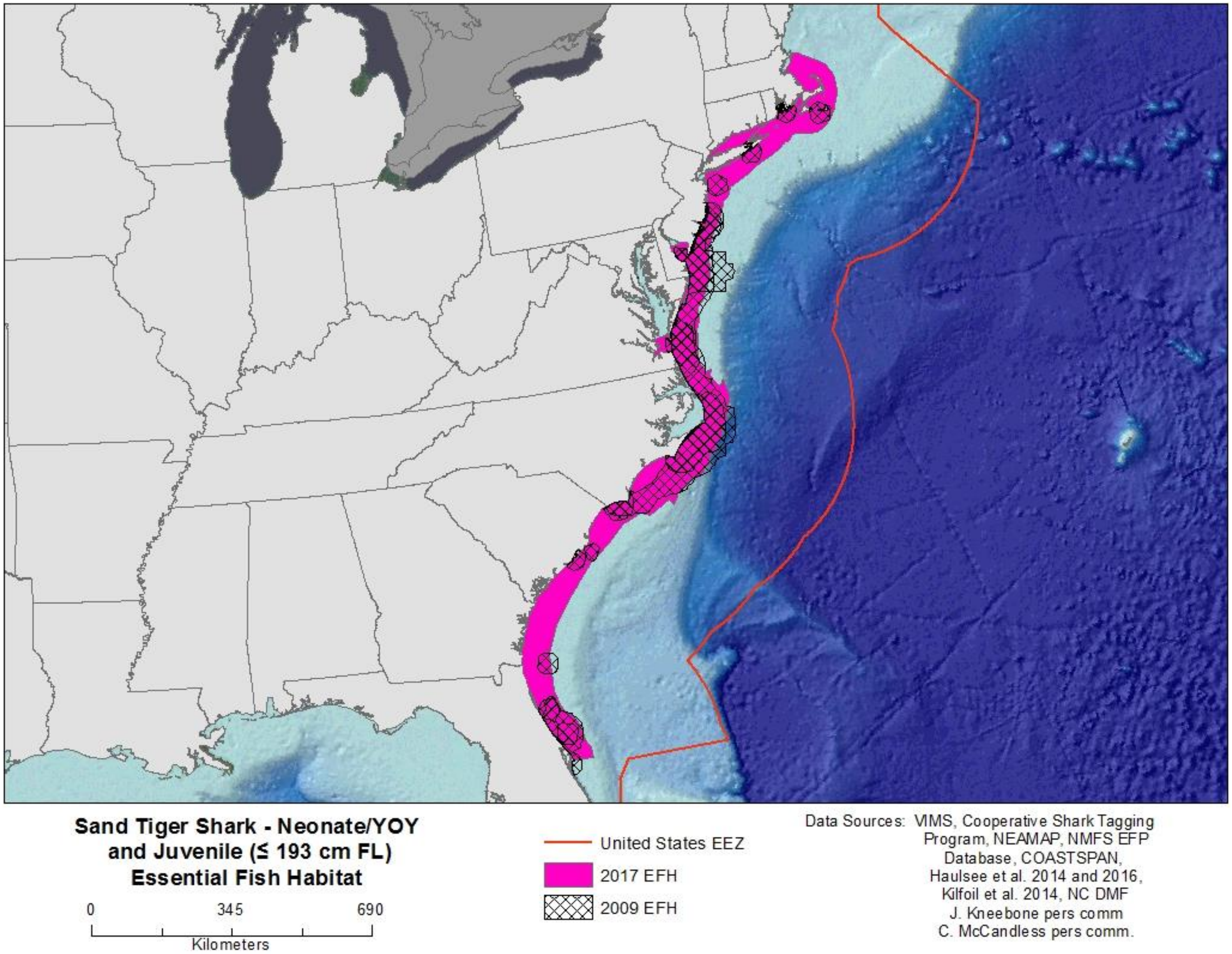


Figure G 78 **Night Shark - All Lifestages Combined**



Data Sources: VMS, Cooperative Shark Tagging Program, NEAMAP, NMFS EFP Database, COASTSPAN, Haulsee et al. 2014 and 2016, Kilfoil et al. 2014, NC DMF J. Kneebone pers comm C. McCandless pers comm.

Figure G 79 Sand Tiger – Neonate/YOY and Juvenile Combined

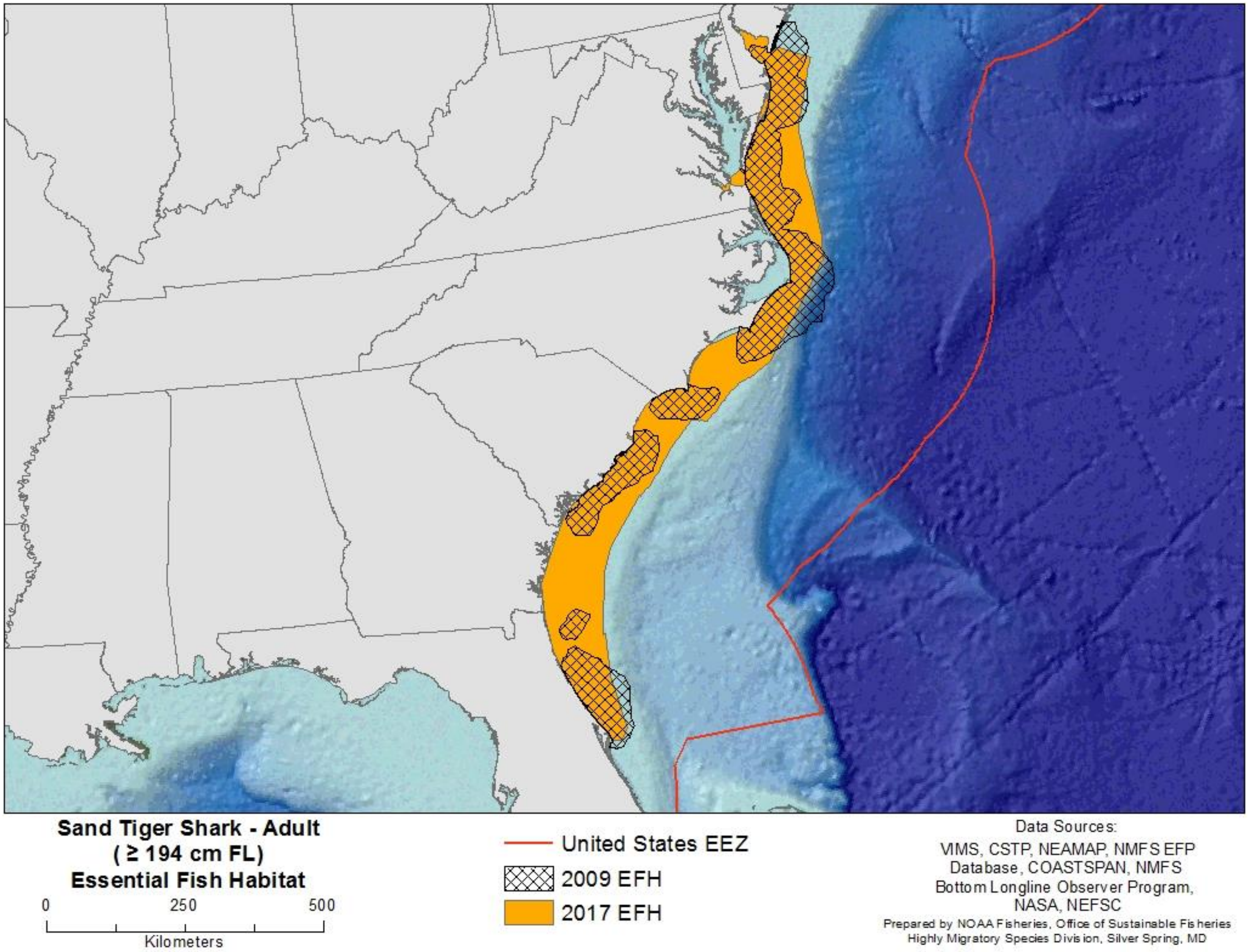
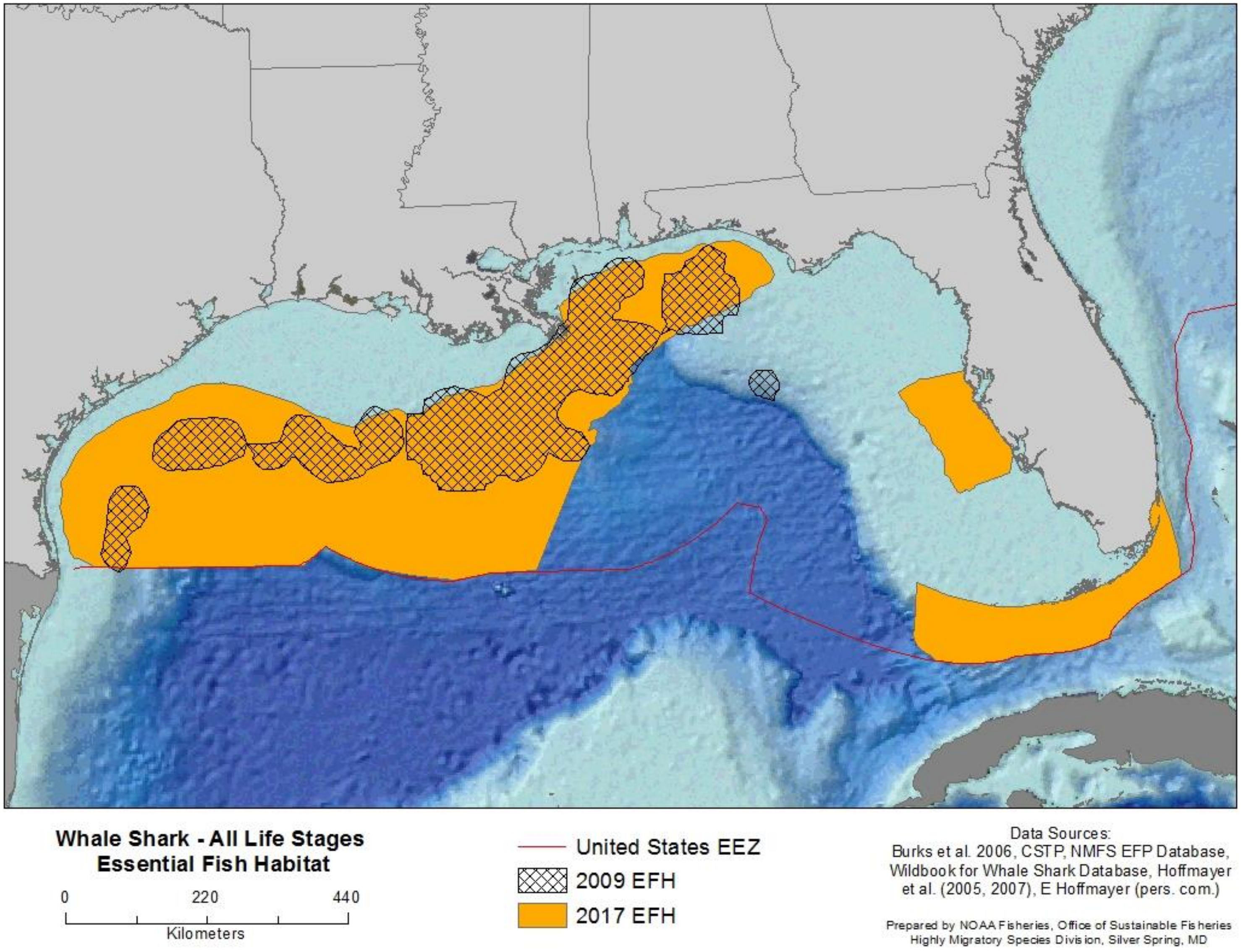


