APPENDIX A – "METHODS"

EFH DESIGNATION ALTERNATIVES
# Table of Contents

1.0 Alternative 1 – Status Quo ................................................................. 3
2.0 Alternative 2 – Abundance Only ....................................................... 11
3.0 Alternative 3 – Abundance + Habitat Considerations .......................... 12
   3.1 Text Descriptions ........................................................................... 17
   3.2 Map Representations ....................................................................... 21
      3.2.1 Inshore .................................................................................. 21
      3.2.2 Shelf EFH ............................................................................ 23
      3.2.3 Off-Shelf EFH ...................................................................... 26
4.0 Alternative 4 – Species Range ................................................................. 27
5.0 Special Exceptions ............................................................................. 27

# List of Tables and Figures

Table 1. Sources and Levels of EFH Information for Status Quo EFH Designations * ...... 7
Table 2. Sources and Levels of EFH Information ................................................................. 16

Figure 1. Distributions of American plaice eggs ............................................................... 18
Figure 2. Distributions of juvenile American plaice and trawls in Massachusetts coastal waters ............................................................................................... 19
Figure 3. Frequency distribution of average catch rates by 1 degree Centigrade intervals of bottom temperature for adult American plaice during 1968-2003 spring NEFSC trawl surveys ........................................................................ 23
1.0 ALTERNATIVE 1 – STATUS QUO

There are several sources of distribution and abundance data used to develop the EFH designations. The NMFS bottom trawl survey (1963 - 1997) and the NMFS Marine Resources Monitoring, Assessment and Prediction (MARMAP) ichthyoplankton survey (1977 - 1987) provide the best available information on the distribution and relative abundance of Council-managed species in offshore waters. The bottom trawl survey is used for juveniles and adults, and the MARMAP survey is used for eggs and larvae. The Council used other sources of information on inshore areas; including the Massachusetts inshore trawl survey (1978 - 1997), information from Long Island Sound (1990 - 1996), and NOAA’s Estuarine Living Marine Resources (ELMR) program. Data on the distribution and relative abundance of fish in other inshore areas, especially estuaries and embayments, were not available in a timely manner in some cases. The Council also considered information provided by the fishing industry, as well as several sources of historical information. Information on the distribution and abundance of sea scallops was obtained primarily from the NMFS sea scallop survey (1982 - 1997) and from representatives of the scallop fishing industry. Information on the range and distribution of Atlantic salmon was obtained primarily from the available literature. Detailed descriptions of the surveys and databases used by the Council in the EFH designation process, including the sampling protocols and methods, are provided in Appendix C of the 1998 EFH Omnibus Amendment. A detailed discussion of the limitations associated with using these data and information sources as the basis for designating EFH is provided in Appendix D of the 1998 EFH Omnibus Amendment.

ELMR Program Information

Used by the Council as the primary source of information on species distribution and abundance in the bays and estuaries of New England and the Mid-Atlantic, NOAA’s Estuarine Living Marine Resources (ELMR) program has been conducted jointly by the Strategic Environmental Assessments (SEA) Division of NOAA’s Office of Ocean Resources Conservation and Assessment (ORCA), NMFS, and other agencies and institutions. The goal of this program is to develop a comprehensive information base on the life history, relative abundance and distribution of fishes and invertebrates in estuaries throughout the nation. The nationwide ELMR database was completed in 1994, and includes information for 135 species found in 122 estuaries and coastal embayments. The Jury et al. (1994) report summarizes information on the distribution and abundance of 58 fish and invertebrate species in 17 North Atlantic estuaries. The Stone et al. (1994) report summarizes information on the distribution and abundance of 61 fish and invertebrate species in 14 Mid-Atlantic estuaries.

Most existing estuarine fisheries data cannot be compared among estuaries because of the variable sampling strategies. In addition, existing research programs do not focus on
how groups of estuaries may be important for regional fishery management. The ELMR program was developed to integrate fragments of information on many species and their associated habitats into a useful, comprehensive and consistent format. The framework employed for the ELMR program enables a consistent compilation and organization of all available data on the distribution and abundance of fishes and invertebrates in estuaries. For the New England region, thirteen north Atlantic estuaries were selected from the National Estuarine Inventory (NEI) Data Atlas Volume I, and after discussions with several regional researchers, four additional estuaries were included. Although not every New England or mid-Atlantic estuary is addressed, thirty-one estuaries are included in the Jury et al. (1994) and Stone et al. (1994) reports:

- Passamaquoddy Bay
- Englishman/Machias Bays
- Narraguagus Bay
- Blue Hill Bay
- Penobscot Bay
- Muscongus Bay
- Damariscotta River
- Sheepscot River
- Kennebec/Androscoggin Rivers
- Casco Bay
- Saco River
- Wells Harbor
- Great Bay
- Merrimack River
- Massachusetts Bay
- Boston Harbor
- Gardiners Bay
- Long Island Sound
- Great South Bay
- Hudson River/Raritan Bay
- Barnegat Bay
- New Jersey Inland Bays
- Delaware Bay
- Delaware Inland Bays
- Chincoteague Bay
- Chesapeake Bay
- Cape Cod Bay
- Waquoit Bay
- Buzzards Bay
- Narragansett Bay
- Connecticut River
Project staff compiled species distribution and abundance information for these estuaries by conducting exhaustive literature searches and examining published and unpublished data sets. To complement the information from these quantitative studies, regional, state, and local biologists were interviewed for their knowledge of estuary/species-specific spatial and temporal distribution patterns and relative abundance levels based upon their experience and research. The final level of relative abundance assigned to a particular species was determined from the available data and expert review. To rank relative abundance, ELMR staff used the following categories:

*Not present* -- species or life history stage not found, questionable data as to identification of species, and/or recent loss of habitat or environmental degradation suggests absence.

