# 4.0 ENVIRONMENTAL CONSEQUENCES OF ALTERNATIVES

## 4.1 Essential Fish Habitat

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

**Alternative 1** No Action - maintain current EFH boundaries.

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

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

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

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

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

*Ecological, Social, and Economic Impacts*

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

Conservation measures to encourage the conservation and enhancement of EFH are described in Chapter 6, and these measures may be among those provided to an agency during an EFH consultation process. Since the measures are non-binding and are not specific to a particular project at this time, the description of these measures does not have an environmental consequence associated with their development as a part of this final FMP amendment. Therefore, the conservation measures are not analyzed in more detail in this section. Note that the consideration of cumulative impacts on EFH is required by the EFH implementing regulations, and cumulative impacts also must be considered in an EIS. The consideration of cumulative impacts under these different, but related, requirements are provided in section 6.2.1, and that subsection serves as a component of this environmental impact analysis for the proposed action.

### 4.1.1 Data Sources Used to Update HMS EFH

One of the overarching challenges of identifying EFH for HMS is that the available data sets for HMS are largely based on presence/absence data. By nature, these species are highly migratory and occupy a wide range of habitats, including estuarine, coastal, neritic, and offshore pelagic environments. HMS are typically associated with fronts and current boundaries or oceanographic conditions with specific temperatures, salinity, dissolved oxygen, or other physical characteristics that may be seasonal or ephemeral and therefore difficult to map. Furthermore, not all areas where water characteristics appear to be ideal habitat for a particular species constitute EFH. Basing EFH exclusively on the presence of specific environmental conditions may therefore not be the most appropriate means for identifying true EFH. Stationary features such as shelf edges and sea mounts are more easily identified and represent sites of higher abundance for some HMS on a seasonal basis.

For some species and life stages, particularly young-of-the-year sharks (less than age 1) and juvenile sharks, specific benthic habitat associations (such as submerged aquatic vegetation or sandy bottom) have been observed and documented in the scientific literature. Where appropriate, these areas were included in the EFH descriptions. As in the past, geographic features such as the shoreline or bathymetric features such as depth contours (isobaths) were used to delineate the boundary, or a portion of an EFH boundary. In some cases, such as pelagic species, the U.S. EEZ boundary was used to delineate the seaward extent of EFH because the EEZ is the limit of authority to identify EFH. EFH boundaries were determined based primarily on the data indicating the presence of species in a specific area, and additional features described above may have been used to further refine or create natural borders on the EFH boundaries. Due to the inherent difficulties in identifying EFH for HMS, a precautionary approach of using the 95 percent probability boundary was used. In some, but not all, cases this may result in larger areas than were identified in 1999.

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

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

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

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

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

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

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

Several of the major sources of data used to identify EFH came from voluntary tagging programs. The NMFS Southeast Fisheries Science Center (SEFSC) Cooperative Tagging Center (CTC), and TBF collect data primarily on tunas and billfish, whereas the NMFS Northeast Fisheries Science Center (NEFSC) Apex Predators Program, which runs the CSTP, primarily collects data on sharks.

The CTC program began in Woods Hole Oceanographic Institution (WHOI) in 1954 under the name Cooperative Game Fish Tagging Program (CGTP), with an initial focus on bluefin tuna. The program was expanded to include billfish, and in 1973 it became a joint effort between NMFS and WHOI. In 1980, the SEFSC took responsibility for the operation, funding and maintenance of the CGTP. In 1992, the SEFSC changed the program name to the CTC due to an increase in tagging efforts from a wider variety of species. The CTC also includes the Cooperative Tagging System (CTS), as well as other research projects such as tag development and performance research and cooperative work with endangered species. Records in the CTC database date back to 1954.

The CSTP has collected data on sharks since the 1960s and represents one of the longest time series of any data set used to identify HMS EFH. The CSTP was initiated in 1962 with an initial group of less than 100 volunteers. The program has expanded in subsequent years and currently includes over 6,500 volunteers distributed along the Atlantic and Gulf coast of North America and Europe. There are inherent limitations in voluntary data collection programs that may include misidentification, inaccurate or inconsistent size determination, in part due to the fish being kept in the water while being measured, or incomplete data collection. NMFS removed any records that were incomplete, did not include a size measurement, or that did not indicate the type of measurement taken (*e.g.*, fork length, total length).

Other factors that were taken into consideration include gear selectivity and the type of fishing effort (*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 young-of-the-year and juvenile sharks are more abundant than adults. Commercial longline fishery data from the shark bottom longline and pelagic observer programs tends to be collected further offshore and consists predominantly of adult specimens. Geographic difference in data by gear type were also evident for gillnet gear which is typically fished closer to shore than bottom longline gear. Since NMFS sorted the species by size and life stage, the inherent gear biases in the data collection were minimized.

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

New data collected since the 1999 FMP for Atlantic Tunas, Swordfish, and Sharks, Amendment 1 to the Billfish FMP, and Amendment 1 to the 1999 FMP as well as previously existing data used to identify the 1999 EFH boundaries, were analyzed using Geographic Information System (GIS) software (ESRI Arcview 9.2). The data from all the datasets described above were combined into a single dataset for each species and life stage.

