8.0 Description of the Resource and the Affected Environment

8.1 Description of the Species

The deep-sea red crab (*Chaceon quinquedens*) is a deep-water species of brachyuran crab (Family *Geryonidae*) that inhabits deep waters of the continental shelf and slope off the Atlantic coast of the U.S. Geryonid crabs are true deep-water species found in all oceans. Geryonid crabs occur from approximately 100 meters to more than 2800 meters in depth. The family contains three genera: *Geryon* proper; *Chaceon*; and *Zariquieyon*. *Chaceon* contains 11 species previously placed in *Geryon* (including *C. quinquedens*). Most species in this genus are either red or tan (the South Atlantic "golden" crab is actually of the tan variety) (Manning 1990). Generally, red species live in deeper water than tan ones, young crabs live in considerably deeper waters than adults, and the geographic ranges for these species tend to be limited rather than cosmopolitan (Manning 1990).

8.1.1 Life History Characteristics

The following description of the life history of the deep-sea red crab is in part excerpted from the essential fish habitat (EFH) source document for red crab (Steimle et al. 2001). The EFH source document is provided as Appendix A and contains a comprehensive description of the red crab life history, as well as a detailed description of the environment in which red crabs occur and the habitat characteristics of the red crab.

The red crab, like most deep-sea organisms, is slow growing but reaches a maximum size of about 180 mm carapace width (CW), and may live for 15 years or more, although precise information on growth rate and life span are lacking (Serchuk and Wigley 1982).

As for most decapod crustaceans, red crab eggs are ovipositioned and held *en masse* on the female pleopods under their abdominal flap for up to nine months until the eggs hatch and the larvae are released into the water column (Haefner 1978). Mature eggs are large and yolky for crustaceans and range in diameter from 484 to 846 μm, and are thought to be the largest eggs known for crabs with planktonic development (Haefner 1977, 1978; Hines 1982, 1988).

Much of what we know about the development of the larval stage of red crabs comes from eggs that were collected from captured females and then hatched and raised in laboratories. Larval development was observed to consist of four zoeal stages and a final megalopa. The zoea is typical in appearance to most brachyurans, i.e., with a large dorsal spine, and the megalopa is also of a typical crab form (Perkins 1973). The larval stages of this species are relatively large in size compared to other brachyuran crabs (Sulkin and Van Heukelem 1980). Kelly et al. (1982) estimated that, depending upon the water temperatures and food encountered during development, the red crab larvae require about 23 - 125 days from hatching until the megalopa settle. Red crab larvae appear more nutritionally flexible than more shallow-water crab species, and appear to have no difference in survival when presented with different diets in the lab (Sulkin and Van Heukelem 1980). Sulkin and Van Heukelem (1980) suggest that nutritional flexibility may be an evolutionary adaptation for survival in deep waters.

Settlement of juvenile red crabs is reported at a relatively large first post-megalop instar stage, about 4 mm CW (Van Heukelem et al. 1983). This large size at settlement may be an adaptation to slow post-settlement growth, in that a large size at settlement will reduce the time and number of instars required to reach maturity (Hines 1986, 1990). Growth of juveniles is also partially temperature dependent, as Van Heukelem et al. (1983) reported that juvenile crabs maintained at 9 - 15° C grew six times faster than those maintained at 6° C, and at least five molts are required to grow to about 20 mm CW. Juvenile red crabs are most abundant from 700 - 1800 meters in depth (Hastie 1995; Steimle et al. 2001; Wigley et al. 1975). It is interesting to note that although juvenile red crabs appear to grow much faster at higher temperature (Van Heukelem et al. 1983), the actual bottom temperature where juvenile crabs are found is less than 5° C[23].

Haefner (1978) and Van Heukelem et al. (1983) suggest that the red crab requires 18 - 20 molts before it reaches its maximum size of about 180 mm CW. Based on tagging studies, older crabs might molt infrequently, and intermolt periods can be 6 - 7 years for larger crabs, > 100 mm CW (Gerrior 1981; Lux et al. 1982). After a molt, carapace size may be increased by about 7 - 12% and body weight by about 33% (Serchuk and Wigley 1982). Adults are largely segregated by sex, with females shallower than males. Overall, adult red crabs occupy depths ranging from 200 - 1300 meters and occur in the highest concentrations between 320 - 914 meters (Wigley et al. 1975).

Because of the long intermolt period for adult females (5 - 7 years), and the assumption that like most other brachyurans fertilization only occurs at molting, it has been speculated that red crabs may not spawn annually. It is possible that sperm could be stored for intermolt spawning efforts; thus there can be annual brooding within the population, although not for every mature individual (Hines 1982; Lux et al. 1982; Erdman et al. 1991; Biesiot and Perry 1995). Haefner (1977) reports the size at maturity of red crabs off Virginia was between 80 - 91 mm CW. Several studies reported ovigerous crabs between 80 - 130 mm CW (Wigley et al. 1975; Haefner 1977; Hines 1988), although some egg-bearing red crabs were observed as small as 61 mm CW (Elner et al. 1987).

Mating behavior is considered typical of other crabs (Hastie 1995). Elner et al. (1987) studied the mating behavior of the red crab. Male crabs form a protective pre-copulatory "cage" around the female until she molts. Copulation takes place once the female molts and the male continues to hold onto and protect the female for an extended period (1 - 2 weeks) until the female's shell hardens. Males do not actually carry females prior to their molt, but they do carry females afterward. Prolonged protection of the female serves to ensure the survival of the female during her fragile molt period and

[23] In fact, Wigley et al. (1975) found no juvenile red crabs in temperatures greater than 6° C.

ensures the male's paternity. Both males and females can apparently mate more than once; males by repeating the mating process with multiple partners and females if they are released by the first male while they are still in a soft shell state (Elner et al. 1987).

Eggs of the red crab are the largest known among brachyuran crabs with planktonic development (Hines 1988). Hines (1988) studied the fecundity and reproductive output of red crabs. The body size of female brachyuran crabs is the primary determinant of fecundity. Larger females produce larger brood masses and have greater fecundity per brood than smaller crabs. For most brachyurans, brood weight, on average, is constrained to approximately 10% of female body weight by the space available for yolk accumulation. Red crabs have larger brood masses as a percentage of body weight than most other brachyurans, with brood masses equaling as much as 22% of body weight (Hines 1988). Red crabs also have larger eggs than other crab species, but have relatively low fecundity (160 - 275 thousand eggs per red crab female compared with 1 - 3 million eggs per female for similarly sized crabs) (Hines 1988). The large eggs of this species may help provide nutritional flexibility to the larvae hatched in the deep-sea.