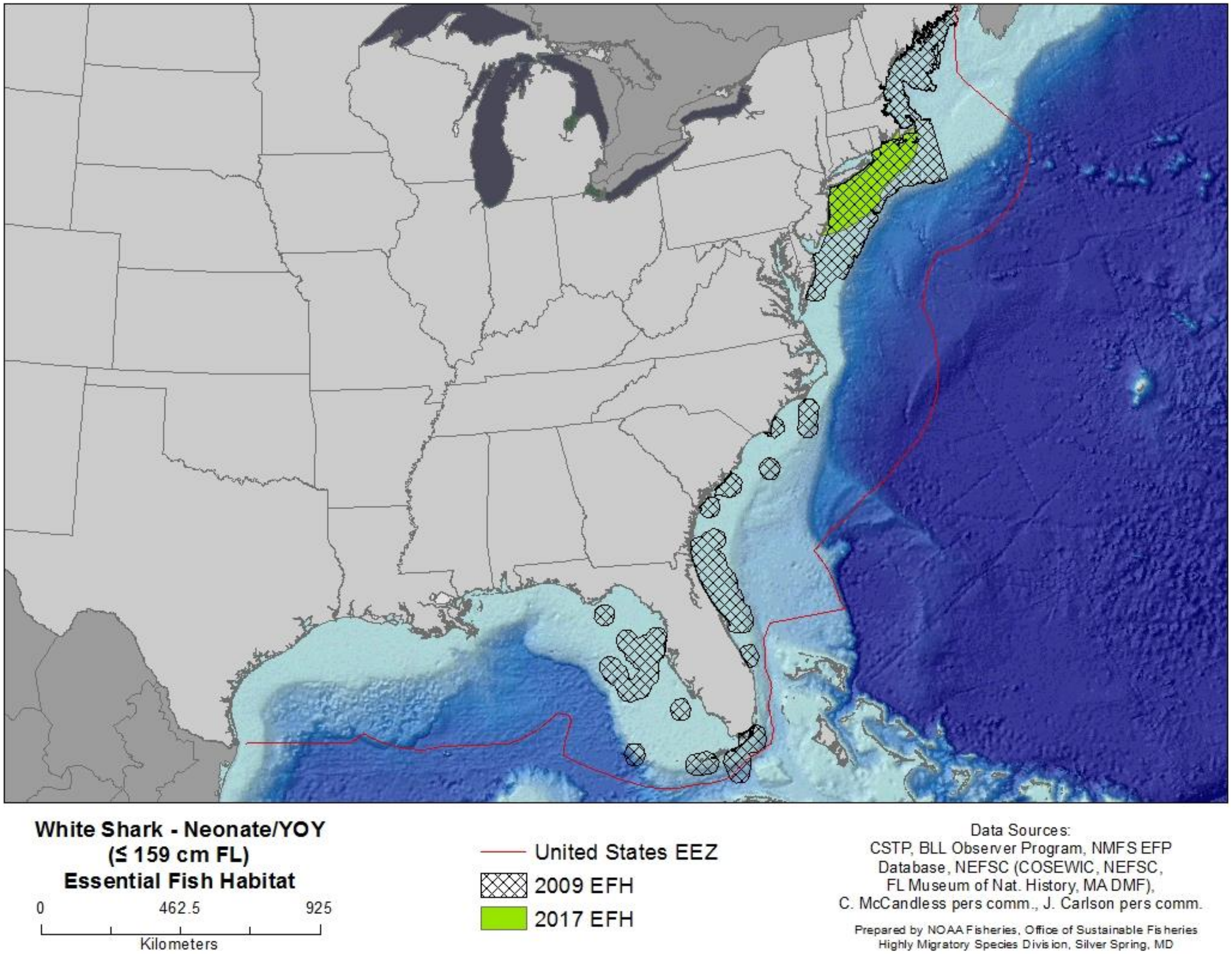
Figure G 80 **Sand Tiger Shark - Adult**



Data Sources:
Burks et al. 2006, CSTP, NMFS EFP Database, Wildbook for Whale Shark Database, Hoffmayer et al. (2005, 2007), E Hoffmayer (pers. com.)

Prepared by NOAA Fisheries, Office of Sustainable Fisheries
Highly Migratory Species Division, Silver Spring, MD

Figure G 81 **Whale Shark - All Life Stages Combined**



Data Sources:
CSTP, BLL Observer Program, NMFS EFP
Database, NEFSC (COSEWIC, NEFSC,
FL Museum of Nat. History, MA DMF),
C. McCandless pers comm., J. Carlson pers comm.

Prepared by NOAA Fisheries, Office of Sustainable Fisheries
Highly Migratory Species Division, Silver Spring, MD