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

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

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

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

Although NMFS used the 95 percent probability boundary as the preferred area, NMFS also decided to generate the 70, 80, and 90 percent probability boundaries for comparative purposes. All four of the probability boundaries were shown during the public comment period on maps in the electronic pdf version of this document and in the online EFH Evaluation Tool site:

http://sharpfin.nmfs.noaa.gov/website/EFH_Mapper/HMS/map.aspx

In addition, maps and downloadable spatial EFH files for all federally managed species can be found on the NMFS EFH Mapper at:

http://sharpfin.nmfs.noaa.gov/website/EFH_Mapper/map.aspx

Both the electronic pdf version and the online mapping site have options that allow the viewer to turn layers on and off, thereby providing the viewer with the ability to differentiate between the different probability boundaries. All four of the probability boundaries were not included on the maps in the hard copy version of the DEIS because it was difficult to see the preferred probability boundary due to the four overlapping probability boundaries and other layers. Thus, for ease of viewing, the hard copy maps only include the preferred 95 percent probability boundary. The same approach was used in this FEIS.

The 70 percent probability boundary contains approximately 70 percent of all the points that were used to generate the probability boundary, the 80 percent probability boundary includes approximately 80 percent of the points, and so on. This pattern holds true for data rich species with a large numbers of data points. For species with fewer data points (< 1,000), the relative number of points included in each probability boundary is higher. For example, the 70 percent probability boundary for a data poor species such as basking sharks may include 80 percent of the total points. The result is a more precautionary approach for delineating EFH for data poor species. The advantage of using probability boundaries is that they are reproducible, have a predictable outcome, and more accurately reflect key areas of distribution for species because the points are weighted proportionally to one another. NMFS selected the 95 percent probability boundary as the preferred boundary because it represented the most precautionary approach of the four probability boundaries, in many cases (but not all) was most similar to the existing EFH boundaries established in 1999, and tended to provide more continuous boundaries than some of the lower probability boundaries, which were based on fewer data points.

Generating the probability boundaries was the first step in creating the EFH boundaries under Alternative 3. The resulting probability boundaries were then compared to existing EFH boundaries, bathymetric features, or other known areas of important habitat, verified and corroborated to the extent possible with NMFS scientists and researchers familiar with the habitat requirements and distribution for a particular species, and then, if necessary, modified based on input from the scientists and analysis of the data. Where appropriate, NMFS used bathymetric features such as isobaths or the shoreline to delineate the edges of the probability boundaries. Depending on the species and/or life stage, if the probability boundary overlapped with the shoreline, NMFS clipped the resulting probability boundary along the shoreline. For other species that infrequently occupy nearshore waters, the edge of the probability boundary may have been clipped along a particular isobath. For example, if a species is known to primarily occur seaward of the 100m isobath, then the boundary 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.

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

The 95 percent probability boundary thus reflects all data points collected ocean-wide and not just data points inside the EEZ. As a result, for species that included data points outside the EEZ, NMFS generated all four probability boundaries based on all data points. All of the boundaries were shown on the EFH Evaluation Tool site during the public comment period, and viewers would have noticed that probability boundaries extended beyond the EEZ. Those areas were not considered EFH, but rather were shown for comparative purposes and to clearly indicate how the proposed EFH boundary within the EEZ was created.

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

In some cases, usually for data poor species, the probability boundaries included small(er) pockets of probability boundaries. In a few extreme cases, every known data point for a data poor species may have 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, excluded them if they were smaller than a given size or beyond a given distance of a larger probability boundary, or manually created new boundaries based on expert knowledge.

In the past, EFH descriptions were provided in text with specific geographic coordinates describing the boundaries. Because the probability boundaries do not have straight lines, but rather follow contour lines, isobaths, or the data points themselves, and are naturally smoothed and rounded, describing them in text would be difficult and impracticable. With new mapping capabilities and the ability to provide spatial files to the public via the internet, NMFS will provide electronic versions of the maps in Adobe pdf format, and on the HMS EFH Evaluation Tool site, an internet-based mapping program to provide the EFH boundaries. The EFH descriptions in Chapter 5 will provide general descriptions of the EFH boundaries, and will direct people to the internet mapping site for the precise spatial boundaries. In addition to being viewable on the internet, the spatial files will be downloadable as ArcGIS shapefiles. With this new tool, NMFS now has the capability to provide EFH spatial files to the public via the internet and will not have to provide text descriptions of the actual boundaries.