8.1.2 Distribution

Deep-sea red crabs are patchily distributed along the continental shelf edge and slope of the western Atlantic, occurring mostly between 200 and 1800 meters from Emerald Bank, Nova Scotia (and into the Gulf of Maine) and along the continental slope of the east coast of the U.S. into the Gulf of Mexico (Pequegnat 1970; Williams and Wigley 1977; Elner et al. 1987). Previous reports of the occurrence of *Geryon (Chaceon) quinquedens* off West Africa and elsewhere outside of the western North Atlantic continental shelf edge and slope (including Bermuda, Brazil, and Argentina) were found to involve several new geryonid species or mis-identifications (Manning and Holthuis 1981, 1986, 1989). The species' distribution in the depths of the Caribbean Sea, around the West Indies Islands, and off northeastern South America remains uncertain (R. Manning, National Museum of Natural History, Smithsonian Institution, Washington DC, personal communication, January 2000).

As noted above, deep-sea red crabs are distributed along the edge of the continental shelf and on the continental slope from the Scotian Shelf and the Gulf of Maine to at least the coast of Florida and into the Gulf of Mexico. The species is also reported to occur in the deep-water canyons along the coast, such as Norfolk, Hudson, Hydrographer, and Oceanographer Canyons (see Figure 17). The species appears constrained by depth to a fairly narrow band from about 200 meters in depth to as deep as 1800 meters. Density is not known across this depth range (Wigley et al. 1975). The maps on the following pages display the variety of depth ranges known to be occupied by red crabs (Figure 18 - Figure 21).

The larvae of this species are pelagic and occur in warmer and lower salinity surface waters above the continental slope habitat frequented by adult females (Steimle et al. 2001). Post-larval red crabs are primarily inhabitants of the silty seabed of the deep cold water on the outer continental shelf and mid to upper continental slope of the western North Atlantic, south of the Gulf of Saint Lawrence (Canada), into the partially rocky Gulf of Maine, and along the continental shelf edge and slope into the Gulf of Mexico, and possibly the northwestern South Atlantic. These crabs are considered part of an assemblage of deep-water crustaceans that inhabit the mid to upper continental slope of the northwest Atlantic, and this assemblage includes a number of smaller shrimp and crabs (Wenner and Boesch 1979). Salinities on the upper slope where benthic red crabs occur tend to be stable and oceanic at about 35-36 ppt (Schmitz et al. 1987). The thermal regime can be more variable, ~ 4-10ºC, and include the temporary warming effects of the passage of an inshore loop of the Gulf Stream along the upper slope and shelf edge.

The NEFSC bottom trawl surveys collect small quantities of benthic red crabs; these surveys are typically restricted to depths less than 366 meters on the upper slope, although they occasionally trawl in deeper canyons (Reid et al. 1999). Fishery independent information of red crab distributions below this NEFSC bottom trawl survey depth limit are only available from infrequent, special surveys, such as those reported by McRae (1961), Haefner and Musick (1974), Wigley et al. (1975) or Hecker (1983).

In the Northeast, adult red crabs occur along the continental shelf edge and upper slope from the Scotian Shelf and the Gulf of Maine to Cape Hatteras (Serchuk and Wigley 1982). The species also occurs south of Cape Hatteras into at least the Gulf of Mexico at similar depths. The NEFSC bottom trawl survey data (1964 - 1999) were examined for the occurrence of red crabs above the 366 meter depth limitation of the survey. Adult red crabs were segregated into two groups for analysis: below harvestable-size (small) adults (8-11 cm CW) and large adults at or above the commonly used harvestable size of 11 cm CW (see Figures 6 and 7 in Appendix A). The small adults were not collected during the winter bottom trawl surveys and only a few were collected in the summer surveys within and around the perimeter of the Gulf of Maine, but during the spring and fall surveys, they were collected in minor to moderate numbers both within the western Gulf of Maine and along the outer continental shelf between southern Georges Bank and Norfolk Canyon. The larger, harvestable adults were collected in a similar pattern, although fewer of the larger crabs were collected within the Gulf of Maine during the spring and fall trawl surveys.

As previously noted, there may be an inverse relationship between body size and depth for adults (Wigley et al. 1975). Stone and Bailey (1980) reported that large crabs were only collected at 180-360 meter depths on the Scotian Shelf. In the Gulf of Mexico, red crabs were not commonly collected above the 677 meter depth zone; temperature or bottom sediment type could be prime factors controlling their distribution in the Gulf of Mexico (Lindberg et al. 1990; Lockhart et al. 1990). From around Cape Hatteras into the Gulf of Mexico, red crabs may partially overlap the distribution of a larger congenetic species, the golden crab (*C. fenneri*, previously called *Geryon affinis*), that was noted to occur uncommonly off southern New England as well (Wigley et al. 1975).