Figure G 82 **White Shark – Neonate/YOY**

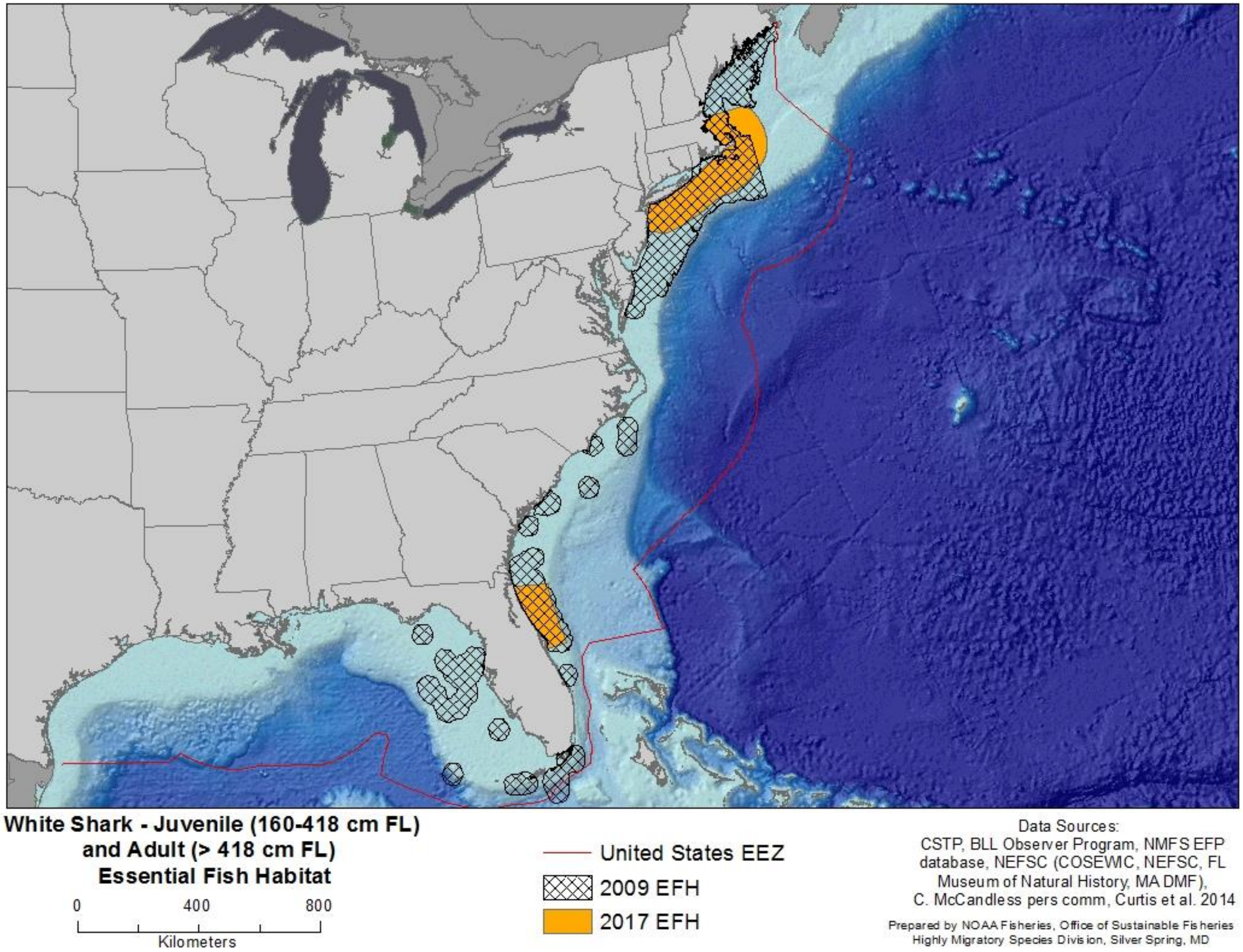


Figure G 83 **White Shark – Juvenile and Adult Combined**

Appendix H Response to Comments

NMFS received 26 unique written comments from fishermen, council members, states, environmental groups, academia and scientists, and other interested parties on the Draft EA during the public comment period. Comments included submissions of 17 form letters that were identical or similar to comments provided by organizations. We also received comments from fishermen, states, and other interested parties at Council meetings, Atlantic HMS Advisory Panel meetings, and at two public conference calls/webinars. All written comments can be found at http://www.regulations.gov.

Comments are summarized below by major topic together with NMFS' responses.

1. Draft EA Content (Comments 1-2),
2. EFH Methodology (Comments 3-5),
3. Bluefin Tuna EFH Boundary Designations (Comments 6-9),
4. Bluefin Tuna HAPC Alternative (Comments 10-11),
5. Shark EFH Boundary Designations (Comments 12-16),
6. Sandbar Shark HAPC Alternative (Comment 17),
7. Lemon Shark HAPC Alternative (Comments 18-20),
8. Sand Tiger Shark HAPC Alternative (Comments 21-22),
9. Other Comments (Comment 23), and
10. Research and Restoration (Comments 24-26).

Comments By Subject

1. Draft EA Content

Comment 1: NMFS received several comments on the content of the Draft EA, requesting information confirming the importance of habitat associations, seasonality of peak EFH utilization, and a rationale for the changes in EFH made between Amendment 1 and Draft Amendment 10.

Response: Habitat association and seasonality information, based on available scientific literature, have been included in both the Life History reviews and EFH Text Descriptions for Atlantic HMS species (see Chapter 6 of the Final EA). If appropriate, NMFS may develop products, such as GIS maps depicting peak seasonal use of EFH by region in the future. A rationale for the changes in EFH between Amendment 1 and those established by Final Amendment 10 is included for each species, where applicable, following EFH Text Descriptions in Chapter 6 of the EA.

Comment 2: NMFS should provide online access to the shapefiles and maps of non-preferred alternatives.

Response: Shapefiles and maps depicting preferred alternative EFH and HAPC boundaries, and maps showing the extent of non-preferred HAPC alternatives, may be downloaded at the following website: http://www.nmfs.noaa.gov/sfa/hms/documents/fmp/am10/index.html. NMFS did not make available shapefiles or maps of the non-preferred EFH boundary alternative (i.e., status quo) on the Amendment 10 website to reduce confusion between what EFH designations are currently in effect and what is being considered in this amendment. Shapefiles representing the previous EFH revision exercise, which reflect the status quo - no action alternative in Draft Amendment 10, are available on the website for Amendment 1 to the 2006 Consolidated Atlantic HMS FMP.

2. EFH Methodology

Comment 3: Preferred Alternative 2, which updates all Atlantic HMS EFH designations using the methodology established under Amendment 1, is appropriate.

Response: NMFS concurs that it is appropriate to update Atlantic HMS EFH using new data collected since 2009 and the methodology established under Amendment 1. Review and updates of Atlantic HMS EFH are consistent with the EFH provisions of the Magnuson-Stevens Act and National Standard 2 (i.e., that conservation and management measures be based on the best scientific information available). During the 5-Year Review process, NMFS evaluated 11 different approaches used to assess EFH by the Agency or published in the literature, and determined that the methodology established under Amendment 1 remained the best approach to update Atlantic HMS EFH.

Comment 4: NMFS should consider designations of EFH by depth (surface, middle, and bottom) where appropriate and if there is scientific information that supports such a designation.

Response: EFH text descriptions (see Chapter 6 of the EA) include references to depth where appropriate based on best available scientific information. EFH delineation in other sections of the water column could be useful in Habitat Consultations; however, information describing vertical distribution and habitat utilization in the water column are not available for all Atlantic HMS species in the literature. While NMFS did not specifically request vertical depth data from the public during the 5-Year Review and Draft Amendment comment periods, NMFS generally requested information on relevant EFH data and ideas for delineation methods and no data on vertical depth distribution data were submitted. NMFS may explore new models and approaches in the future, and at that time, could evaluate the feasibility of designating EFH vertically through the water column for Atlantic HMS.

Comment 5: The methods used to delineate EFH may bias results. Sampling intensity can affect the observed density, particularly for larvae, as well as for determining the distribution of other species, which impacts EFH designations. In those cases, EFH becomes a function of data availability, not a function of animal behavior.

Response: The current approach to designating EFH uses an unweighted model that delineates contour intervals around data points; therefore, the models are influenced by sampling intensity, the spatial distribution of data, and data availability. Several Atlantic HMS species are data-poor, and the available datasets may provide data points that are clustered in space or time based on the extent of sampling. NMFS may explore alternative models and approaches in the future, if appropriate, that better account for the spatial distribution of available data and other biases that may influence results.

3. Bluefin Tuna EFH Boundary Designations

Comment 6: NMFS received comments both supporting and not supporting the inclusion of the Slope Sea into the bluefin tuna EFH for the Spawning, Eggs, and Larval life stage. Some commenters supported the inclusion of Slope Sea spawning areas into EFH designations for this life stage because this reflects the best available scientific information. Other commenters voiced opposition to including EFH for bluefin tuna larvae areas outside the Gulf of Mexico, stating that the designation of EFH cannot be justified based on current scientific knowledge. Specifically, commenters had concerns about limited sample sizes in space and time across the Slope Sea. As discussed in Comment 24 below, commenters asked that NMFS encourage additional research on the Slope Sea.

Response: During preparation of Draft Amendment 10, NMFS identified relevant research by Richardson et al. (2016) that included 67 data points where larval bluefin tuna were collected in the Slope Sea. Those data points were used as information input for the model. Despite the small sample size associated with Richardson et al. 2016, the number and distribution of data points were sufficient to meet or exceed model thresholds for inclusion in the 95 percent volume contour. Since model results included the Slope Sea areas as part of the EFH for the bluefin tuna Spawning, Eggs, and Larval life stage, NMFS is retaining the Slope Sea area as EFH but is also encouraging additional research on these habitats (see Chapter 7 of the EA) and Comment 24 below.

Comment 7: Several commenters expressed concerns about management implications of identifying Spawning, Eggs, and Larval EFH in areas outside of the Gulf of Mexico given that current ICCAT management recommendations stipulate that the United States should not permit directed fishing on bluefin tuna in spawning areas.