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

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

### 4.1.3 Comparison of EFH Alternatives

For each of the alternatives, there are no direct ecological, social, or economic impacts that result from either changing or maintaining the existing EFH boundaries. In addition to the status quo, the alternatives represent a range of options from smaller, more refined areas to larger, more broadly delineated areas. The primary effect of changing EFH boundaries would be a change in the areas that are subject to consultation with NMFS under the EFH regulations. As such, if a proposed project is federally funded, authorized, or undertaken by a federal agency or proposed to be undertaken by a federal agency, which may adversely affect EFH, then the agency is required to consult with NMFS. NMFS provides written recommendations on measures that would minimize, mitigate, or otherwise reduce the impacts of a proposed project on EFH. The action agency is then required to respond in writing on what measures were taken to minimize impacts. If consulting agencies implement recommended measures to minimize impacts, the indirect and cumulative impacts of EFH designations should contribute to a reduction in the impacts to EFH and a positive conservation benefit. While these indirect effects are dependent on independent future federal decisions, to provide federal agencies with a sense of the types of activities that may adversely affect EFH and the associated conservation recommendations that, if implemented, would indirectly benefit EFH conservation, Chapter 6 provides a series of conservation recommendations related to a variety of potential federal activities.

Similarly, the analysis of fishing impacts to EFH is specifically required as part of the EFH designation process, and Chapter 6 of this document describes those fishing impacts. At this time, since no fishing impacts are occurring that would adversely affect EFH, no new measures are currently being implemented to reduce fishing impacts (*e.g.*, closures). Should such required measures be identified in the future, NMFS would propose and appropriately analyze those measures in a separate action at that time.

For alternative 1, the no action alternative, EFH and the areas subject to consultation would not change. For alternative 2, establishing new EFH boundaries based on the highest concentration of a particular species by selecting high count cells, EFH would be reduced in size for some species and potentially increased for others. Thus, the areas subject to consultation would vary by species.

For alternative 3, establishing EFH based on the 95 percent probability boundary preferred alternative would decrease EFH for some species but potentially increase it for others. Thus, the areas subject to consultation would vary by species and areas. NMFS prefers alternative 3 because it provides an objective approach to identifying EFH, is transparent, and reproducible. The preferred alternative of using the 95 percent probability boundary is the most precautionary of the different probability boundaries considered and encompasses on average 95 percent of the observations. For data poor species whose EFH boundaries may be discontinuous or fragmented, in some cases, NMFS made manual edits to the 95 percent probability boundary to make the fragmented areas more continuous. In other cases, NMFS may have combined the data from different lifestages in order to increase the number of available data points used to generate the probability boundary, and generated a single EFH boundary for the species rather than separate EFH boundaries for each lifestage. In some cases, this approach helped alleviate the problem of small pockets of EFH.

For alternatives 4 and 5, establishing EFH based on all points or cells where species are present (alternative 4) or the entire range of species distribution (alternative 5) would result in very large areas identified as EFH, particularly if all the points are connected through continuous boundaries. NMFS did not prefer either of the last two alternatives because they would potentially encompass all areas where the species are present and not the areas that represent the most important habitat.

## 4.2 Habitat Areas of Particular Concern

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

Alternative 1 No Action - maintain current HAPCs.

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

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

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

*Ecological, Social, and Economic Impacts*

Similar to the reasons described for EFH, HAPCs are not expected to have direct ecological, social, or economic impacts. A HAPC designation 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. If NMFS determines that human activities are having an effect on HAPCs, then NMFS could consider proposing measures to minimize impacts if they are determined to result from fishing activities, or develop conservation recommendations for non-fishing activities. NMFS has developed such recommendations for non-fishing activities as described in Chapter 6. Since HMS fishing gears are largely fished in the water column, they have little or no impact on EFH. The exception may be BLL gear whose impacts are further analyzed in Section 6.1.

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

Alternative 2, the preferred alternative, would designate a HAPC for bluefin tuna in the central Gulf of Mexico west of 86º W Longitude and south of the 100m isobath (Figure 4.1) while maintaining the current HAPCs for sandbar sharks along the Atlantic coast.

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

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

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

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

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

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

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

Although there are no direct environmental effects of designating a HAPC for spawning bluefin tuna in the Gulf of Mexico, it could help focus current and future conservation efforts in the area. For example, given the increased attention on domestic oil and gas production, many new leases are being issued in the Gulf of Mexico (see Non-Fishing Impacts Section 6.2). The Department of Interior's Minerals Management Service (MMS) data show that there are approximately 4,000 existing oil and gas structures and 33,000 miles of pipelines in the Gulf of Mexico (Figure 4.6), with plans for development of additional deep water oil production sites (Figure 6.12) and liquefied natural gas (LNG) sites in the Gulf of Mexico (Figure 6.14), many of which overlap with bluefin tuna spawning areas and the HAPC designation. In addition, there are plans for renewable energy projects off the U.S. Atlantic coast including the Florida Straits (see Non-Fishing Impacts Section 6.2). NMFS has provided conservation recommendations on a number of oil and gas development projects in the Gulf of Mexico in the past and would continue to do so in the future in order to mitigate potential adverse effects on EFH for a number of federally managed species that occur in the Gulf, including bluefin tuna. Having a HAPC designation for bluefin tuna would help identify and focus additional conservation efforts to minimize the impacts of oil and gas development projects on bluefin tuna spawning habitat.