*No information available* -- no existing data available, and after expert review it was determined that not even an educated guess would be appropriate. This category was also used if the limited data available were extremely conflicting and/or contradictory; in these cases, *no information available* actually describes a situation where the available information was indecipherable.

*Rare* -- species is definitely present but not frequently encountered.

*Common* -- species is frequently encountered but not in large numbers; does not imply a uniform distribution over a specific salinity zone.

*Abundant* -- species is often encountered in substantial numbers relative to other species with similar life modes.

*Highly abundant* -- species is numerically dominant relative to other species with similar life modes. The Council considers the *abundant* and *highly abundant* categories to be the same for the purposes of designating EFH.

For many well-studies species, quantitative data were used to estimate spatial and temporal distributions. For other species, however, reliable quantitative data were limited. Therefore, nearly all information used in the reports was submitted to panels of local researchers, managers, and technicians for peer review based upon their knowledge of individual species within an estuary. More than 72 scientists and managers at 33 institutions were consulted (the ELMR reports list the individuals and their affiliations). An important aspect of the ELMR program, because it is based primarily on literature and consultations, was to determine the reliability of the available information. The reliability of available information varied between species, life stage, and estuary, due to differences in gear selectivity, difficulty in identifying larvae, difficulty in sampling various habitats, and the extent of sampling and analysis in particular studies. Data reliability was classified using the following categories:
"Highly certain" -- considerable sampling data available. Distribution, behavior, and preferred habitats well documented within the estuary.

"Moderately certain" -- some sampling data available for the estuary. Distribution, preferred habitat, and behavior well documented in similar estuaries.

"Reasonable inference" -- little or no sampling data available. Information on distributions, ecology, and preferred habitats documented in similar estuaries.

The ELMR information, as presented, should be considered "Level 1" data, as defined in the then Interim Final Rule, which was in effect during the development of the 1998 Omnibus Amendment. Guidance in the Interim Final Rule suggests that when working only with Level 1 data, "presence / absence data should be evaluated . . . to identify those habitat areas most commonly used by the species." As it relates to the information presented in the ELMR reports, estuaries where a particular species is abundant are assumed to be more commonly used than estuaries where a particular species is rare. More commonly used estuaries should be considered in the designation of essential fish habitat.

Several members of the Council’s EFH Technical Team (precursor group to the current Habitat Plan Development Team) had direct involvement with the process for developing the ELMR information, either as interviewees or as reviewers. In their experience, all levels of data reliability provide sound information for use in determining the presence or absence of a species within an estuary. Information classified on the basis of reasonable inference may not be based on directed research to assess the abundance of a particular species within an estuary, but it does reflect the professional experience and personal knowledge of scientists and managers intimately involved with the species and estuaries in question. Information of a dubious nature, or information that is not verifiable would be categorized as no information available and the species would therefore not appear as rare, common, abundant, or highly abundant in an estuary.

The Council determined that the information presented in the ELMR reports met the qualifications of the Interim Final Rule, which was in effect in 1998, for "Level 1" data, and as such, should be considered and incorporated into the EFH designation process. Although the NMFS ichthyoplankton and bottom trawl survey remained the primary source of information for designating EFH, the ELMR reports serve as "additional information." Although the Council reserved the right to evaluate individually the appropriate EFH designations based on the ELMR information, the following provides a general guide for how the Council applied the information. For those species' life history stages for which the Council designated EFH based on the 100% alternative (i.e., EFH is designated as 100% of the range observed for the species' life history stage), all estuaries in which the species' life history stage is categorized as rare, common, abundant, or highly abundant were included in the EFH designation. For those species' life history stages for which the Council designated EFH based on the 90% alternative, all estuaries in which the species' life history stage is categorized as common, abundant, or highly abundant were included in the EFH designation. Species for which the 50% or 75% alternative
was used, all estuaries in which the species’ life history stage is categorized as *abundant* or *highly abundant* were included in the EFH designation.

Table 1 displays the level of information available for each species’ status quo EFH designation. For most species, the best information consists of relative abundance and distribution data (Level 2) and presence / absence data (Level 1). In a few cases, some Level 3 information is available, but there is a definite lack of detailed and scientific information relating fish productivity to habitat type, quantity, quality and location. Guidance provided by NMFS in the Interim Final Rule, which was in effect in 1998 during the submission period, suggests that when working only with Level 1 and Level 2 data, "the degree that a habitat is utilized is assumed to be indicative of habitat value." In other words, if all that is known is where the fish tend to be in relatively high concentrations, these areas are assumed to be the essential fish habitat. This is the approach the Council has adopted, using relative densities and areal extent to determine the EFH designations.