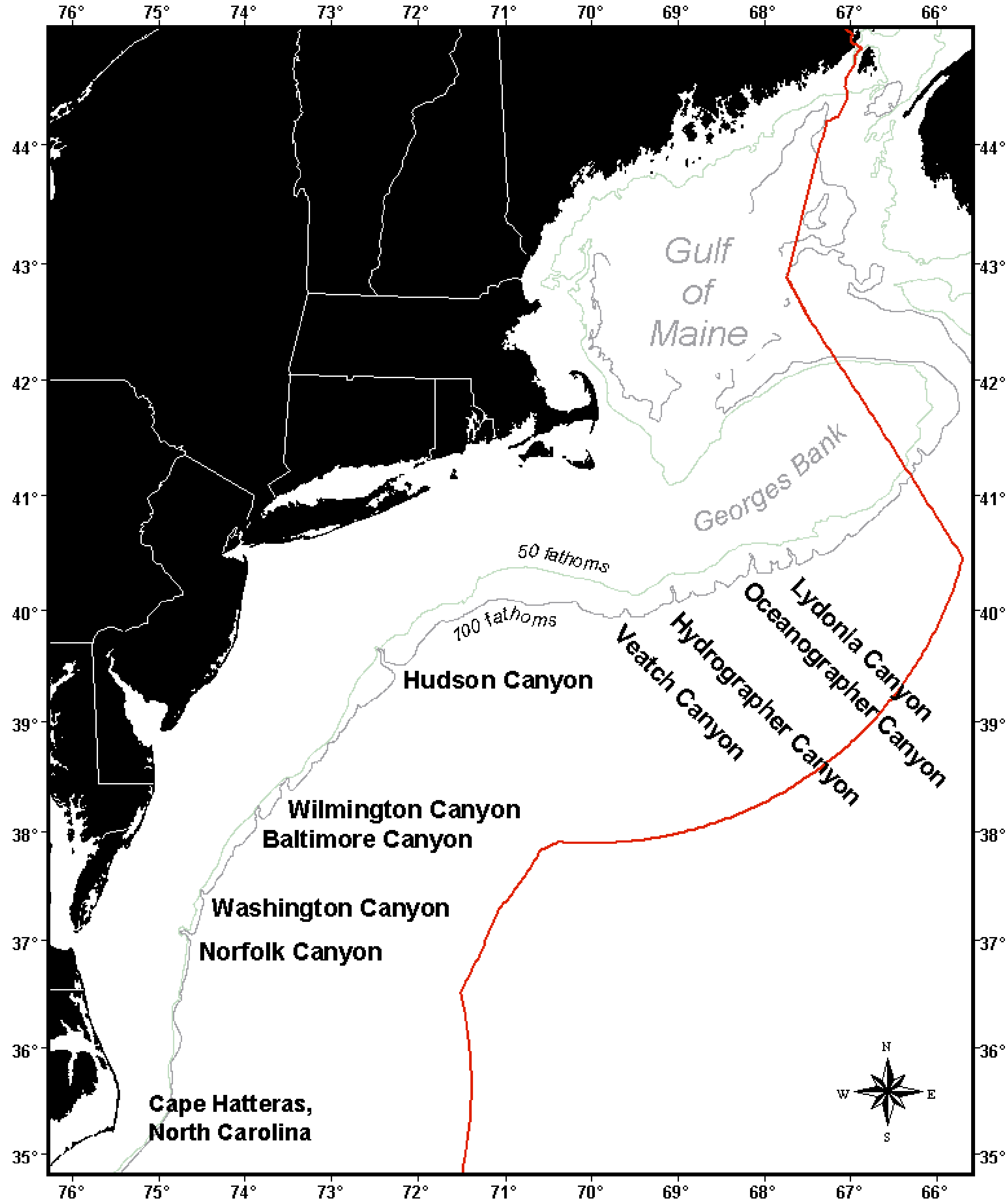

Figure 17: Map of the major offshore canyons in the area of the red crab fishery.

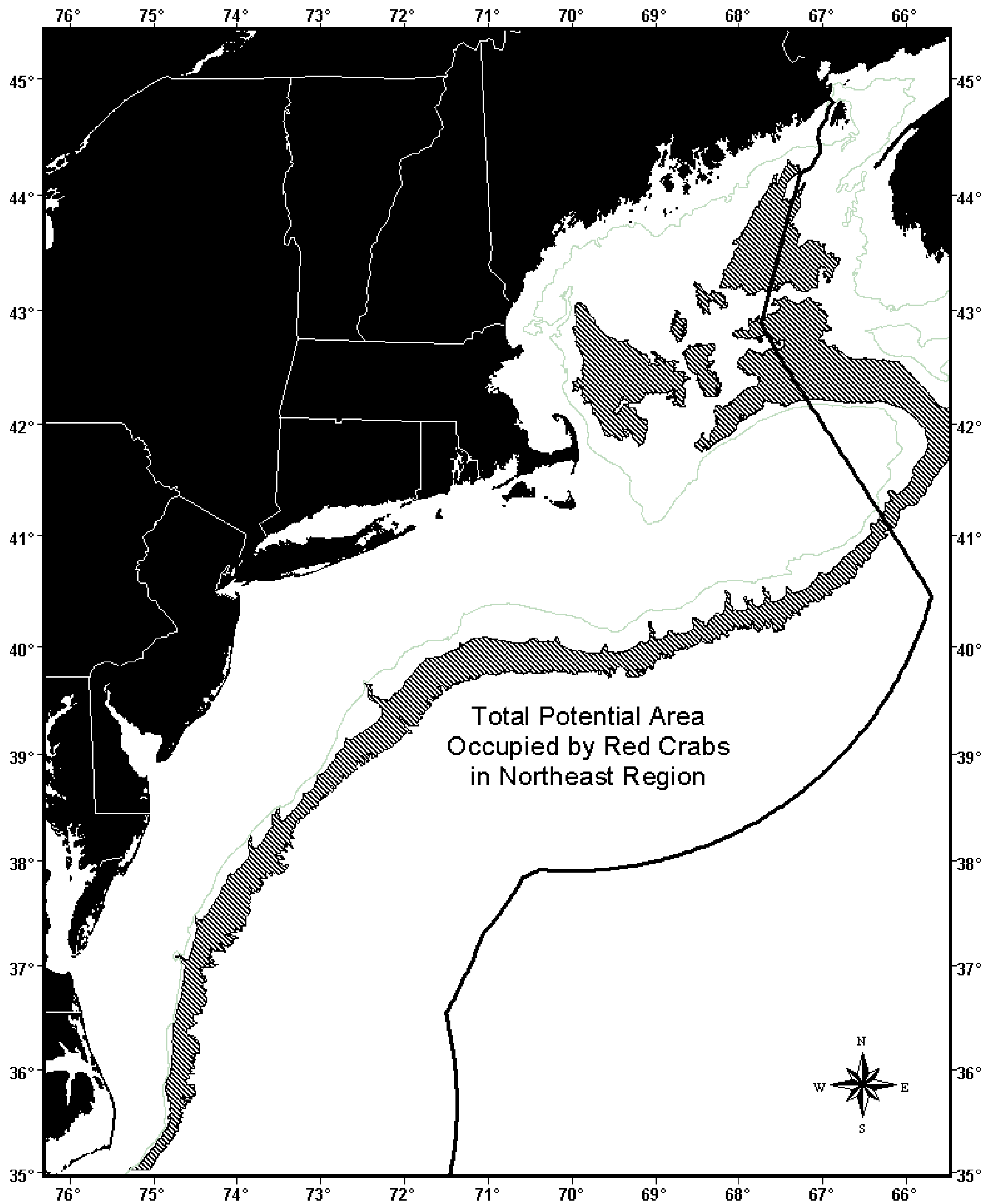

Figure 18: Map of total area (based on depth, 200 - 1800 meters) where red crabs may occur in the Northeast Region.