Response: The relative importance of the Slope Sea bluefin tuna spawning, eggs and larval EFH to the stock is unclear at this time, however the EFH model results included the Slope Sea as part of the EFH for the bluefin tuna Spawning, Eggs, and Larval life stage because the distribution of data points met the model's threshold for inclusion in the 95 percent volume contour. ICCAT's Standing Committee on Research and Statistics (SCRS) has noted that hypotheses concerning the Slope Sea's importance as a spawning area still need to be tested (ICCAT 2016, http://iccat.int/Documents/Meetings/Docs/2016_BFT_DATA_PREP_ENG.pdf). Furthermore, there are a number of concerns about the conclusions drawn by the Richardson et al. (2016) paper concerning sample size, larval data corrections, variance in data, and conclusions about early maturation (e.g., Walter et al. 2016). The SCRS has recommended additional research be conducted to address these concerns and, at this time, the Slope Sea has not been recognized by ICCAT as western Atlantic spawning grounds. As additional information on the relative importance of the Slope Sea and if recognition as spawning grounds becomes available, NMFS will consider that information in developing or advocating for appropriate domestic and international measures.

Comment 8: In concert with accepting Preferred Alternative 3b (Expand HAPC eastward), NMFS should, at a minimum, expand adult bluefin EFH to include the entire HAPC boundary.

Response: Model results did not include the entire Gulf of Mexico into the EFH boundaries of adult bluefin tuna. Expansion of adult bluefin EFH eastward in the Gulf of Mexico to encompass all areas of the bluefin spawning, eggs, and larval life stage HAPC, would add only an additional 25 locations (+ ~2% of data points in the Gulf of Mexico). PSAT tagging data suggest that adult bluefin tuna migrate through this area, but do not utilize it as heavily as other areas of the central and western Gulf of Mexico (e.g., Wilson et al. 2015; see Figure 6.1, Section 6.2.3). As previously mentioned, the intent of EFH is not to delineate all areas where the species is known to occur, but rather the areas that are necessary for spawning, breeding, feeding, or growth to maturity. Therefore, NMFS has not modified the EFH designation for adult bluefin EFH to include the entire eastern GOM.

Comment 9: NMFS should incorporate the migratory corridor to the Gulf of Mexico as adult EFH, rather than stopping abruptly off the coast of North Carolina, most importantly including the waters around the Charleston Bump where tagging studies have shown adult bluefin feed (Wilson et al. 2015).

Response: Examination of PSAT tagging data (see Figure 6.1, Section 6.2.3) implies that tagged bluefin tuna may heavily use pelagic habitats ranging from coastal North Carolina to areas north and east of the Bahamas. Data available for EFH analyses also indicate that pelagic habitats of the Blake Plateau are necessary habitat for adult Bluefin tuna. Therefore, based on further review of available data, NMFS adjusted the boundaries of adult bluefin EFH to include some of the areas recommended by the commenter. However, it is important to note that EFH designations are designed to focus attention on those habitats necessary for feeding, breeding, spawning, or growth to maturity. Migration routes, while important in their own right, are not within the scope of EFH as defined under NMFS' regulations.

4. Bluefin Tuna HAPC Alternative

Comment 10: NMFS should accept Preferred Alternative 3b to expand the bluefin tuna HAPC in the Gulf of Mexico, as it meets all four considerations for a HAPC pursuant to § 600.815(a)(8).

Response: NMFS agrees that Preferred Alternative 3b is warranted based on the application of the HAPC criteria to the current body of scientific literature. Therefore, NMFS has expanded the current HAPC for the bluefin tuna Spawning, Eggs, and Larval life stage as provided under this alternative.

Comment 11: NMFS should designate or include the Slope Sea, newly discovered bluefin tuna spawning habitat, as a HAPC.

Response: A HAPC designation for a particular habitat must be based on one of four criteria: the importance of the ecological function provided by the habitat; the extent of sensitivity to human induced environmental degradation; whether, and to what extent, development activities are or will be stressing the habitat type; and the rarity of the habitat type. Whether the Slope Sea satisfies these criteria for bluefin tuna is unknown and research to better understand the role of this area as a spawning ground and other habitats for the species continue. Given the limited sample size to date, it is difficult to determine the importance of the ecological function provided by the Slope Sea for the western Atlantic bluefin stock. Additional sampling and research are also needed in order to effectively evaluate all HAPC criteria. The number of data points are fairly small and are limited temporally; therefore, it is difficult to delineate boundaries for an effective HAPC at this time.

5. Shark EFH Boundary Designations

Comment 12: Dusky sharks do not occur in New England waters. NMFS should establish a north/south demarcation line off New England where appropriate measures to reduce dusky shark mortality and protect dusky shark EFH could be implemented in areas south of the demarcation line. Eighteen copies of a form letter suggested that dusky shark EFH should be moved to waters south of New England and/or Montauk, NY. Other commenters supported designation south of an area known as "The Dump" (approximately 75 km east and slightly south of Montauk), or designation south of a line extending eastward from Shinnecock, NY (40º50'25" N latitude).

Response: Most of the data points collected for the EFH modeling exercise were located south of the Gulf of Maine, and therefore NMFS agrees it was not appropriate to include Gulf of Maine habitats in the proposed updates to EFH boundaries that were included in Draft Amendment 10. The available data and historical information from the scientific literature indicate that dusky sharks do occur in southern New England waters. The dusky shark EFH boundaries included in Draft Amendment 10, and the data used in the EFH models considered in Draft Amendment 10, reflect data points that are located offshore of southern New England (i.e., south of the southern coast of Long Island, Nantucket, and Martha's Vineyard) and along the southern edge of Georges Bank and the continental shelf. However, the proposed EFH boundaries in Draft Amendment 10 for dusky sharks also included some inshore areas in Narragansett Bay, near coastal Rhode Island, and areas adjacent to southeastern Massachusetts. In consideration of public comments received and review of life history information and distribution data on dusky sharks, NMFS determined that minor adjustments to EFH boundary designations to remove some nearshore coastal areas of southern New England were appropriate. For example, model output published in Draft Amendment 10 as EFH for dusky sharks included Narragansett Bay and parts of Buzzards Bay, however, the salinity of these areas is generally considered to be too low for dusky sharks (C. McCandless, pers. comm, NOAA NEFSC). Parts of Vineyard Sound, Rhode Island Sound, Block Island Sound, and Nantucket Sound were also included, likely as a result of their proximity to a larger cluster of data points located further south and offshore. Generally, dusky sharks are collected in scientific surveys further offshore (C. McCandless, pers. comm, NOAA NEFSC). Therefore, in response to public comment and based on further review of the best available biological information, the EFH boundary designations for dusky shark have been revised to exclude these coastal areas.

Commenters also advocated for the use of a north/south demarcation line to be used for management measures that would reduce dusky shark mortality and to implement EFH. Under the current modeling method, EFH boundaries are based on the distribution and availability of point data, which provide empirical evidence that the habitat is important for feeding, breeding, spawning or growth to maturity. While landmarks or features can be used as representations to describe the extent of current EFH, they must take into account the specific locations of a species' habitat. Available data and the models developed using the current EFH delineation methodology suggested that some areas north and east of Montauk and Shinnecock NY or "the Dump" should be included within the EFH Boundaries. NMFS has described these locations within the EA.

Comment 13: NMFS should adjust its EFH boundaries to encompass highly suitable habitats for great hammerhead and tiger sharks as predicted from habitat suitability modeling. The updates to EFH boundaries proposed by NMFS in Draft Amendment 10 are consistent with habitat suitability modeling for bull sharks.

Response: NMFS compared the areas of high habitat suitability to data available for EFH analyses and found that, in general, the adjustment of EFH based on habitat suitability models is inconsistent with the approach used by NMFS in Amendment 10 because certain areas that were deemed highly suitable by the commenter contained little to no empirical point data. Rather the identification of highly suitable habitat was based on the confluence of certain environmental characteristics that was predicted to create a more favorable habitat for that species. The intent of EFH is not to delineate all areas where the species is known to occur, but rather areas that are necessary to a species spawning, breeding, feeding, and growth to maturity. The current methodology assumes a relationship between the presence and density of points and the presence of EFH, and does not at this time incorporate a predictive aspect based on environmental variables. NMFS may explore alternative models and approaches for the next revision of EFH and, at that time, would evaluate the feasibility of incorporating habitat suitability modeling approaches (such as those put forward by this commenter) into the delineation of EFH, if appropriate.

Comment 14: Maps and data pertaining to drumline surveys conducted between 2008-2015 by the University of Miami Shark Research and Conservation Lab suggest that areas with high catch rates in northern Biscayne Bay (between Elliot Key and Key Biscayne) should have been included in updates to EFH for blacktip sharks. NMFS should expand the EFH proposed in Draft Amendment 10 to include these areas. Areas with highest nurse, lemon, and sandbar shark CPUE are already contained within the proposed updates to EFH boundaries. NMFS should finalize the EFH boundary adjustments included in Draft Amendment 10 for these species.