## 4.3 Preferred Alternatives

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

## 4.4 Other NEPA Considerations

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

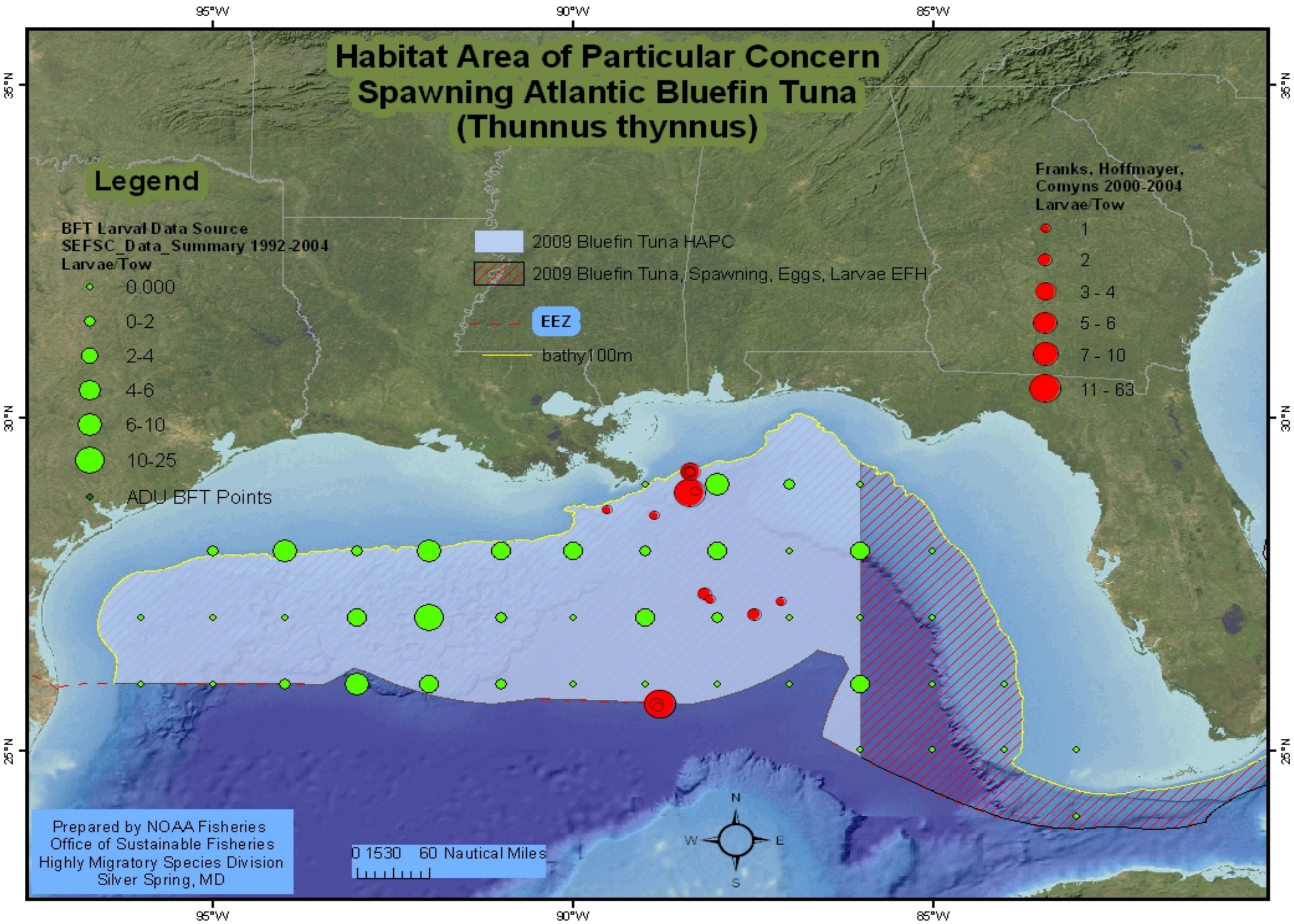


**Figure 4.1** HAPC for spawning bluefin tuna in the Gulf of Mexico. The figure shows existing EFH boundaries for bluefin tuna spawning/larval EFH (hatched areas) and potential new HAPC boundaries (light blue area) based on alternative 2.