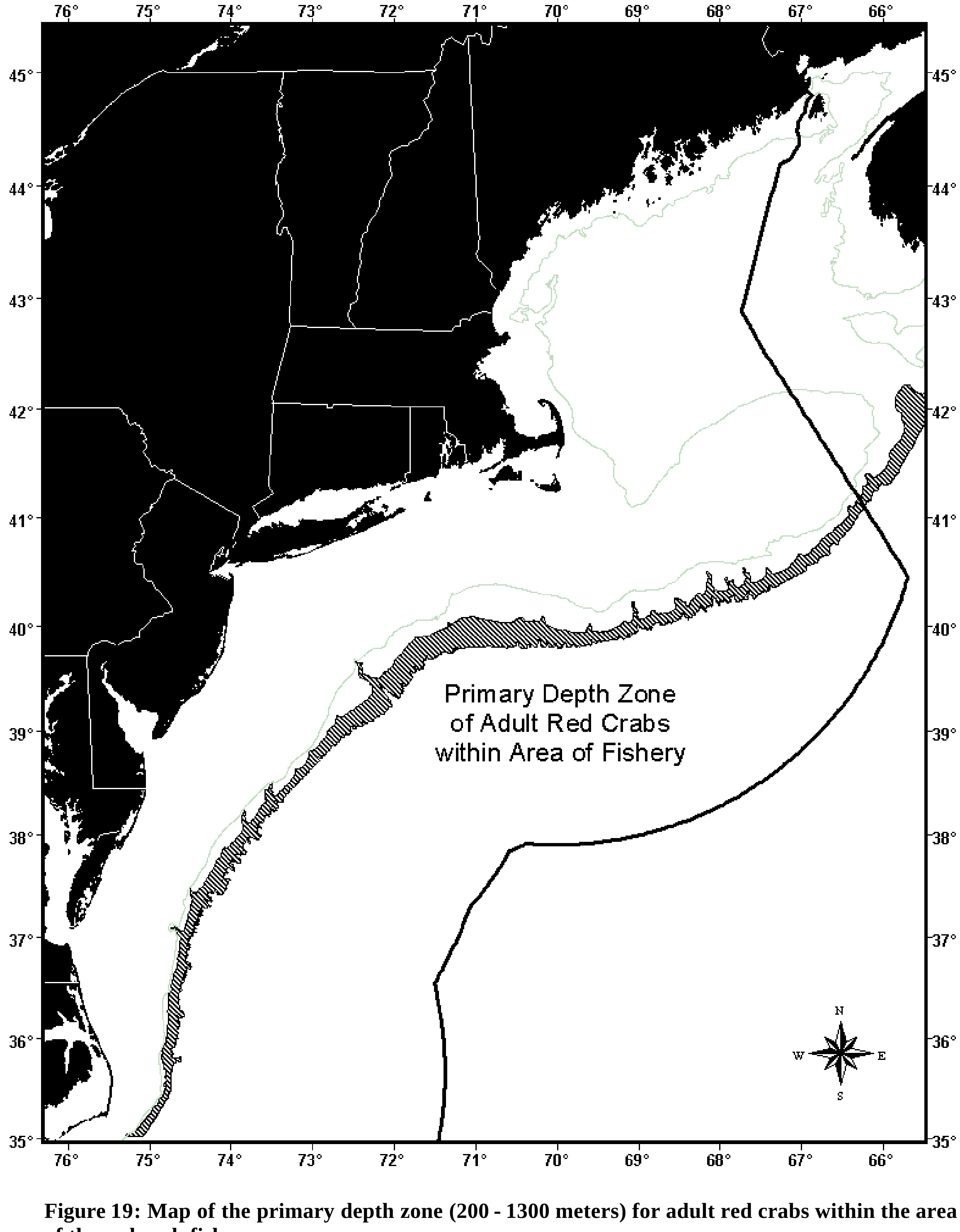

Figure 19: Map of the primary depth zone (200 - 1300 meters) for adult red crabs within the area of the red crab fishery.