Response: NMFS agrees that areas identified for blacktip, nurse, lemon, and sandbar shark EFH off South Florida are necessary habitats for these species, and it is therefore appropriate to include these areas in the EFH boundaries that would be finalized under Amendment 10. Blacktip sharks are managed regionally, with a demarcation line separating the Gulf of Mexico and Atlantic shark stocks at 25º 20.4’ N latitude. In response to public comment and in consultation with the NEFSC and SEFSC, NMFS determined that adjustments to the EFH boundaries for the Atlantic stock of blacktip sharks were appropriate and, in Final Amendment 10, extended the southern extent of juvenile and adult EFH boundaries southward along the Florida east coast to 25º 20.4’ N latitude (which includes northern Biscayne Bay). Similarly, NMFS determined that the Gulf of Mexico stock boundary needed to be moved south along the Florida coast to terminate at the 25º 20.4’ N latitude stock demarcation line in order to be consistent with the management extent for this stock (it previously extended north of this line).

Comment 15: NMFS should adjust EFH boundaries to include portions of Pamlico Sound, Core Sound, Back Sound, and other inshore coastal waters for juvenile and adult blacktip sharks, neonate/YOY and juvenile bull sharks, neonate/YOY and juvenile sandbar sharks, juvenile and adult blacknose sharks, neonate/YOY and adult Atlantic sharpnose sharks, and all life stages of smooth dogfish based on data from the annual North Carolina Division of Marine Fisheries (NC DMF) gillnet and longline survey and from research on delineation of coastal shark habitat within coastal North Carolina waters using acoustic telemetry, fishery-independent surveys, and local ecological knowledge (Bangley 2016).

Response: The information and data referenced in this comment, NC DMF gillnet and longline survey data and data from Bangley 2016, provided NMFS an opportunity to evaluate Atlantic

HMS nursery habitat utilization in inshore and coastal North Carolina waters. As noted in Heupel et al. (2007), "the use of the term 'shark nursery area' by a wide array of scientists, resource managers and conservationists appears to be inconsistent and lacks proper scientific analysis and justification. In some cases regions are labeled shark nursery areas simply because of the presence of a few juvenile sharks…[which] threatens to undermine the importance of protecting EFH by potentially identifying all coastal waters as shark nursery areas." Due to inconsistent use of the term "nursery area" across the scientific community and concerns identified in Heupel et al. 2007), NMFS now prefers to apply the definitions laid out in Heupel et al 2007 to identify habitats in which: 1) sharks are more commonly encountered in these areas versus other areas; 2) sharks remain or return to these areas for extended periods of time (i.e., site fidelity that is greater than mean fidelity to all sites across years); and 3) the habitat is repeatedly used across all years, whereas others are not. The annual mean number of neonate/YOY bull, sandbar, and blacktip sharks was small (e.g., approximately 5 bull and sandbar sharks per year, 9 blacktip sharks per year) and not consistent from year to year. Additionally, the survey with the longest timespan, NC DMF, had no supporting data for these species in Back and Core Sounds.

Although some acoustic data are available (n = 1 blacktip and 3 blacknose sharks), a bigger sample size would be needed to establish residency patterns of individuals and demonstrate site fidelity through time for these species in inshore North Carolina waters. The NC DMF dataset also contained only one blacknose shark, and therefore does not provide a scientifically sufficient means to analyze habitat utilization and potential EFH. NMFS had very few data points for juvenile and adult blacktip sharks (n = 23 out of 6,383) and adult blacknose sharks (n = 2) in Pamlico, Core, and Back Sound.

A larger number of smoothhound and Atlantic sharpnose shark records were noted in areas of Pamlico Sound closer to the inlets of the Outer Banks, and the model results supported keeping EFH in these areas as proposed. However, the NC DMF dataset did not include any Atlantic sharpnose or smoothhound shark data points for Core Sound or Back Sound, and the number of data points from the Bangley (2016) dataset in these locations were also small (n = 33 Atlantic sharpnose sharks and 10 smooth dogfish) so these are excluded for these species and life stages. Many of the habitats identified near inlets as potentially important may reflect a temporary condition that is tolerable to these animals as they follow schools of baitfish to feed; however, these conditions are temporary as the tides change. Bangley (2016) analyzes data with respect to distance to inlets and salinity, however, it does not consider tidal influence on the creation of temporary habitat through the presence of prey schools responding to tidal fluctuations. Therefore, NMFS encourages additional research to further evaluate these areas as nursery habitat per the definitions outlined in Heupel et al. 2007 (see Section 7.1.6), but has not designated Pamlico, Core, and Back Sounds as EFH for blacktip, sandbar, and bull sharks; or Core and Back Sounds as EFH for Atlantic sharpnose sharks and smooth dogfish. NMFS may evaluate inshore areas of coastal North Carolina for inclusion in these species' EFH boundaries in the future if more data become available.

Comment 16: Neonate/YOY and juvenile sandbar sharks are among the most common coastal sharks captured in NC DMF gillnet and longline surveys conducted in the spring and fall.

NMFS should adjust EFH boundaries for sandbar shark to include portions of Pamlico Sound based on a dissertation (Bangley 2016) that suggested coastal North Carolina habitats, including Pamlico Sound, may be primary and secondary nursery habitats for multiple shark species, including sandbar shark.

Response: Using NC DMF gillnet and longline survey data,and the data presented in Bangley (2016), NMFS assessed whether the information provided by the commenter supported inclusion of these habitats into neonate/YOY EFH boundaries as nursery areas which are necessary for feeding and growth to maturity. Due to inconsistent use of the term "nursery area" across the scientific community and the contention of Heupel et al. (2007) that "the occurrence of juvenile sharks in an area is insufficient evidence to proclaim it a nursery", NMFS now prefers to apply the definitions laid out in Heupel et al 2007 to identify habitats in which 1) sharks are more commonly encountered in these areas versus other areas; 2) sharks remain or return to these areas for extended periods of time (i.e., site fidelity that is greater than mean fidelity to all sites across years); and 3) the habitat is repeatedly used across all years, whereas others are not. NC DMF data indicate that, while these species are caught consistently between years in Pamlico Sound, the numbers of data points tend to be low compared to areas seaward of the Outer Banks. Additional research is needed to indicate an elevated degree of dependency, site fidelity, and utilization of these habitats compared to nearshore habitats that are seaward of the Outer Banks before they should be included within EFH boundaries per the rationale that they are "nursery areas".

6. Sandbar HAPC Alternative

Comment 17: NMFS should implement Alternative 4a (No Action Alternative) in concert with recommendations for Alternative 2 (see comments 15 and 16 above), which would update existing EFH designations and include an expansion of sandbar neonate/YOY and juvenile EFH into estuarine waters of North Carolina to protect nursery habitats.

Response: As discussed in Comments 15 and 16, there was a small number of data points available on neonate/YOY and juvenile sandbar sharks from the datasets and information referenced in this public comment (NC DMF inshore gillnet and trawl data, and Bangley 2016). NOAA scientists from the SEFSC and NEFSC recommended that Pamlico Sound not be included in neonate/YOY EFH or that a HAPC for this life stage be retained in inshore North Carolina waters because insufficient data was available to compare the spatial and temporal utilization of these habitats with adjacent habitats, which are critical aspects of athe the nursery area definition outlined in Heupel et al. 2007. Therefore, updates to EFH finalized in this Amendment do not include inshore coastal waters of North Carolina (i.e., Pamlico Sound). The commenter recommends accepting the No Action Alternative, which would retain HAPC boundaries in Pamlico Sound. Since a HAPC must be nested within updated EFH, and the updated EFH for sandbar shark does not include Pamlico Sound, it would be inconsistent with NMFS' regulations that implement the EFH provisions of the Magnuson-Stevens Act to retain the current boundaries of the Sandbar HAPC. NMFS will continue to evaluate inshore areas of Pamlico Sound for EFH or HAPC inclusion as more data becomes available.

7. Lemon Shark HAPC Alternative

Comment 18: NMFS received three comments (including one from the Florida Fish and Wildlife Conservation Commission) in support of Preferred Alternative 5b, the proposed lemon shark HAPC that spans from Cape Canaveral to Jupiter Inlet. Commenters indicated that the HAPC is needed and well placed, and could provide additional protection for Southeastern Florida lemon shark aggregations. Other commenters indicate that this alternative is most appropriate based on available tagging and genetic research that identifies the importance of aggregation sites and migration pathways contained within the proposed HAPC.

Response: NMFS agrees that the proposed HAPC is the most appropriate alternative given independent research conducted by multiple institutions that confirm the areas are rare aggregation sites of unique importance (i.e., thermal refugia, nursery grounds for juveniles, resting/feeding grounds for adults) for lemon shark populations off the southeastern United States. Tagging and genetic studies also support the inclusion of habitats in between the two aggregation sites into the HAPC. These areas are adjacent to a region with extremely high population density, and are thus subject to potential environmental degradation and development activities.