**Table 1. Sources and Levels of EFH Information for Status Quo EFH Designations**

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<thead>
<tr>
<th>Species</th>
<th>eggs</th>
<th>larvae</th>
<th>juvenile</th>
<th>adult</th>
<th>spawners</th>
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<td>Clearnose skate</td>
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<td>Deep-sea red crab</td>
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<td></td>
</tr>
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<td>Species</td>
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<td>larvae</td>
<td>juvenile</td>
<td>adult</td>
<td>spawners</td>
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<td>1</td>
</tr>
</tbody>
</table>

*The numbers represent the highest available level of information available for each life history stage. Level "0" indicates that there is very little information available for this life history stage. "N/A" indicates that this does not exist as a distinct life history stage for this species.*

The alternatives considered by the Council were based on the relative densities of fish observations. For all species, a set of alternatives was developed for each of the major life history stages, with the exception of sea scallops, Atlantic salmon, and Atlantic halibut. Those stages include eggs, larvae, juveniles, and adults. The maps presenting the alternatives display the distribution and abundance data by ten minute squares of latitude and longitude. This is the most efficient and understandable spatial scale for use in this process because the NMFS distribution and abundance data were easily represented by ten minute squares and the data can be compared to other data sets, information from the fishing industry, and existing management measures.

The Council used two methods for developing the EFH designations: one based on catch-per-unit-effort per ten minute square, and the other based on straight percentages of observed range. The catch-per-unit-effort method was used for all demersal life history stages (juveniles and adults of all species with the exception of Atlantic herring and Atlantic salmon). The percentage of observed range method was used for all planktonic life history stages (eggs and
lарvae of most species) and the juvenile and adult stages of the pelagic schooling Atlantic herring. The "observed range" for each species includes all areas where the species was observed by either the NMFS bottom trawl or MARMAP surveys.

Selection factors were applied to the bottom-trawl and ichthyoplankton survey databases to construct the data sets for the Council alternatives and EFH designation maps. The selection factors were recommended by NMFS Northeast Fisheries Science Center (NEFSC) scientists who collected and work with the data. Correction factors were used to standardize the bottom-trawl catch of various species due to variation in doors, trawls, and/or vessels among the surveys. Correction factors were applied to specific species (see Appendix C, Methods Report, Table 4). After the bottom-trawl and ichthyoplankton data were selected, the summarization process was the same. Data were assigned to a ten minute square based on the location of the starting point of the bottom-trawl or ichthyoplankton sample tow. Only those squares that had greater than three samples and one positive catch were selected. Catch data were transformed by taking the natural logarithm of the catch [ln(catch + 1)] and the mean of the transformed data was calculated for each ten minute square.

In analyzing the data for each species’ life stage using the catch-per-unit-effort method, each ten minute square throughout the survey area and included in the analysis was ranked from highest to lowest according to an index of the mean catch per unit of effort of the survey (i.e., the number of fish caught in each tow of the survey trawl). For each life history stage, the alternatives considered include: (1) the area that comprises the top 50% of catch per unit effort abundance index, (2) the area that comprises the top 75% of catch per unit effort abundance index, (3) the area that comprises the top 90% of catch per unit effort abundance index, (4) 100% of the observed range of the species, and (5) no EFH designation (the status quo option).

In analyzing the data for each species’ life stage using the straight area percentage method, each ten minute square throughout the survey area and included in the analysis was also ranked from highest to lowest according to an index of the mean catch per unit of effort of the survey. In this case, however, the alternatives represent the percentage of the overall area (the observed range) rather than a percentage of the catch-per-unit effort. For each life history stage, the alternatives considered include: (1) the area that comprises the top 50% of the observed range, (2) the area that comprises the top 75% of the observed range, (3) the area that comprises the top 90% of the observed range, (4) 100% of the observed range of the species, and (5) no EFH designation (the status quo option). The former method was used because it accurately reflected that for most demersal life history stages, the population is rather concentrated in some portions its overall range, especially where environmental conditions such as habitat and prey resources were most favorable, and it is less concentrated in other portions of its overall range where environmental conditions are not as favorable. Clearly, EFH should be designated where environmental conditions, especially habitat, are most favorable, thus the highest percentages of the catch-per-unit-effort index were a suitable proxy for identifying these areas.
In the case of the planktonic life history stages and the pelagic schooling nature of juvenile and adult Atlantic herring, this method did not necessary capture the “area” most favorable to the species. Planktonic eggs tend to be clumped only immediately after a spawning event, and they soon after disperse rapidly and move with the prevailing currents. Currents and other oceanographic phenomenon tend to move and shift around the concentrations of planktonic eggs and larvae, and chance plays a large role in the eggs and larvae ending up in areas of the species’ range where environmental conditions are most favorable. Other factors related to the sampling methods for these life stages also contribute to the catch-per-unit-effort method not being as appropriate (see 1998 Omnibus Amendment Appendices C and D). The straight percentage method was used in these cases as a more inclusive process to better represent the areas where the species tended to be.

For each life history stage of each species, the Council considered the remaining alternatives, selecting the EFH designation for each individually. The Council employed the most consistent approach possible, given the variety of species and unique characteristics of many of the life history stages and the limitations of the available data and information considered. The Council’s approach was focused on designating the smallest area possible that accounted for the majority of the observed catch, taking into account the habitat requirements of the species and any areas known to be important for sustaining the fishery. The Council considered the status of the resource, and was more conservative with those species considered overfished. The Council also considered the historic range of the species, including areas of historic importance, where appropriate. In some cases, the Council used a proxy to determine the most appropriate EFH designation for certain life history stages. This was done by applying the range of one life history stage as the EFH designation for another stage. The Council most often used a proxy designation when information was not available for a particular life history stage, but also used a proxy on occasion when the observed range of a particular life history stage did not accurately represent the true range.