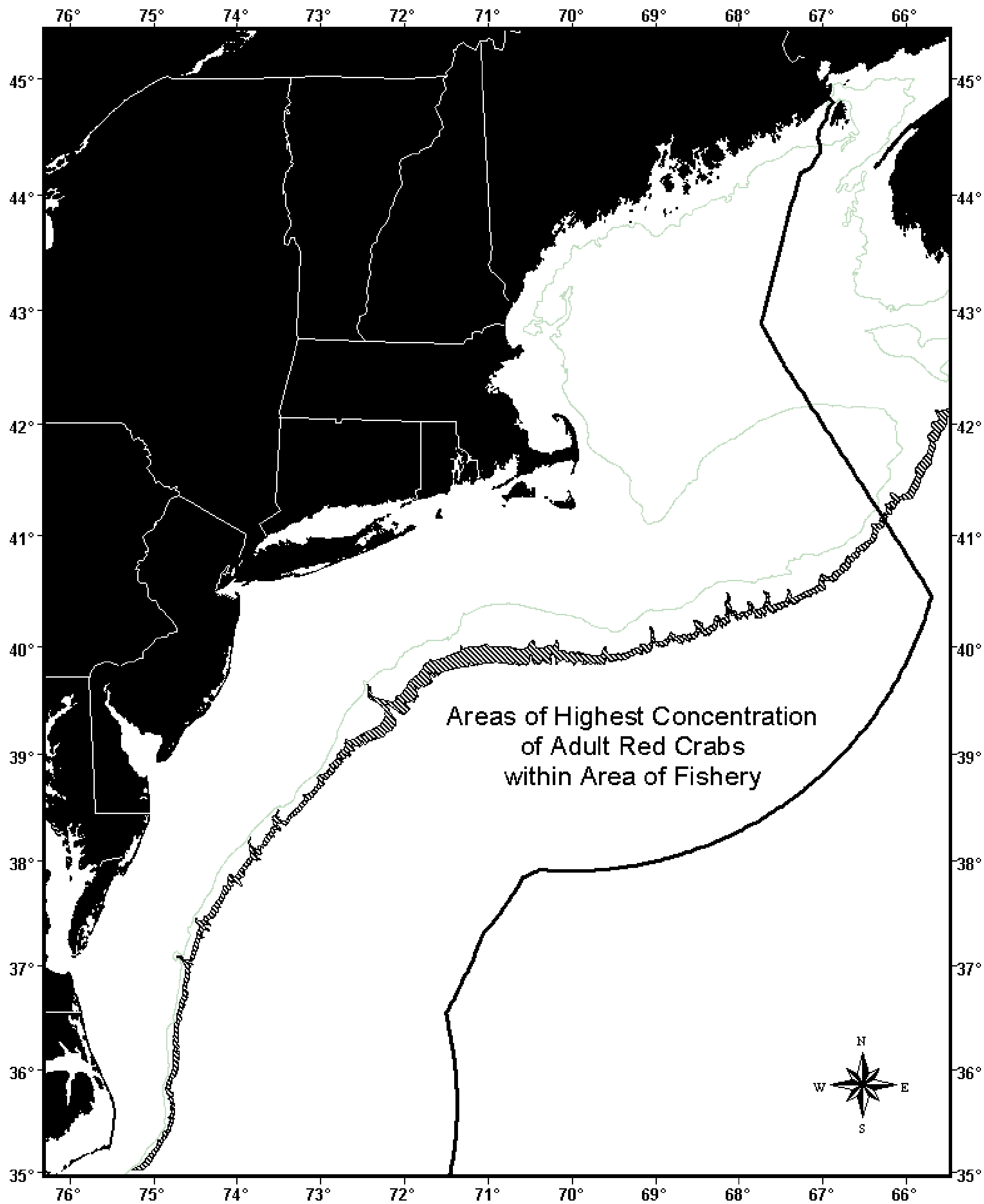

Figure 20: Map of the area of highest concentration (320 - 914 meters) for adult red crabs within the area of the red crab fishery.

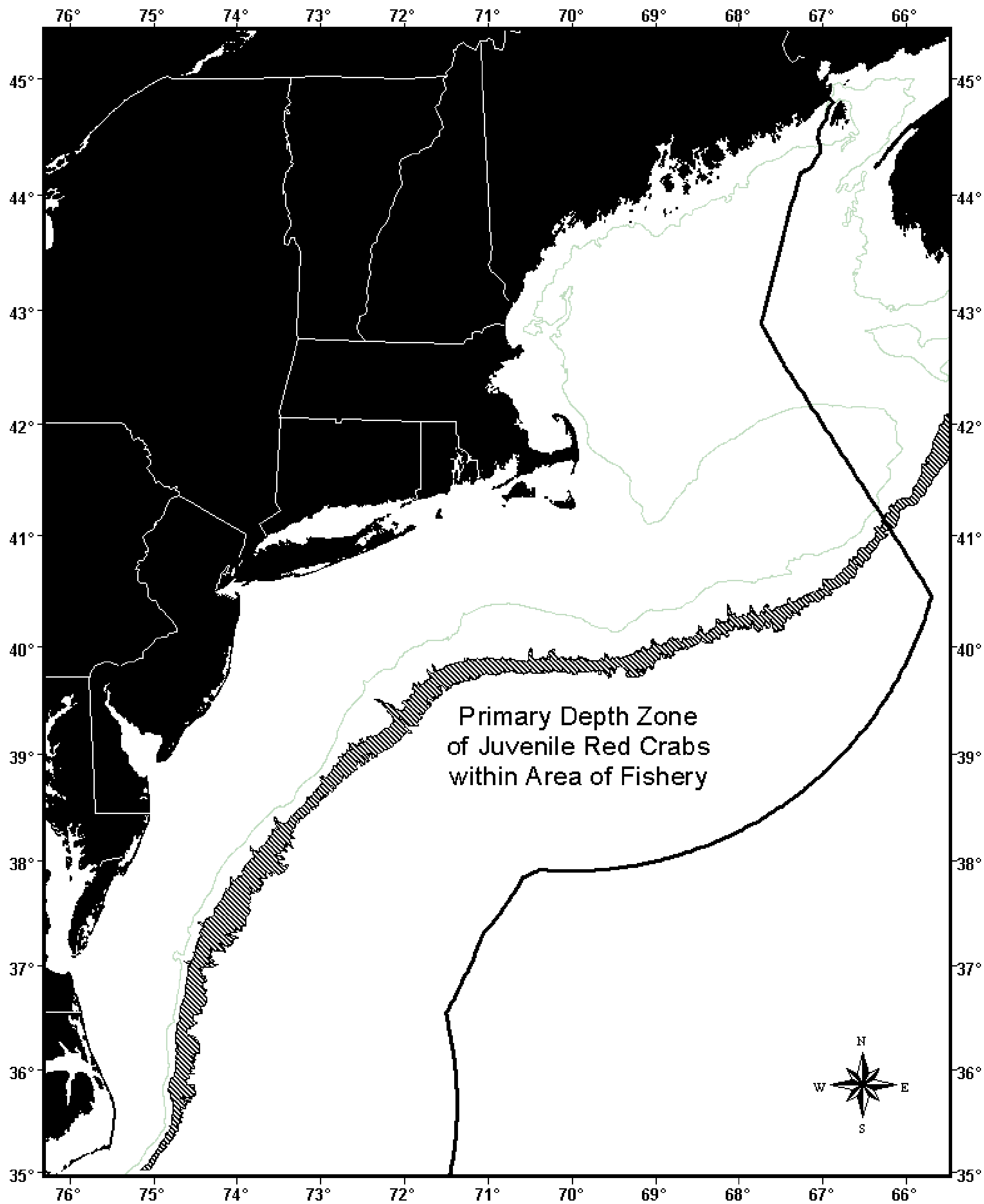

Figure 21: Map of the primary depth zone (700 - 1800 meters) for juvenile red crabs within the area of the red crab fishery.