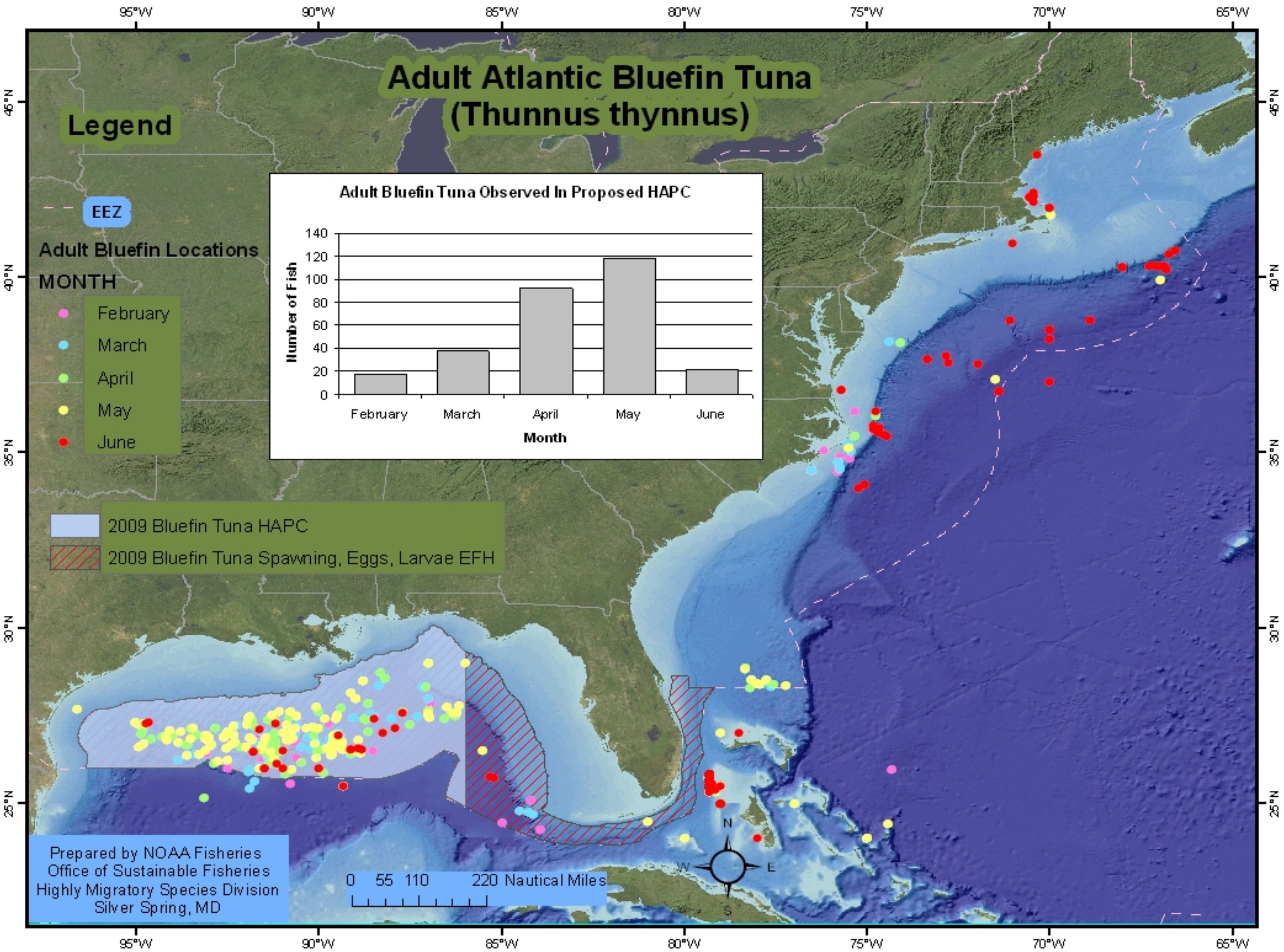


**Figure 4.2** Monthly distribution data for adult bluefin tuna (≥ 231 cm) showing the temporal and spatial overlap within the HAPC implemented under alternative 2. Other boundaries are shown for reference.