The habitat description and identification for a managed species is based on the biological requirements and the distribution of the species. For all species, this includes a combination of state, federal, and international waters. According to the regulations, EFH can only be designated within U.S. federal or state waters. Although there may be areas outside of U.S. waters which are very important to Council-managed species, EFH can not be designated in Canadian waters or on the high seas. In cases where the range of a species extends into waters managed by the Mid-Atlantic Fishery Management Council (MAFMC), the NEFMC has designated EFH as long as the species is managed under a New England Fishery Management Council FMP. Accordingly, the maps representing the Council’s EFH designations include those ten minute squares in Canadian waters where each species was caught in the NMFS surveys, but the actual EFH designations stop at the U.S - Canada boundary. The Council recognized that in many cases, habitat located in Canadian waters may be just as important, if not more important, than the habitat located in U.S. waters.
Quite often, the EFH designations appear quite patchy in spatial distribution. While this is normal in natural systems, to some extent this patchy distribution was based not on the natural distribution of the species, but on the limitations of the sampling protocols. Once the proposed designations were completed, including whatever additional information was available (ELMR, inshore surveys, fishing industry, landings, historical, etc.), the Council chose to also include any empty ten minute squares surrounded by either seven or eight "filled in" ten minute squares. This approach "smoothes" the designations, and, thereby reducing to some degree the patchy nature of the EFH designations. For instance, there appeared certain areas where quite large expanses of EFH surrounded a single empty ten minute square. This may have resulted from the ten minute square not being sampled enough to be included in the analysis, or may have resulted from some topographic feature that prevented the survey gear from operating efficiently. Including these areas in the EFH designations assumes that they are important to the species. No ten minute squares were eliminated from the EFH designations in this process.

Certain geographic regions were not represented in the data considered by the Council, such as near shore waters of Maine, eastern Long Island, and smaller estuaries. These areas, therefore, have not been considered in the EFH designation process. This does not mean that they are not potentially important, but rather they represent data and information gaps. There is a need for information on the relative abundance of managed species in all areas that are not surveyed systematically. As information becomes available on these areas, the Council will consider including them in the EFH designations of the appropriate species. The Council will also consider whether certain near shore areas that represent data gaps should be designated EFH based on identified EFH in adjacent or nearby areas that share similar environmental characteristics.

2.0 ALTERNATIVE 2 – ABUNDANCE ONLY

The Status Quo EFH designations will employ a similar method as described above under Alternative 1 (No Action) except that the years of NMFS spring and fall Bottom Trawl Survey data will include data from 1968 to 2005. Data collected during 1963-1967 fall surveys will be eliminated from the analysis in order to create a more uniform time series that equally represents the two times of year. In addition, any TMS which occurred entirely within select survey strata that were poorly sampled were neither included in these calculations nor mapped. (This included areas south of Cape Hetaeras, in Canadian waters off Nova Scotia and on the entire Scotian Shelf.) For species that are separately managed by Canada (Cod, Haddock, Herring, Winter and Yellowtail Flounders) all TMS entirely within Canadian waters were removed from the analysis. The cumulative CPUEs will change from 50%, 75%, 90% and 100% as considered in the No Action alternative to 25%, 50%, 75% and 90% to better reflect the range of the species habitats. This is consistent with the approach used in Alternative 3 below. Text descriptions will be the same as the up-dated descriptions used in Alternative 3, without any
information on prey species. They will differ from the descriptions in the No Action alternative because they are based on analysis of up-dated NMFS trawl survey data, analysis of inshore survey data, analysis of a greatly expanded USGS marine sediment database that became available in 2005, and new evaluations of habitat-related information in updated versions of the EFH Source Documents. They also do not include any descriptions for a separate Spawning Adults life stage. (See methods for Alternative 3 for more details). Additionally, survey catch data will be processed slightly differently in order to reduce the impact of high abundance tows on average catch rates for each ten minute square. This will considerably reduce the number of ten minute squares that are associated with all the cumulative CPUE levels below 100% and increase the number at the 100% level. Additionally, state fisheries survey data will be included, along with ELMR data, in the GIS analysis used to create the inshore portions of the EFH maps. Any ten minute square (TMS) of latitude and longitude that is included within the area surveyed by any of the states in which the percentage of positive tows (i.e., any tow catching at least one fish) for a given species and life stage exceeds 10% of all the tows made in that TMS will be included as EFH. For a complete listing of state survey used see the Alternative 3 methods section below.

3.0 ALTERNATIVE 3 – ABUNDANCE + HABITAT CONSIDERATIONS

Based on the general advice provided in the short-term recommendations by the Habitat Evaluation Review Committee, the PDT is developing EFH designations using a modified status quo approach for each life stage (eggs, larvae, juvenile and adults with supplementary information provided for young-of-the-year juveniles and spawning adults). To this end, spatial extent of EFH has been divided into three general spatial realms, largely because of the different data sets available within each (inshore, shelf and offshelf). Below is a general description for each spatial realm of the developing method being used to create options under Alternative 3. Additionally, these are the data sources we are consulting for the EFH designation Alternative 3 development:

Abundance/ Distribution Data Sources

Inshore
- ME Beam Trawl Survey (2000 - 2004)
- NH Estuarine Seine Survey
• RI Coastal Ponds Survey
• RI Narragansett Bay Juvenile Finfish Survey
• CT Long Island Sound Trawl Survey (1984 – 2004)
• CT Small Mesh Trawl Survey (1991-93, 1996)
• NY Raritan Bay Survey (1992 – 1997)
• NJ Trawl Survey (1988-2004)
• NJ Delaware Bay Trawl Survey (1991 – 2005)
• DE 16ft Trawl Survey (1980-2004)
• DE 30ft Trawl Survey (1966-2004)
• VA Juvenile Fish and Trawl Survey
• MD Coastal Bays Fisheries Investigation Project
• NC Trawl Survey
• NOAA Estuarine Living Marine Resource information

Shelf
• NMFS bottom trawl survey (1968 - 2005)
• NMFS sea scallop survey (1982-2005)
• NMFS MARMAP ichthyoplankton survey (1977 – 1987)

Offshelf
• NMFS Deep-Sea Survey
• Deep Sea Experimental Fishery project reports
• Smithsonian collection data

Habitat Data Sources

Shelf
• NGDC 2-Minute Gridded Bathymetry Data (ETOPO2)
• usSEABED Marine Substrate Database
• Bottom temperature derived from NMFS MARMAP, bottom trawl, and hydrographic survey data.

EFH designations include a text description and a map for each life stage of each managed species. The maps produced as part of the exercise are approximate spatial representations of the EFH text descriptions and are used to inform the “geographic extent” item in the text description. For the purposes of these Amendments, this alternative will also include a table that will contain supplementary information for each species and life stage, e.g., generic information on habitat features, depth, temperature, and salinity ranges, and information that is specific to a particular time of year, survey, or location. This information will not be part of the legally-binding EFH description.
This method will be applied to four life stages as described here. Pertinent information on young-of-the-year juveniles and spawning adults will be included in their respective life stage EFH text description.

Life Stages:

1. **Egg stage** – The life history stage of an animal that occurs after reproduction and refers to the developing embryo, its food store, and sometimes jelly or albumen, all surrounded by an outer shell or membrane. Occurs before the larval or juvenile stage.

2. **Larval stage** – The first stage of development after hatching from the egg for many fishes and invertebrates. This life stage looks fundamentally different than the juvenile and adult stages, and is incapable of reproduction; it must undergo metamorphosis into the juvenile or adult shape or form.

3. **Juvenile stage** – The life history stage of an animal that comes between the egg or larval stage and the adult stage; juveniles are considered immature in the sense that they are not yet capable of reproducing, yet they differ from the larval stage because they look like smaller versions of the adults. Young-of-the-year juveniles are juveniles less than one year old.

4. **Adult stage** – In vertebrates, the life history stage where the animal is capable of reproducing. Spawning adults are adults that are currently producing eggs.

The map designations of essential fish habitat identify the geographic extent within which certain types of habitat are considered EFH. EFH must be designated according to the level of information available on the species distribution, abundance, and habitat-productivity relationships. The levels of information, as defined in the Interim Final Rule, are:

- **Level 1**: Presence / absence data are available for portions of the range of the species. At this level, only presence / absence data are available to describe the distribution of a species (or life history stage) in relation to potential habitats. In the event that distribution data are available for only portions of the geographic area occupied by a particular life history stage of a species, EFH can be inferred on the basis of distributions among habitats where the species has been found and on information about its habitat requirements and behavior.

- **Level 2**: Habitat-related densities are available. At this level, quantitative data (i.e., density or relative abundance) are available for the habitats occupied by a species of life history stage. Density data should reflect habitat utilization, and the degree that a habitat is utilized is assumed to be indicative of habitat value. When assessing habitat value on the basis of fish densities in this manner, temporal changes in habitat availability and utilization should be considered.
• Level 3: Growth, reproduction, and survival rates within habitats are available. At this level, data are available on habitat-related growth, reproduction, and/or survival by life history stage. The habitats contributing the most to productivity should be those that support the highest growth, reproduction, and survival of the species (or life history stage).

• Level 4: Production rates by habitat are available. At this level, data are available that directly relate the production rates of a species of life history stage to habitat type, quantity, and location. Essential habitats are those necessary to maintain fish production consistent with a sustainable fishery and the managed species’ contribution to a healthy ecosystem.

Table 2 displays the level of information available for each species’ EFH designation. For most species, the best information consists of relative abundance and distribution data (Level 2) and presence / absence data (Level 1). In a few cases, some Level 3 information is available, but there is a definite lack of detailed and scientific information relating fish productivity to habitat type, quantity, quality and location.
<table>
<thead>
<tr>
<th>Species</th>
<th>eggs</th>
<th>larvae</th>
<th>juvenile</th>
<th>adult</th>
</tr>
</thead>
<tbody>
<tr>
<td>American plaice</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Atlantic cod</td>
<td>2+3</td>
<td>2</td>
<td>2+3</td>
<td>2</td>
</tr>
<tr>
<td>Atlantic halibut</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Atlantic herring</td>
<td>1</td>
<td>2</td>
<td>2+3</td>
<td>2+3</td>
</tr>
<tr>
<td>Atlantic salmon</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Atlantic sea scallops</td>
<td>0</td>
<td>3</td>
<td>2+3</td>
<td>2+3</td>
</tr>
<tr>
<td>Barndoor skate</td>
<td>0</td>
<td>N/A</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Clearnose skate</td>
<td>0</td>
<td>N/A</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Deep-Sea red crab</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Haddock</td>
<td>2+3</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Little skate</td>
<td>0</td>
<td>N/A</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Monkfish</td>
<td>1</td>
<td>2</td>
<td>2</td>
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<tr>
<td>Ocean pout</td>
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<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Offshore hake</td>
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<td>2</td>
</tr>
<tr>
<td>Pollock</td>
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<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Red hake</td>
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<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Redfish</td>
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</tr>
<tr>
<td>Rosette skate</td>
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<td>N/A</td>
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<td>0</td>
</tr>
<tr>
<td>Silver hake</td>
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<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Smooth skate</td>
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<td>N/A</td>
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<td>2</td>
</tr>
<tr>
<td>Thorny skate</td>
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<td>N/A</td>
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<td>2</td>
</tr>
<tr>
<td>White hake</td>
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<td>2</td>
<td>2</td>
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</tr>
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<td>Windowpane flounder</td>
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<td>2+3</td>
<td>2+3</td>
</tr>
<tr>
<td>Winter skate</td>
<td>0</td>
<td>N/A</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Species</td>
<td>eggs</td>
<td>larvae</td>
<td>juvenile</td>
<td>adult</td>
</tr>
<tr>
<td>--------------------------</td>
<td>------</td>
<td>--------</td>
<td>----------</td>
<td>-------</td>
</tr>
<tr>
<td>Witch flounder</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Yellowtail flounder</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2+3</td>
</tr>
</tbody>
</table>