Comment 19: NMFS should not create a HAPC for lemon sharks. NMFS should apply the HAPC criteria strictly for this area, and not designate a HAPC as a response to pressure the agency has received to curtail fishing activity in the area.

Response: As part of EFH designations for lemon sharks, NMFS considered whether those areas should include HAPCs based on the criteria for HAPC specification under 600.815(a): the importance of the ecological function provided by the habitat, the extent that the habitat is sensitive to human induced environmental degradation, the extent that development activities are or could be stressing the habitat type, and the rarity of the habitat type. A HAPC was included in the Final Amendment based on these analyses, as triggered by the identification of scientific papers (e.g., Reyier et al. 2012; Kessel et al. 2014, Reyier et al. 2014) that indicated there was scientific evidence that habitats and areas had an important ecological function, were adjacent to highly populated areas and therefore susceptible to human use or degradation, and were rare aggregation sites for this population of lemon sharks.

Comment 20: One commenter expressed concern that a HAPC designation for lemon sharks would open the door for new regulations to be implemented in the area.

Response: The purpose of identifying HAPCs is to focus conservation efforts on localized areas within EFH that are vulnerable to degradation or are especially important ecologically for managed fish. HAPCs can also be used to target areas for area-based research. HAPCs are not required to have any specific management measures. However, such measures may need to be considered to achieve the stated goals and objectives of the HAPC. Public comment reflected concern for the status of populations of lemon sharks off Southwest Florida. Identification of a HAPC, or variations in abundance or even a change in stock status of a species for which a HAPC is identified does not, by itself, trigger an EFH rulemaking. Rather, an EFH rulemaking is triggered by a verifiable adverse effect on habitat from a fishing or non-fishing activity. The EFH provisions of the Magnuson-Stevens Act specify that FMPs must minimize to the extent practicable adverse effects of fishing on EFH, and that Councils (and NMFS) must act to prevent, mitigate, or minimize any adverse effects from fishing, to the extent practicable, if there is evidence that a fishing activity adversely affects EFH in a manner that is more than minimal and not temporary in nature (600.815(a)(2)(ii). If sufficient evidence became available to suggest that fishing activity adversely affects EFH in a manner that is more than minimal and not temporary in nature, NMFS would provide notification to the public of any regulations associated with EFH or the HAPCs in a future rulemaking.

8. Sand Tiger HAPC Alternative

Comment 21: NMFS should implement Preferred Alternative 6b to update EFH, as Delaware Bay and the PKD bay system have been found to be important habitats for sand tiger sharks.

Response: Data collected by the NEFSC via the Cooperative Atlantic States Shark Pupping and Nursery (COASTSPAN) survey and scientific research published by Haulsee et al. (2014 and 2016), Kilfoil et al. (2014), Kneebone et al. (2012 and 2014) suggest that the habitats meet several HAPC criteria (e.g., ecological function provided by the habitat - discrete and relatively rare nursery areas and adult aggregation sites, published concerns about development and environmental degradation). NMFS therefore agrees that it is appropriate to establish HAPCs in Delaware Bay and the PKD bay system.

Comment 22: NMFS should consider a HAPC designation in the western end of New York's Great South Bay since it has been discovered to be an important nursery ground for sand tiger sharks. Tagging studies show strong juvenile interannual site fidelity, that the area is only used by juveniles, and the area is located in a heavily populated area of New York that is susceptible to human induced habitat degradation.

Response: NMFS was unable to obtain data associated with a potential nursery in Great South Bay, NY. One commenter, who was not a data author, provided a point of contact associated with the New York Aquarium that have initiated research on sand tiger sharks in Great South Bay and several newspaper and gray literature articles. The data author submitted a comment with recommendations, but did not provide data associated with the comment. NMFS staff attempted to communicate with the data author multiple times by phone and email between October 2016 and January 2017, however the data author/commenter ultimately did not provide information or data to NMFS that would allow NMFS to further evaluate the assertion that Great South Bay habitat met the HAPC criteria. Therefore, NMFS has not delineated a HAPC for sand tiger sharks in this area at this time.

9. Other Comments

Comment 23: There is a white shark nursery off Long Island. NMFS should protect young white sharks in this area.

Response: In Draft Amendment 10, NMFS considered a potential HAPC in the northern Mid-Atlantic and off southern New England for neonate/YOY and juvenile white sharks. In particular, Curtis et al. (2014) noted that a large number of YOY shark observations occurred between Great Bay, NJ and Shinnecock Inlet, NY. Depth and temperature associations were provided in this paper for YOY and juveniles; however, this report alone was not enough to support any one HAPC criterion. For this final amendment, NMFS examined additional data and literature that might support HAPC designation; however, the findings were insufficient to identify a discrete area that meets the criteria for a HAPC. The area identified by the commenter is already included as part of the EFH for neonate/YOY white sharks; therefore, impacts on EFH would be considered as part of Habitat Consultations in the future.

10. Research and Restoration

Comment 24: Additional research is needed to evaluate the Slope Sea as a potential bluefin tuna spawning site, the parentage of bluefin tuna larvae on the Slope Sea, and the relative magnitude of spawning in this area compared to other known spawning grounds.

Response: NMFS has included these as high priority items in the Research Needs chapter of Final Amendment 10. Additionally, in June of 2017, the Northeast Fisheries Science Center sponsored a cruise on NOAA vessel Gordon Gunter to conduct research on Slope Sea larval fish populations (specifically, bluefin tuna).

Comment 25: Ongoing monitoring is prudent to ensure that there is no change in the distribution of dusky sharks or other species due to climatic shift.

Response: In 2014, NMFS published the Atlantic HMS Management-Based Research Needs and Priorities document. The document contains a list of near- and long-term research needs and priorities that can be used by individuals and groups interested in Atlantic HMS to identify key research needs, improve management, reduce duplication, prioritize limited funding, and form a potential basis for future funding.

The priorities range from biological/ecological needs to socioeconomic needs and the document can be found at: http://www.nmfs.noaa.gov/sfa/hms/documents/hms_research_priorities_2014.pdf. The Research Needs and Priorities document, along with feedback gathered on the Final Atlantic HMS EFH 5-Year Review and Draft Amendment 10 from the public and the scientific research community was used to develop a list of research priorities that would support future HMS EFH designation and protection in Chapter 7 of the Amendment 10 Final EA. These research priorities are further characterized as high, medium, or low priority depending upon the needs identified by the managers. High priority items are generally those that are needed to address near-term stock assessment or management needs. Medium priority items are generally those that address longer-term needs, while low priority needs would provide for more effective HMS management, despite lacking an immediate need. NMFS has listed as a medium priority for all Atlantic HMS species "[examination of] the influence of climate change on range, migration, nursery/pupping grounds, and prey species for Atlantic HMS in general" in Chapter 7 (which itemizes Research Needs) because EFH as a management tool is not useful if the EFH boundaries do not account for shifts in the distribution of managed species.

Comment 26: NMFS should conduct focused research or provide funding to evaluate impacts to Atlantic HMS EFH in the western Gulf of Mexico (specifically, Flower Garden Banks National Marine Sanctuary) and for restoration.

Response: Funding to evaluate EFH impacts to degraded habitats and for habitat restoration is beyond the scope of this Amendment. NOAA staff from the Flower Garden Banks National Marine Sanctuary conduct sanctuary implemented and sanctuary facilitated ecological and biological research, including research focused on habitat. It is beyond the scope of this amendment for the Atlantic HMS Management Division to directly conduct focused research, or for the Atlantic HMS Management Division to direct the Sanctuary to conduct focused research, on Atlantic HMS EFH within Flower Garden Banks National Marine Sanctuary. Interested persons should visit the Flower Garden Banks National Marine Sanctuary webpage for more information on current research programs: https://flowergarden.noaa.gov/science/research.html

FINDING OF NO SIGNIFICANT IMPACT

Finding of No Significant Impact for Final Amendment 10 to the 2006 Consolidated Atlantic Highly Migratory Species Fishery Management Plan

The Highly Migratory Species (HMS) Management Division of the Office of Sustainable Fisheries submits the attached Environmental Assessment (EA) for Atlantic HMS fisheries for Secretarial review under the procedures of the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act). This EA analyzes the impacts of updating HMS essential fish habitat (EFH) based on recent data and information. This EA also analyzes the impacts of updates to existing, and the establishment of new habitat areas of particular concern (HAPCs) for certain HMS. No management measures such as gear changes, time or area closures, quota increases or decreases, changes in fishing pressure, etc., will occur as a result of this Amendment, and no regulations are implemented with the Amendment. The responses in the Finding of No Significant Impact statement are supported by the analyses in the EA as well as in the other National Environmental Policy Act (NEPA) documents referenced. Copies of the EA are available at the following address:

Highly Migratory Species Management Division, F/SF1

National Marine Fisheries Service

1315 East-West Highway

Silver Spring, Maryland 20910

Phone: (301)-427-8503

or

http://www.nmfs.noaa.gov/sfa/hms

The preferred alternatives analyzed in the EA are:

- Alternative 2: Update all Atlantic HMS EFH designations with new data collected since 2009, using the methodology established under Amendment 1
- Alternative 3: Evaluate and, if warranted, modify current HAPCs for bluefin tuna
    - Alternative 3b: Modify current HAPC for bluefin tuna
- Alternative 4: Evaluate and, if warranted, modify current HAPCs for sandbar sharks
    - Alternative 4b: Modify current HAPC for sandbar shark
- Alternative 5: Evaluate and, if warranted, establish new HAPCs for lemon sharks
    - Alternative 5b: Create a new HAPC for lemon sharks between Jupiter Inlet and Cape Canaveral FL
- Alternative 6: Evaluate and, if warranted, establish new HAPCs for sand tiger sharks

  - o Alternative 6b: Create two HAPCs: (1) Delaware Bay for all life stages of sand tiger shark and (2) PKD bay system in coastal Massachusetts for neonates/YOY and juvenile sand tiger sharks

The National Oceanic and Atmospheric Administration Administrative Order 216-6A (NAO 216-6A) (April 22, 2016) contains criteria for determining the significance of the impacts of an action. In addition, the Council on Environmental Quality (CEQ) regulations at 40 C.F.R. §1508.27 state that the significance of an action should be analyzed both in terms of context and intensity. Each criterion listed below is relevant to making a finding of no significant impact and has been considered individually, as well as in combination with the others. The significance of this action is analyzed based on the NAO 216-6A criteria and CEQ's context and intensity criteria. These include:

1. Can the action be reasonably expected to jeopardize the sustainability of any target species that may be affected by the action?

No. This final amendment only updates EFH descriptions for Atlantic HMS and identifies new HAPCs. Because no management measures such as gear changes, time or area closures, quota increases or decreases, changes in fishing pressure, etc., will occur as a result of this Amendment, and no regulations are implemented with the Amendment, this final amendment is therefore not expected to jeopardize species targeted in commercial or recreational fisheries.

2. Can the action be reasonably expected to jeopardize the sustainability of any non-target species?

No. This final amendment only updates EFH descriptions for Atlantic HMS and identifies new HAPCs. Because no management measures such as gear changes, time or area closures, quota increases or decreases, changes in fishing pressure, etc., will occur as a result of this amendment, and no regulations are implemented with the amendment, this amendment is not expected to jeopardize the sustainability of non-target species in commercial or recreational fisheries.

3. Can the action be reasonably expected to cause substantial damage to the ocean and coastal habitats and/or EFH as defined under the Magnuson-Stevens Act and identified in FMPs?

No. Because no management measures such as gear changes, time or area closures, quota increases or decreases, changes in fishing pressure, etc., will occur as a result of this amendment, and no regulations are implemented with the amendment, this amendment is not expected to result in adverse effects on EFH. Updating EFH and updating and establishing HAPCs, would better inform future EFH consultations on both Agency and non-Agency actions, or proposed actions, likely resulting in future neutral short-term direct and indirect and minor, and minor beneficial long-term direct and indirect social, ecological, and economic impacts to EFH.

4. Can the action be reasonably expected to have a substantial adverse impact on public health and safety?

No. Because no management measures such as gear changes, time or area closures, quota increases or decreases, changes in fishing pressure, etc., will occur as a result of this amendment, and no regulations are implemented with the amendment, this amendment is not expected to result in adverse effects on public health and safety.

5. Can the action reasonably be expected to adversely affect endangered or threatened species, marine mammals, or critical habitat of these species?

No. No management measures such as gear changes, time or area closures, quota increases or decreases, changes in fishing pressure, etc., will occur as a result of this amendment, and no regulations are implemented with the amendment. The final amendment actions are expected to have neutral short-term direct and indirect impacts on endangered or threatened species, marine mammals, and the critical habitat of these species. There may be minor beneficial long-term impacts to threatened and endangered HMS that have EFH, in which the EFH area has expanded or HAPCs are proposed and would thus be subject to consultation on any actions or proposed actions that would have an adverse effect on EFH or HAPCs.

6. Can the action be expected to have a substantial impact on biodiversity and/or ecosystem function within the affected area (e.g., benthic productivity, predator-prey relationships, etc.)?

No. No management measures such as gear changes, time or area closures, quota increases or decreases, changes in fishing pressure, etc., will occur as a result of this amendment, and no regulations are implemented with the amendment. The final amendment actions are expected to have neutral short-term direct and indirect impacts on biodiversity and/or ecosystem function within the affected area. There may be minor long-term beneficial impacts to federally-managed species in which the EFH area has expanded or HAPCs are proposed and would thus be subject to consultation on any action or proposed actions that would have an adverse effect on EFH or HAPCs.

7. Are significant social or economic impacts interrelated with significant natural or physical environmental effects?

No. No management measures such as gear changes, time or area closures, quota increases or decreases, changes in fishing pressure, etc., will occur as a result of this amendment, and no regulations are implemented with the amendment. The final amendment actions are expected to have neutral short-term direct and indirect social and economic impacts, and minor long-term beneficial social and economic impacts, interrelated with significant natural or physical environmental effects.

8. To what degree are the effects on the quality of the human environment expected to be highly controversial?

The effects of this action on the human environment are not expected to be highly controversial. No management measures such as gear changes, time or area closures, quota increases or decreases, changes in fishing pressure, etc., will occur as a result of this amendment, and no regulations are implemented with the amendment. NMFS expects some interest in this actions, however, the term “controversial” does not refer to the mere existence of opposition to, or interest in a proposed action; rather “controversial” refers to cases where a substantial dispute exists as to the size, nature, or effect of the major federal action. Such substantial dispute does not exist here.

9. Can the action be expected to result in substantial impacts to unique areas, such as historic or cultural resources, park land, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas?

No. Because no management measures such as gear changes, time or area closures, quota increases or decreases, changes in fishing pressure, etc., will occur as a result of this amendment, and no regulations are implemented with the amendment, this amendment is not expected to result in adverse effects on unique areas, such as historic or cultural resources, park land, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas.

10. Are the effects on the human environment likely to be highly uncertain or involve unique or unknown risks?

No. Because no management measures such as gear changes, time or area closures, quota increases or decreases, changes in fishing pressure, etc., will occur as a result of this amendment, and no regulations are implemented with the amendment, this amendment is not expected to result in highly uncertain, unique, or unknown risks on the human environment.

11. Is the action related to other actions with individually insignificant, but cumulatively significant impacts?

No. Because no management measures such as gear changes, time or area closures, quota increases or decreases, changes in fishing pressure, etc., will occur as a result of this amendment, and no regulations are implemented with the amendment, this amendment is not expected to result in individually insignificant, but cumulatively significant impacts.

12. Is the action likely to adversely affect districts, sites, highways, structures, or objects listed in or eligible for listing in the National Register of Historic Places or may cause loss or destruction of significant scientific, cultural, or historical resources?

No. Because no management measures such as gear changes, time or area closures, quota increases or decreases, changes in fishing pressure, etc., will occur as a result of this amendment, and no regulations are implemented with the amendment, this amendment is not expected to result in adverse impacts on districts, sites, highways, structures, or objects listed in or eligible for listing in the National Register of Historic Places or cause loss or destruction of significant scientific, cultural, or historical resources.

13. Can the action reasonably be expected to result in the introduction or spread of a non-indigenous species?

No. Because no management measures such as gear changes, time or area closures, quota increases or decreases, changes in fishing pressure, etc., will occur as a result of this amendment, and no regulations are implemented with the amendment, this amendment is not expected to result in the introduction or spread of a non-indigenous species.

14. Is the action likely to establish a precedent for future actions with significant effects or represent a decision in principle about a future consideration?

No. This action does not establish a precedent; rather, it follows an existing precedent established under the Magnuson-Stevens Act. The purpose of this action is to update and revise existing HMS EFH following protocols established in Amendment 1 to the 2006 Consolidated HMS FMP, to consider modifying current HAPCs for bluefin tuna (*Thunnus thynnus*) and sandbar shark (*Carcharhinus plumbeus*), to consider designating new HAPCs for lemon shark (*Negaprion brevirostris*), sand tiger shark *(Carcharias taurus*), as necessary, and to analyze fishing and non-fishing effects on EFH by considering environmental and management changes and new information since 2009. The final amendment actions are expected to have neutral short-term direct and indirect impacts on endangered or threatened species, marine mammals, and the critical habitat of these species. There may be minor beneficial long-term impacts to threatened and endangered HMS that have EFH, in which the EFH area has expanded or HAPCs are proposed and would thus be subject to consultation on any actions or proposed actions that would have an adverse effect on EFH or HAPCs.