8.1.3 Abundance and Present Stock Condition

8.1.3.1 Total and Commercial Biomass

See Section 3.4 for a discussion of estimates for total and commercial biomass for the red crab stock to be managed under this FMP.

8.1.3.2 Present Stock Condition

The lack of fishery-independent data on the red crab resource presents a real challenge to the Council, as we have no current estimates of red crab biomass to be used to determine the present stock condition. The NMFS bottom trawl survey only occasionally captures any red crabs (Steimle et al. 2001) and these appear to occur at the shallowest fringe of their habitat. Red crabs are known to occupy depths from 200 - 1800 meters, but the highest densities and biomass occur between 320 - 910 meters (Wigley et al. 1975 and Steimle et al. 2001). The NMFS otter trawl survey does not tow deeper than 366 meters (Reid et al. 1999).

There are plans for a survey to be conducted sometime in the next two to three years. The proposed survey would be conducted independently of NMFS in a joint venture by several area scientists and members of the red crab fishing industry. Depending on how the survey is designed and implemented, the resulting data may be comparable with the 1974 Albatross IV survey and therefore useful in developing an index of biomass. Unfortunately, the timing of the proposed survey is such that the earliest at which we could assess the current stock condition using biomass data would be 2004 - 2005.

8.1.4 Ecological Relationships

8.1.4.1 Predator-Prey Relationships

As reported in Steimle et al. (2001), there is little indication that red crab constitute a major prey item for any species. There are a few records of predation on red crabs, but these appear only as minor components of prey sources (Steimle et al. 2001). Also, there are few records of red crab prey sources. Gray (1969) and Beyers et al. (1980) both report some observations and suggest a variety of food sources eaten by red crabs. Sea anemones may be a desired prey (Gray 1969), but most likely red crabs are opportunistic omnivores due to the limited availability of food at the water depths common for this species (Beyers et al. 1980; Steimle et al. 2001).

8.1.4.2 Other Affected Fishery Resources

Steimle et al. (2001) describes few competitive interactions between red crab and any other fishery resources. The primary competitive interactions involve Jonah crab, *Cancer borealis*, American lobster, *Homarus americanus*, and golden crab, *Chaceon fenneri*, but none of these appears significant.

8.1.4.3 Marine Mammals and Protected Species

There is no information in any of the available literature reviewed for this FMP that suggests red crabs are a significant, or even a minor, component of the diets of any marine mammals or endangered species.

8.1.5 Probable Future Condition

Deep-sea red crabs are a long-lived and slow-growing species with delayed maturity (Steimle et al. 2001). Their reproductive biology is likely to result in infrequent and periodic recruitment. The current biomass of red crabs in the management area is unknown. Given these life history characteristics and the data poor situation, conservative management is appropriate to guard against overfishing.

The number of vessels interested in fishing for red crabs full-time has increased 100% in the last two years and is likely to continue to increase in the near future without conservative management that controls access to the fishery. Without some form of management action that constrains fishing effort and harvests of red crab in this fishery, it is likely that overfishing will occur. During the first emergency period (May 18 - November 14, 2001), 2.825 million pounds were harvested and the fishery shut down on August 17, 2001. If this level of effort was sustained year-round, expected landings would equal 11.3 million pounds -- more than twice the baseline estimate of MSY.

This species is not likely to be able to sustain the high fishing mortality that would result from a fleet as large as is likely to engage in the directed fishery; however, if the management measures proposed in this FMP are adopted and implemented in a timely manner, the fishing effort would be expected to stabilize at a sustainable level and the stock would be less likely to be overfished or subject to overfishing.

8.1.6 Life History Information and Research Needs

The essential fish habitat source document describing the red crab life history and habitat characteristics provided in Appendix A (Steimle et al. 2001), includes a description of information and research needs for this species. As this document suggests, there is a lot more that needs to be learned about the distribution of the species at all life history stages, the variability and trends in population abundance and dynamics, and a way to adequately sample larval stages. The most important information and research needs for this species includes:

- age-size relationships;
- durations of intermolt periods for all size classes;
- fishing mortality rates and natural mortality rates for all size classes;
- mortality of discarded crabs caught in the directed fishery;
- yield per recruit information;

- upslope and lateral migrations (including spawning or size-related);
- larval dispersal patterns and testing of larval dispersal models;
- genetic comparison of the Northwest Atlantic and the Florida/Gulf of Mexico populations;
- when and where females primarily spawn and the possibility of sperm storage by intermolt females;
- role of sex ratio and male size on fertilization success;
- a cost-effective approach to conducting stock assessment surveys for this species; and
- standardized size measurements.

8.2 Description of the Habitat

8.2.1 Description of the Physical Environment

8.2.1.1 Description of the Geological Environment

The deep-sea red crabs are most often associated with the continental slope of the Atlantic coast of North America, from 200 - 1800 meters of depth, between Emerald Bank, Nova Scotia (and into the Gulf of Maine) and in the Gulf of Mexico. The continental slope extends from the shelf break to water depths of about 2000 meters. The slope is the most prominent and complex physiographic feature along the Atlantic coast (Tucholke 1987). The continental slope has a low gradient (3 - 6º) but is steeper than other provinces of the continental margin. The slope is divided into three segments, each different in character: Georges Bank to Cape Hatteras; Florida-Hatteras Slope south of Cape Hatteras; and the Blake Escarpment. For the purposes of this FMP, we will focus on a description of the Georges Bank to Cape Hatteras segment, which comports with the red crab management unit.

The morphology of the present continental slope largely appears to be a result of sedimentary processes that occurred during the Pleistocene, including:

(1) slope upbuilding and progradation by deltaic sedimentation principally during sea-level low-stands;

(2) canyon-cutting by sediment mass movements (slides, debris flows, turbidity currents) during and following low-stands; and

(3) sediment slumping (Tucholke 1987).