The numbers represent the highest available level of information available for each life history stage. Level "0" indicates that there is very little information available for this life history stage. "N/A" indicates that this does not exist as a distinct life history stage for this species. Please see the introduction (Section 1.0) for an explanation of the information levels.

### 3.1. Text Descriptions

The following methods were used to determine substrate types, depths, temperature, salinity, and prey information associated with all four life stages of each managed species in the inshore, continental shelf, and off-shelf spatial realms. All relevant information was summarized in a table and EFH text descriptions were written based on a synthesis of this information. In many cases, the same information was used to map habitat features that were used in the final spatial representation of EFH.

**Pelagic eggs and larvae**

**Inshore:**

Extract relevant information for all habitat characteristics from EFH Source Document (original version or recent 2nd edition) or Update Memo, or from other sources.

**Continental Shelf and Slope:**

In EFH Source Document (original version or recent 2nd edition) of Update Memo, determine minimum and maximum depth and average water column temperature (0-200 m) ranges from monthly 1978-1987 MARMAP (and 1995-1999 GLOBEC, if available) data, after discounting months with insufficient numbers of positive tows, based on intervals where the percentage of catches exceeds the percentage of tows made. In the example (), the depth range is 50-130 meters and the temperature range is 2-7°C (January and July-December were eliminated because of low numbers of positive tows). Because values shown on the X axis of the histograms represent the mid-points of the intervals, the lower limit of the minimum value and
the upper limit of the maximum value (40-140 meters and 1.5-7.5°C in this case) were used in
the text description.

Extract relevant information for salinity from EFH Source Document (original version or recent
2nd edition) or Update Memo, or from other sources.

Insert information on larval prey based on information in EFH Source Document (original
version or recent 2nd edition) or Update Memo.

**Figure 1.** Distributions of American plaice eggs. Collected during monthly 1978-1987 NEFSC MARMAP ichthypoplankton surveys relative to water column temperature and bottom depth. Open bars represent the proportion of all stations which were surveyed, while solid bars represent the proportion of the sum of all standardized catches (number/10 m²). Note that the bottom depth interval changes with increasing depth.
Benthic eggs

Inshore and continental shelf: Extract any relevant information from EFH Source Document (original version or recent 2nd edition) or Update Memo, or from other sources.

Benthic juveniles and adults

Inshore:

Determine minimum and maximum values of depth, bottom temperature, and salinity from analysis of data collected during all inshore (state) trawl survey tows in ten minute squares where at least 10% of the total number of tows caught any number of the species and life stage under consideration (see Alternative 3 mapping methods). These ranges were considered to represent habitat conditions that are correlated with presence (Level 1 information).

For coastal areas where a given species and life stage was considered to be “common” or “abundant” in the ELMR database, derive depth, bottom temperature, and salinity ranges from data (histograms) published in the appropriate EFH Source Document (original version or recent 2nd edition) or Update Memo, or in state survey reports, using the same method used for eggs and larvae (). (In this example, the depth range is 41-85 meters and the temperature range is 3.5-10.5°C). For surveys conducted at more than one time a year, the lowest minimum and highest maximum values were selected to represent an annual range. Survey data used for this analysis were from Massachusetts, Raritan Bay, Delaware Bay, and the lower Chesapeake Bay. These ranges were considered to represent habitat conditions that are correlated with relative abundance (Level 2 information), and were used in preference to Level 1 information whenever possible.

Figure 2. Distributions of juvenile American plaice and trawls in Massachusetts coastal waters.
Relative to bottom water temperature and depth based on fall Massachusetts inshore bottom trawl surveys (1978-2003, all years combined). Light bars show the distribution of all the trawls, dark bars show the distribution of all trawls in which American plaice occurred and medium bars show, within each interval, the percentage of the total number of American plaice caught.
Continental Shelf:

Analyze frequency distributions of fall and spring NEFSC trawl survey catch rates by depth and bottom temperature, to determine minimum and maximum values for benthic juveniles and adults during 1963-2003, using the same data that was used to create the GIS coverages for depth and temperature, and illustrated in Figure 3. Salinity ranges were based on the less restrictive percent catch exceeds percent tows method that was used with the egg and larval survey data (see ). For the text descriptions, the minimum and maximum values for the fall and spring were combined to create a single annual range.