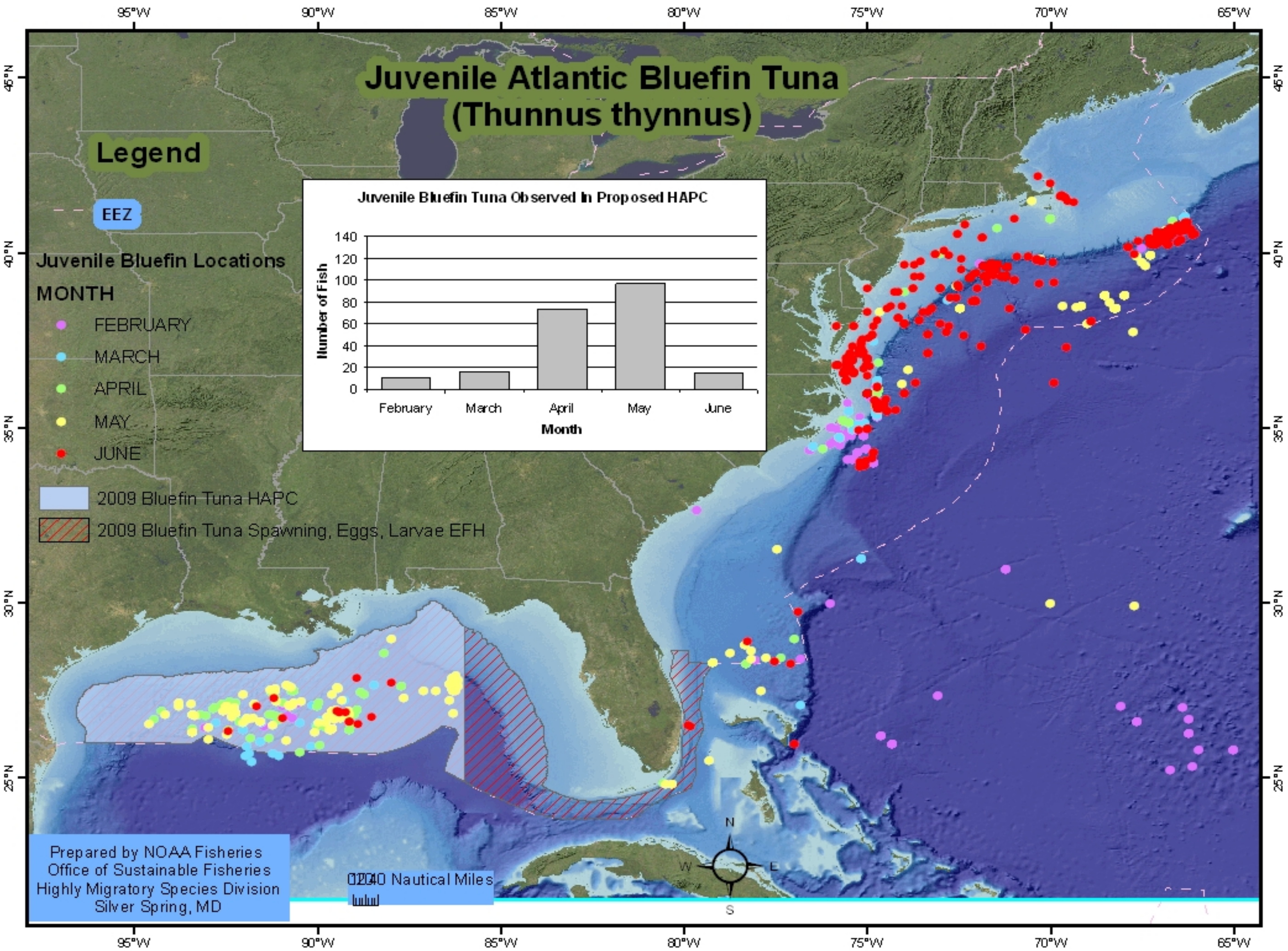


**Figure 4.3** Monthly distribution data for bluefin tuna (< 231 cm) showing the temporal and spatial overlap within the HAPC implemented under alternative 2. Other boundaries are shown for reference.