The top of the continental slope in the Georges Bank and Cape Hatteras region is the shelf break, which occurs at depths between 40 and 160 meters. The shelf break includes old shorelines developed during the Pleistocene Era when the sea levels reached their lowest levels (Tucholke 1987). These old shorelines are most clearly defined in the areas between Hudson Canyon and Norfolk Canyon.

The base of the slope is defined by a marked change in seafloor gradient where the continental rise begins. This occurs near 2000 meters in depth, but can actually vary 200-300 meters either way (Tucholke 1987). The gradient of the seafloor on the continental slope along its entire range averages between 3° and 6°, and averages 8° on the steepest segments (Tucholke 1987).

North of Cape Hatteras, the continental slope contains many submarine canyons. There are at least 70 large canyons and many smaller gullies between Cape Hatteras and the northeast peak of Georges Bank (Figure 17 displays some of the major named canyons in this area). The canyons are not spaced evenly along the slope, but tend to decrease in areas of increasing slope gradient. Canyons are typically "V"-shaped in cross section and often have steep walls and outcroppings of bedrock. The canyons are continuous from the canyon heads to the base of the continental slope. Some canyons stop at the base of the slope, but some continue as channels onto the continental rise. Larger and more deeply incised canyons are generally significantly older than smaller ones, but there is also evidence that some older canyons have experienced several episodes of filling and re-excavation (Tucholke 1987). Many, if not all, of the submarine canyons may first form by mass-wasting processes on the continental slope, although there is evidence that some canyons formed as a result of fluvial drainage (i.e., Hudson Canyon).

8.2.1.2 Description of the Biological Environment

The fauna of the deep-sea are generally divided into three classes, based on size and taxonomy: megafauna, macrofauna, and meiofauna. Megafauna are the largest class and are defined as animals visible in photographs; macrofauna are an intermediate size class; and meiofauna are the smallest animals, including copepods and nematodes. Polychaetes represent the most important deep-sea group in terms of numbers of individuals and species. Gastropods do not appear to be very abundant in the deep sea, but past studies have not collected enough individuals for large-scale community and population studies (Wiebe et al. 1987).

Ophiuroids are considered to be among the most abundant deep-sea organisms, but there are actually only a few species of this group. The taxonomic group with the highest species diversity includes the peracarid crustaceans represented by Amphipoda, Cumacea, Isopoda, and the Tanaidacea (Wiebe et al. 1987). Some species in the deep-sea are widely distributed and others appear to be restricted to particular ocean basins. The ophuiroids and bivalves appear to have the broadest distributions, while the peracarid crustaceans mentioned above appear to be highly restricted because they brood their young and lack a planktonic stage of development (Wiebe et al. 1987).

There is evidence that Cape Hatteras may be a geographic boundary for upper slope fauna along the east coast of the U.S. (Cutler and Doble 1979). This may provide additional rationale for using Cape Hatteras as the southern boundary of the red crab management unit.

In general, fauna occupying hard-surface sediments in the deep-sea are not as dense as in comparable habitats in shallow water (Wiebe et al. 1987). The canyons, however, may develop a lush epifauna. Hecker et al. (1983) found faunal differences between the canyons and the slope environments, due at least in part to increased environmental heterogeneity. At depths of less than 800 meters, the fauna are extremely variable and the relationships between faunal distribution and substrate, depth, and geography are less obvious (Wiebe 1987). Hecker et al. (1983) found highly patchy faunal assemblages in the canyons and that there are additional faunal groups located in the canyons that do not appear to occur on the slope environment (mainly associated with hard substrates).

Prior to studies conducted in the late 1960's, the species diversity of the deep-sea was believed to be low (Wiebe et al. 1987). Several studies conducted in the late 1960's indicated greater diversity of the entire fauna of the continental slope compared with the continental shelf (Sanders 1968; Sanders and Hessler 1969; Grassle 1967, 1972). It is now known that the species diversity of most groups increases from the shelf to the intermediate depths of the slope and then declines in the deeper waters of the continental rise and plain (Rex 1981; Wiebe 1987). Diversity of megafauna also appears greatest at intermediate depths (1000 - 3000 m) (Haedrich et al. 1975, 1980).

Haedrich et al. (1980) studied the benthic megafauna in the deep waters of the continental slope off southern New England. The authors identified several distinct faunal assemblages according to depth zone, and ranked the top ten species by weight and by number in each depth zone. The results of the Haedrich et al. (1980) study as they apply to red crabs can be summarized as follows:

- Shallower than 254 meters, red crabs were not in the top ten by either weight or number.
- Between 283 - 650 meters, red crabs were eighth in number (0.3% of the total number of organisms observed) and first in weight (biomass of red crab = 43% of the total biomass of benthic megafauna).
- Between 653 - 1290 meters, red crabs were second in number (17% of the total number of organisms) and first in weight (51% of the total biomass).
- Deeper than 1290 meters, red crabs were not in the top ten in numbers and ranked tenth in weight in the 1380 - 1947 meter depth zone (2% of the total biomass).

8.2.1.3 Description of the Oceanographic Environment

There are several elements of the oceanographic environment that affect the continental slope where deep-sea red crabs live. From the coast seaward, there is coastal water, the Western Boundary Undercurrent,[24] slope water, the Gulf Stream, warm and cold core rings, and the Sargasso Sea (see Figure 22). The oceanographic environment over the continental slope and rise changes dramatically at Cape Hatteras, North Carolina, where the Gulf Stream diverges from the coast.