Incorporate information on sediment types which overlap spatially with the highest catch rates of juveniles and adults for any given species and were included as one of the habitat features in the EFH maps (see explanation of methodology under mapping). Additional sediment types and substrate features identified in the EFH Source Documents and Update Memos, and in other sources such as Collette and Klein-MacPhee’s new edition of the Fishes of the Gulf of Maine, were also included in the text description.
Extract other relevant information on bottom features, depth, bottom temperatures, and salinity from the EFH Source Documents and Update Memos in order to supplement the information derived from survey data.

Insert information on larval prey based on information in EFH Source Document (original version or recent 2nd edition) or Update Memo, or information based on a recent analysis of the NEFSC food habits database.

Continental Slope and Rise:

For species and life stages that extend beyond the edge of the continental shelf, the text descriptions for depth extend to a maximum depth that was determined by consulting relevant deep-sea trawl survey reports and publications.

### 3.2. Map Representations

#### 3.2.1. Inshore

The EFH/Inshore analysis will rely on data and reports provided by states where appropriate and in consultation with the EFH Source Documents. If possible, state data will only be used as Level 2 (distribution/abundance) within each state where we have the raw fisheries data and as Level 1 (presence/absence) for those state or inshore waters where we were unable to acquire data or no fisheries data exist (fisheries-independent data). The PDT is recommending the inclusion of areas as EFH for those TMS that exceed a 10% frequency of occurrence for each managed species and life stage individually. Additionally, habitat ranges based on the records that successfully meet the 10% frequency of occurrence will be used in the EFH text descriptions; unless there is better information (see explanation of methods used to produce EFH text descriptions for alternative 3). Map 1 depicts the data that have been analyzed. ELMR information (see Alternative 1) for individual coastal embayments and estuaries will also be considered as a second source of information.
Map 1  State fisheries data acquired by PDT and being prepared for use in EFH designations.

**Benthic Life Stages**

**Distribution** maps will be made using state trawl survey data. The percentage of total positive tows in which juveniles and adults of each species was caught in each survey will be calculated by ten minute square. The distribution map will be those ten minute squares where the frequency of occurrence exceeds 10% for any of the state surveys. For species where ELMR data is available EFH will be designated in the estuaries where that species meets or exceeds a certain level of abundance as shown in Alternative 1.

**Geographic extent** of EFH alternatives will be mapped as the combined extent of the state trawl survey and ELMR distribution maps.

**Pelagic Life Stages**
No data on egg and larvae distribution are readily available for the inshore area. The data that are available are not consistent with regard to survey time periods, locations and spatial extent.

3.2.2. Shelf EFH

**Benthic Life Stages**

**Minimum and maximum depths and bottom temperatures** that are associated with the highest catch rates (number of juvenile and adult fish caught per tow) during the 1963-2003 NEFSC fall and spring trawl surveys will be estimated from survey data aggregated by intervals of 20 meters and 1 degree Centigrade. An example frequency distribution curve is shown in Figure 3. Minimum and maximum values for most life stages and species were determined for the fall and spring (separately) by selecting intervals that each represented approximately 50% or more of the modal value. Thus, in the example shown in Figure 3, the temperature range is 3-5 degrees, since the catch rates for each of the temperature classes in that range equals at least 50% (2.75 fish per tow) of the maximum catch rate (5.5 fish per tow) at 3 meters. Some judgment had to be used in the case of frequency distributions that were not uni-modal, or where the data were “noisy” without any clear maxima. In these cases, the 50% criterion had to be somewhat relaxed. These depth and temperature ranges were also considered along with minimum and maximum values derived from state survey data (see explanation of methods for text descriptions for details) and supplementary information from the EFH Source Documents and Update Memos to determine the ranges used in the EFH descriptions. **Depth** maps will be made using NGDC 2-minute gridded bathymetry data (ETOPO2) for the depth ranges derived from the NMFS trawl survey data. Spring and fall values will be mapped separately, and then their spatial extents combined. **Temperature** maps will be made using data complied from the NMFS MARMAP, hydrographic, and bottom trawl surveys (average fall, winter, spring and summer temperatures by TMS). Spring and fall values will be mapped separately, and then there spatial extents combined. This is generic information that applies to all EFH designation options in Alternative 3.

**Figure 3. Frequency distribution of average catch rates by 1 degree Centigrade intervals of bottom temperature for adult American plaice during 1968-2003 spring NEFSC trawl surveys.**

In this example, the temperature range used in the spring GIS temperature coverage was 3-5°C because the catch rates for those three values exceed 50% of the modal value (5.5).
Adult American Plaice
Spring NEFSC Survey, 1968-2003