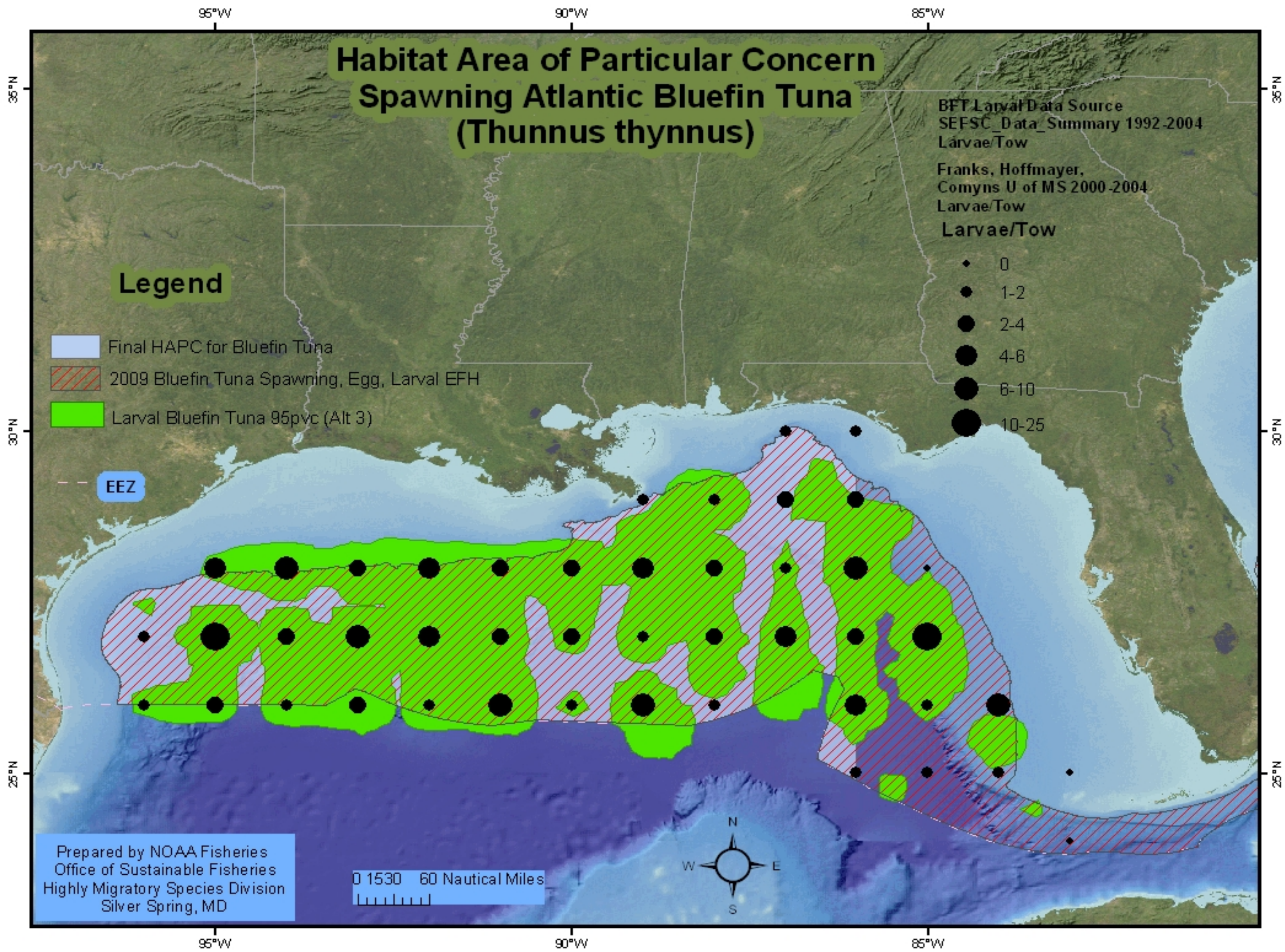


**Figure 4.4** Non-preferred HAPC for spawning bluefin tuna (shown in green) in the Gulf of Mexico based on the 95 probability boundary for bluefin tuna larvae as described in alternative 3. Other boundaries are shown for reference.