While designation of EFH and identification of HAPCs may inform future 5-Year Reviews, Amendments, and EFH consultations completed by the NMFS Office of Habitat Conservation, the alternatives and information presented within this EA would not represent a decision in principle about a future consideration. Among other things, this may be relevant to (1) future EFH designations, (2) rulemakings, and (3) EFH consultations completed by the NMFS Office of Habitat Conservation:

(1) Designation of EFH in an area does not automatically mean that the same area will be included or excluded in a subsequent revision of EFH. Updating EFH is an analytical exercise conducted via the 5-Year Review and Amendment process that is based on the analysis and consideration of all available data and information. This process also includes a rigorous scientific review and consideration of feedback from the public. If new information is identified during the 5-Year Review or Amendment process which warrants the inclusion or exclusion of specific areas, then the scientific merits of that information will be evaluated in concert with the EFH analysis protocols.

(2) Identification of HAPCs does not automatically mean that an area will be subjected to restrictions on HMS and non-HMS fishing activities. Per NMFS Policy 03-201-15, “Guidance to Refine the Description and Identification of Essential Fish Habitat” (http://www.nmfs.noaa.gov/directives/), the purpose of identifying HAPCs is to focus conservation efforts on localized areas within EFH that are vulnerable to degradation or especially important ecological for managed fish. HAPCs may also be used to target areas for area-based research. While the identification of HAPCs does raise attention to certain habitats that are important for Atlantic HMS, any future actions developed by NMFS to protect these habitats would have to go through a separate rulemaking process where the pros and cons of proposed measures would be carefully and publically evaluated.

(3) Revision of EFH and identification of HAPCs is consistent with the provisions of the Magnuson-Stevens Act and ensures that the EFH consultation process is based on the best available scientific information. During an EFH consultation, the NMFS Office of Habitat Conservation may identify conservation recommendations intended to minimize to the extent practicable the adverse effects of fishing and non-fishing actions on EFH, and identify other actions to encourage the conservation and enhancement of EFH. The information presented in this EA does not prematurely prescribe measures for future EFH consultations that must be adopted in order for a consulting agency’s actions to commence.

15. Can the action reasonably be expected to threaten a violation of Federal, State, or local law or requirements imposed for the protection of the environment?

No. The action is consistent with the Magnuson-Stevens Act and the HMS regulations at §635. The action is not expected to violate any Federal, state, or local law or requirement imposed for the protection of the environment.

The Coastal Zone Management Act (CZMA) requires that Federal agency activities be consistent to the maximum extent practicable with the enforceable policies of federally-approved state coastal management program (CMP). NMFS consulted with state CZMA programs to confirm that this action is consistent to the maximum extent practicable with the enforceable policies of the approved coastal management program of coastal states on the Atlantic including the Gulf of Mexico and Caribbean that have approved coastal zone management programs. Following publication of a Notice of Availability for Draft Amendment 10 (81 FR 62100; September 8, 2016), a consistency determination was submitted to the states on September 12, 2016 to initiate review by the responsible state agencies under section 307 of the CZMA. Under 15 C.F.R. § 930.41, states and/or U.S. territories have 60 days to respond after the receipt of the consistency determination and supporting materials. States can request an extension of up to 15 days. If a response is not received within those time limits, NMFS can presume concurrence (15 C.F.R. § 930.41(a)). Twelve states replied within the response time period that the draft amendment was consistent, to the extent practicable, with the enforceable policies of their CMPs (Georgia, South Carolina, Alabama, Mississippi, Louisiana, Rhode Island, Florida, North Carolina, New Jersey, Connecticut, Virginia, and Delaware). Another nine states (Maine, New Hampshire, Massachusetts, New York, Maryland, and Texas, Puerto Rico, Pennsylvania, U.S. Virgin Islands) did not respond within the response time period, nor did they request an extension in the comment period; therefore, NMFS presumes their concurrence. NMFS has therefore determined that the measures in Amendment 10 are consistent to the maximum extent practicable with the enforceable policies of the coastal states in the Atlantic, Gulf of Mexico, and Caribbean.

16. Can the action reasonably be expected to result in cumulative adverse effects that could have substantial effect on the target species or non-target species?

No. Because no management measures such as gear changes, time or area closures, quota increases or decreases, changes in fishing pressure, etc., will occur as a result of this amendment, and no regulations are implemented with the amendment, this amendment is not expected to result cumulative adverse effects that will have substantial effect on target or non-target species.

DETERMINATION

In view of the information presented in this document and the analysis contained in the attached EA that was prepared to update HMS EFH and update and establish HAPCs for certain HMS based on recent data and information, it is hereby determined that this action would not significantly impact the quality of the human environment as described above and in the EA. In addition, all impacts to potentially affected areas, including national, regional, and local, have been addressed to reach the conclusion of no significant impact. Accordingly, preparation of an EIS for this action is not necessary.

AUG 30 2017

Alan D. Risenhoover
Director, Office of Sustainable Fisheries, NOAA

Date

List of Commonly Used Abbreviations & Acronyms	
ABT	Atlantic bluefin tuna
AP	Advisory panel
BASIN	Basin-scale Analysis, Synthesis, and Integration program
BAYS	Bigeye, albacore, yellowfin, and skipjack tunas
Billfish	Highly migratory species distinguished by a long, round, rough bill, and includes blue marlin, white marlin, and sailfish.
BLL	Bottom longline
BOEM	Bureau of Ocean Energy Management
°C	Degrees Celsius
CEQ	Council on Environmental Quality
CFL	Curved fork length
CFR	Code of Federal Regulations
CLIOTOP	Climate impacts on top ocean predators
Cm	Centimeter
COASTSPAN	Cooperative Atlantic States Shark Pupping and Nursery
CPUE	Catch per unit effort
CSR	Center for Shark Research
CSTP	Cooperative Shark Tagging Program
CTC	Cooperative Tagging Center
CZMA	Coastal Zone Management Act
DIVER	Data Integration Visualization Exploration and Reporting
DNA	Deoxyribonucleic acid
DO	Dissovled Oxygen
DPS	Distinct population segment
□^{13}C	Carbon-13 stable isotope
□^{18}O	Oxygen-18 stable isotope
EA	Environmental Assessment
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
ESA	Endangered Species Act
EURO-BASIN	EURO-BASIN the European branch of the International BASIN Program
FAO	Food and Agriculture Organization
FL	Fork length
FMP	Fishery Management Plan
FONSI	Finding of No Significant Impacts
FPEIS	Final Programmatic Environmental Impact Statement
FR	Federal Register
GOM NTL	Gulf of Mexico Region Notice to Leaseholders
GULFSPAN	Gulf of Mexico States Shark Pupping and Nursery Area
ha	Hectare

HAPC	Habitat Area of Particular Concern
HMS	Highly Migratory Species
ICCAT	International Commission for the Conservation of Atlantic Tunas
IPCC	Intergovernmental Panel on Climate Change
kg	Kilogram
km	Kilometer
km^2	Square kilometer
K	von Bertalanffy growth equation parameter K is the growth rate
L	Liter
L_∞	von Bertalanffy growth equation parameter termed 'L infinity' in fisheries science, is the asymptotic length at which growth is zero
Lat.	Latitude
lb	Pound
LDl	Predorsal length
L_{inf}	Asymptotic maximum FL
LJFL	Lower jaw fork length
L_{max}	Maximum recorded length
LNG	Liquefied natural gas
Long.	Longitude
m	Meter
Magnuson-Stevens Act	Magnuson-Stevens Fishery Conservation and Management Act
mg	Milligram
mL	Milliliter
mm	Millimeter
MMPA	Marine Mammal Protection Act
MMS	Mineral Management Service
MPA	Marine Protected Area
MSY	Maximum sustainable yield
mtDNA	Mitochondrial deoxyribonucleic acid
N	North
NC DMF	North Carolina Division of Marine Fisheries
ND4L-ND4	Mitochondrial deoxyribonucleic acid gene sequence
NEFSC	Northeast Fisheries Science Center
NEO	Neonate
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NRDA	Natural Resource Damage Assessment
NS	National Standard
OCS	Outer continental shelf
PAT/PSAT	Pop-up satellite archival tag

PCL	Precaudal length
PEIS	Programmatic Environmental Impact Statement
pH	Potential of hydrogen
PKD	Plymouth, Kingston, and Duxbury bay system
POP	Pelagic Observer Program
ppt	Parts per thousand
PSU	Practical salinity unit
PVC	Percent volume contour
QA/QC	Quality Assurance – Quality Control
S	South
SAFE report	Stock Assessment and Fishery Evaluation Report
SCRS	Standing Committee on Research and Statistics
SEAMAP	Southeast Area Monitoring and Assessment Program
SEDAR	SouthEast Data, Assessment, and Review
SEFSC	Southeast Fisheries Science Centers
SRT	Status Review Team
SST	Sea surface temperature
STL	Stretch total length
t_o	von Bertalanffy growth equation parameter to is included to adjust the equation for the initial size of the organism and is defined as age at which the organisms would have had zero size
TL	Total length is the length between the nose and tip of the tail
U.S.	United States of America
W	West
YOY	Young of the year