Average number per tow vs. Bottom Temperature

24
**Bottom type / sediment** maps will be made using the U.S. SEABED (USGS) marine substrate database. Sediment types will be mapped according to the percentages of bottom samples classified as mud, muddy sand, sandy mud, sand, gravel, mud/sand with gravel, gravel with mud/sand, and rocky bottom in each TMS. TMS were considered to include any given sediment type if that sediment type accounted for 20% or more of the total number of samples in the TMS. Thus, a TMS with 100 sediment samples, 25 of which are classified as sand, 22 as mud, and 20 as gravel, will be considered to “contain” all three of those sediment types. (For this analysis, the term “gravel” refers to all grain sizes above a diameter of 2 mm, i.e., any sediment coarser than sand. “Gravel” therefore includes pebbles, cobbles, and even boulders. “Rocky bottom” refers to visual identification of bedrock on the seafloor, or to attempts to collect a sediment sample that failed because the bottom was so hard that no sample could be collected. Due to sampling limitations, rocky substrates are under-represented in the substrate database.) The sediment type or types associated with each species and life stage will be determined by analyzing which sediment types are correlated with different levels of abundance from the spring and fall NEFSC trawl surveys, and by examining the information in the EFH source documents. A positive correlation will be indicated when the degree of spatial overlap between a sediment type and TMS that account for the 25, 50, and 75% cumulative survey catch rates for the life stage and species in question averages at least 25%. Additional sediment types mentioned in the source documents that are clearly associated with a life stage and species, but were not revealed to be important in the analysis, will be added to the sediment GIS layer for mapping. No bottom type maps will be produced for life stages and species that do not have a well-defined sediment preference.

**Distribution** maps will be made using 1968-2005 NEFSC fall and spring survey data for the 25th, 50th, 75th, and 90th percentiles of cumulative abundance. The method used to compile the data and calculate average CPUE for each TMS will be the same as was used in 1998 (see Alternative 1 – No Action) except that catch rates for each tow, after being log-transformed (ln (x+1)) and averaged for each TMS, will be re-transformed into units of numbers of fish per tow before being mapped. Any TMS which occurred entirely within select survey strata that were poorly sampled were neither included in these calculations nor mapped. (This included areas south of Cape Hetaeras, in Canadian waters off Nova Scotia and on the entire Scotian Shelf.) For species that are separately managed by Canada (Cod, Haddock, Herring, Winter and Yellowtail Flounders) all TMS entirely within Canadian waters were removed from the analysis. Also, 1963-1967 fall survey data will not be used because there are no spring data for those years.

A **habitat map** will be made by calculating the overlapping area of the maps of the appropriate habitat variables for a given species and lifestage. Once created, the habitat map will be combined with each of the individual CPUE survey maps (25, 50, 75, and 90% options) to produce a set of four EFH alternative maps. For a given CPUE percentage the added habitat will be limited to the spatial extent of the next highest CPUE percentage. This ensures that added habitat occurs in areas of abundance consistent with the alternative. As a final step,
portions of designated TMS that are outside the depth range given in the EFH table will be eliminated.

Geographic extent of EFH alternatives will be mapped as the combined area of the Distribution and Habitat maps.

Pelagic Life Stages

Because there is no new information available for species with pelagic eggs and larvae, or for the pelagic larval, juvenile, and adult life stages of Atlantic herring, there will be no alternative 3 designation options for these life stages. New text descriptions for the pelagic life stages were developed, however, and will apply to the alternative 2 designation options.

Note: Alternative 3 EFH maps will be produced for benthic eggs of winter flounder, Atlantic herring, and for eggs and larvae of ocean pout.

3.2.3. Off-Shelf EFH

Available information regarding depths occupied by juvenile and adult life stages will be derived from survey data, EFH source documents and other sources. It will not be specific to any particular level of abundance (option). Information will be obtained from all available sources, but is likely to be incomplete. For text descriptions, focus will be on the maximum depths not represented in data for the shelf. All off-shelf distribution information will be Level 1 presence only information.

Benthic Life Stages

Distribution maps will be made of the presence of managed species using all available sources.

Geographic extent of EFH alternatives will be mapped as the off-shelf depth and latitudinal range which the species is believed to occupy based on an evaluation of available deep-sea survey reports and data, and relevant publications.

Pelagic Life Stages

No additional data on egg and larvae distribution is available for the off-shelf area. All EFH designation options for pelagic eggs and larvae are limited to alternatives 1, 2, and 4.
4.0 ALTERNATIVE 4 – SPECIES RANGE

The alternative designates EFH as the range of the species. This is represented in EFH maps by the union of the several maps used previously. The 100% CPUE from the NMFS trawl survey using the same methods as in Alternative 2. Also, the state trawl survey data above the 10% frequency of occurrence threshold combined with ELMR data as used in Alternatives 2 and 3 for inshore designations. Finally the offshelf designation from Alternative 3 is used if created for the species.

5.0 SPECIAL EXCEPTIONS

Special Considerations for Individual Species EFH Designation Alternatives:

- **Atlantic Halibut**: Only 1 Alternative 3 map was made. It shows the 90% CPUE and habitat layer bounded by the historic range of the species, rather than the 100% CPUE.

- **Atlantic Sea Scallops**: An Alternative 3E was created that combines the 90% CPUE with an unbounded habitat (no restricting to TMS where the species was caught in the survey). This was done because the PDT thought Alternative 3D covered insufficient area.

- **Barndoor Skate**: Due to low catch rates for adults juveniles were used as a proxy for adults in Alternatives 2-4.

- **Deep Sea Red Crab**: Two Alternative 2 designations were made. One in which a polygon was drawn to included all of Bear Seamount in the EFH designation. The other only included those parts that are within the depth range used for EFH designation.

- **Rosette Skate**: Due to low catch rates for adults juveniles were used as a proxy for adults in Alternatives 2-4.

- **Winter Flounder**: Mapped depth range of 0-50m for juveniles and 2-60 for adults at PDTs recommendation. This was done because the coastal waters are very important to this species.