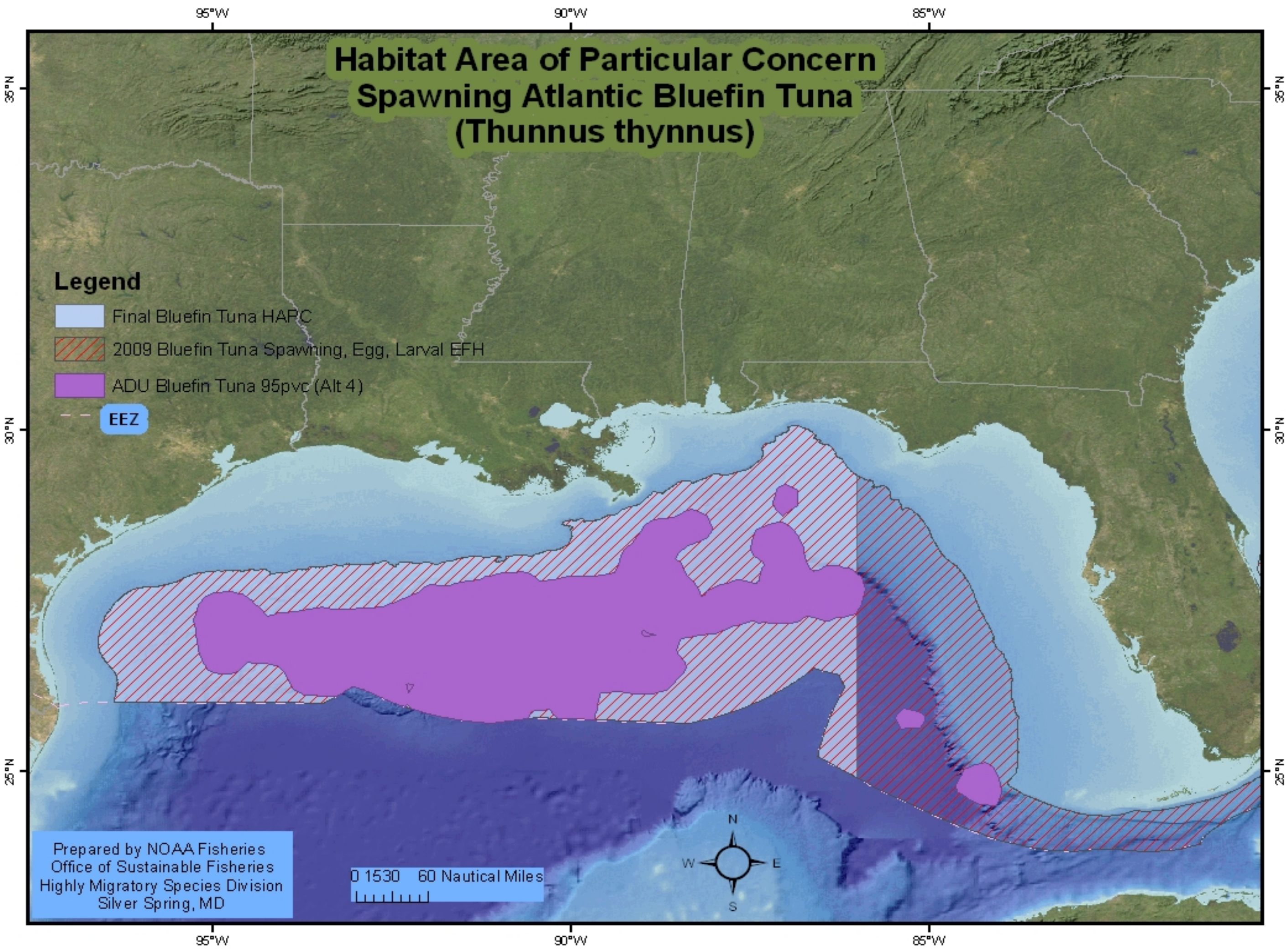


**Figure 4.5** Non-preferred HAPC for spawning bluefin tuna (shown in purple) in the Gulf of Mexico based on the 95 percent probability boundary for adult bluefin tuna as described in alternative 4. Other boundaries are shown for reference.

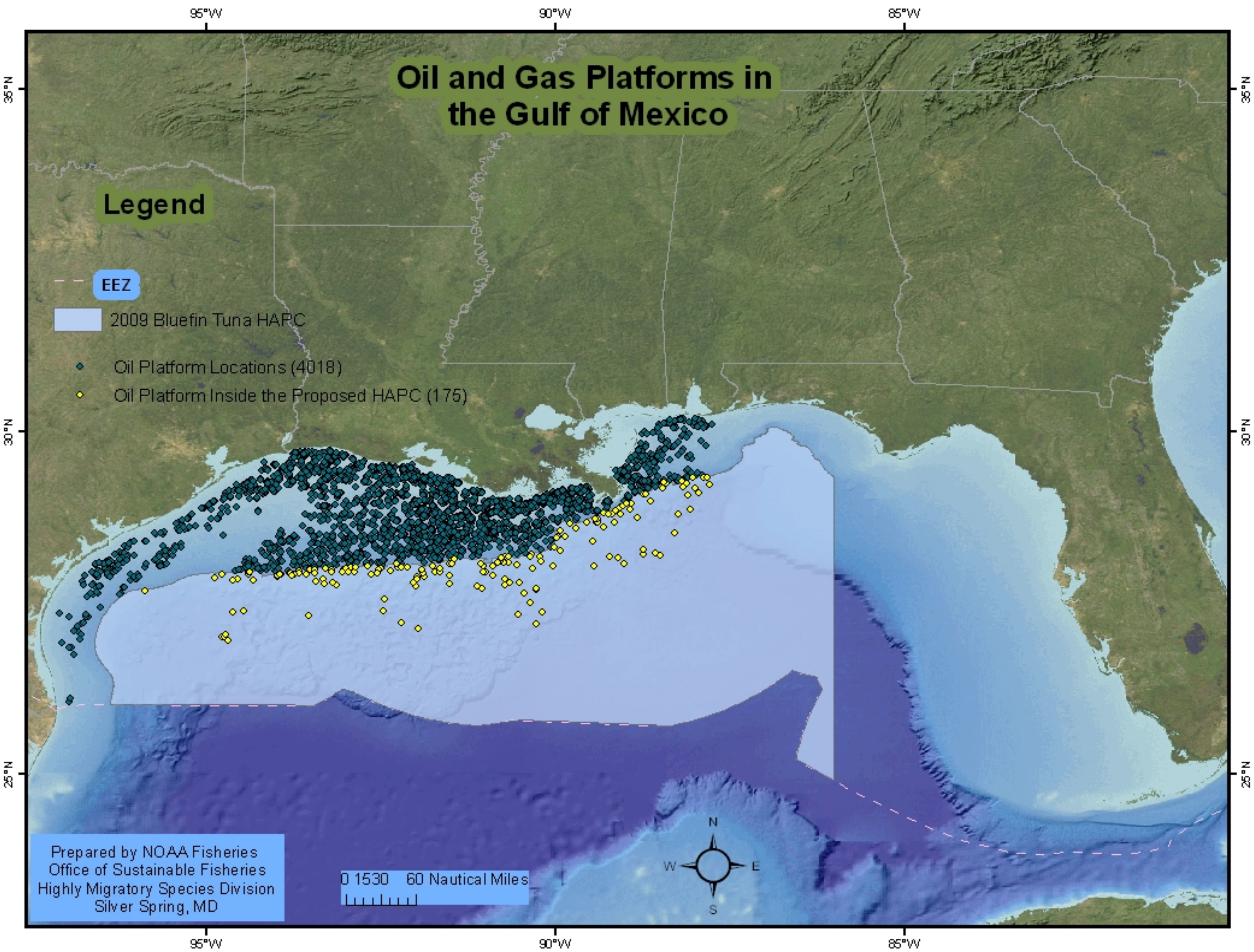


**Figure 4.6** Oil and gas platforms in the Gulf of Mexico showing the overlap with proposed bluefin tuna HAPC. Source: MMS.

## CHAPTER 4 REFERENCES


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