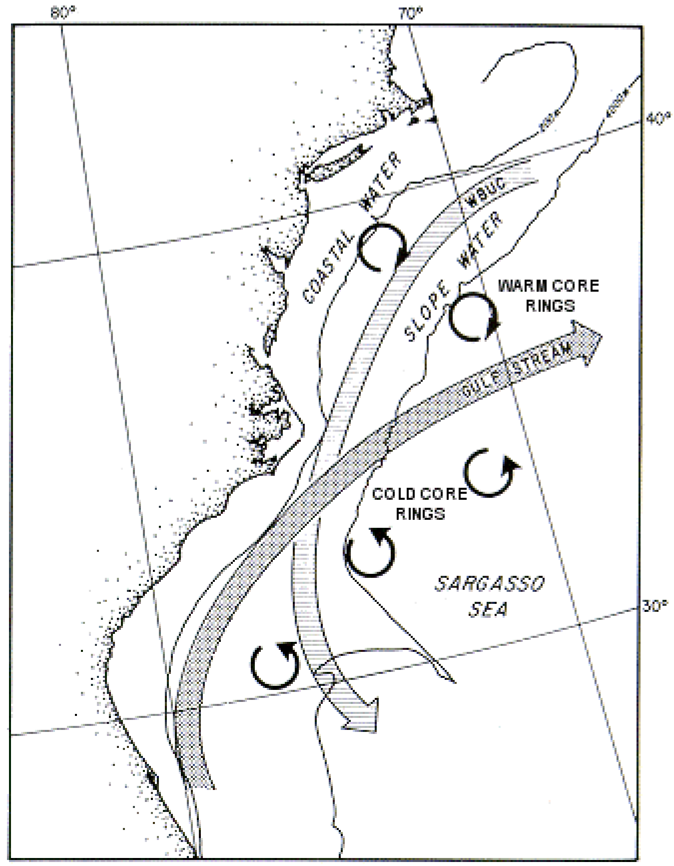

Figure 22: Principal hydrographic regimes of the Atlantic continental slope and rise (from Schmitz et al. 1987).

Southwest of Cape Hatteras, the Gulf Stream flows north and runs directly over the slope, but northeast of Cape Hatteras, the Gulf Stream takes a turn to the east and moves well off the shelf edge and slope. Northeast of Cape Hatteras, the space between the Gulf Stream and the shelf is occupied by slope water. The Western Boundary Undercurrent flows to the southwest along the continental rise (opposite the Gulf Stream). The Gulf Stream and the Western Boundary Undercurrent together represent one of the strongest low frequency horizontal flow systems in the world. Warm and cold core rings spin off from the Gulf Stream, either north or south of the Gulf Stream. The Sargasso Sea is located southeast of Cape Hatteras and does not have a direct affect on the area included in the management unit of this FMP, except to contribute warm water for the formation

[24] North of Cape Hatteras, the Western Boundary Undercurrent (WBUC) is located landward of the Gulf Stream, but south of Cape Hatteras, the WBUC crosses the Gulf Stream and is located seaward of the Gulf Stream.

of warm core rings.

The water column is comprised of three vertical layers: deep water (colder than 4°C), the thermocline (4° - 17°C), and warm water (warmer than 17°C) (Worthington 1976). The water masses of the Atlantic continental slope and rise are essentially the same as those of the North Atlantic Basin (defined in Wright and Worthington 1970). In the North American Basin the deep water accounts for two-thirds of all the water, the thermocline for about one quarter, and the warm water the remainder (Schmitz et al. 1987). In the slope water north of Cape Hatteras, there is no water warmer than 17°C except seasonally in the summer.

The principal cold water mass in the region is the North Atlantic Deep Water, which contributes almost all water colder than 4°C overlying the U.S. continental slope (Schmitz et al. 1987). North Atlantic Deep Water is comprised of a mixture from five sources: Antarctic Bottom Water; Labrador Sea Water; Mediterranean Water; Denmark Strait Overflow Water; and Iceland-Scotland Overflow Water (Schmitz et al. 1987).

The thermocline represents a fairly straightforward water mass compared with either the deep water or the surface water. Nearly 90% of all thermocline water comes from the water mass called the Western North Atlantic Water (Schmitz et al. 1987). This water mass is slightly less saline northeast of Cape Hatteras due to the influx of southward flowing Labrador Coastal Water. In the slope water, the upper thermocline water and the warm water layer appear only during the summer months.

In the winter months, cold temperatures and storm activity create a well-mixed layer down to about 100 - 150 meters, but summer warming creates a seasonal thermocline overlain by a surface layer of low-density water (Schmitz et al. 1987). The seasonal thermocline, in combination with reduced storm activity in the summer, inhibits vertical mixing and reduces the upward transfer of nutrients into the photic zone (Schmitz et al. 1987).

The boundary that separates the warmer, saltier slope water from the colder, less saline shelf water is not vertical; there is a wedge of shelf water extending from about the 100 meter isobath to the sea surface 30 - 80 kilometers seaward (Schmitz et al. 1987). Part of this bulge of shelf water is water that has been cooled by convection in the winter and storms so that it is colder than the underlying slope water (the salinity of the shelf water is lower than the slope water, so there is no density inversion) (Schmitz et al. 1987). Because of the shelf water bulge, there is a temperature maximum zone that is approximately 40 - 80 meters thick, centered at about 120 meters in depth, and usually associated with a salinity maximum. This feature creates a band of warmer water in the range of 9° - 12°C on the seafloor at the shelf break. Below this band of warm water, the temperature steadily decreases and seasonal influences are absent (Schmitz et al. 1987).

Warm and cold core rings are a persistent and ubiquitous feature of the Northwest Atlantic Ocean. Rings which form south of the Gulf Stream usually contain a core of colder slope water and are found only south of Cape Hatteras. Rings which form to the north of the Gulf Stream usually contain a core of warm water from the Sargasso Sea.

Warm core rings are found only in the slope water region northeast of Cape Hatteras and provide the strongest currents in this area (Schmitz et al. 1987). These rings are usually 100 - 200 kilometers in diameter and result from a "pinching off" of a northward Gulf Stream meander. In addition to being a source of strong clockwise currents, these rings can also affect the circulation of water along the shelf/slope front and near the submarine canyons (Schmitz et al. 1987). There is little evidence of ring currents extending deeper than 1000 meters (Saunders 1971).

The numerous submarine canyons along the continental slope between Nova Scotia and Cape Hatteras can alter the physical processes from those in the surrounding slope waters. Fluctuations in the velocities of the surface and internal tides can be large near the heads of the canyons, leading to enhanced mixing and sediment transport (Schmitz et al. 1987). Shepard et al. (1979) concluded that the strong turbidity currents initiated in the canyons were responsible for enough sediment erosion and transport to maintain and modify those canyons. Since surface and internal tides are ubiquitous over the continental shelf and slope, it can be anticipated that these fluctuations are important for sedimentation processes in all the canyons along the eastern continental margin of the U.S. (Schmitz et al. 1987).

A full and detailed description of the habitats utilized by the deep-sea red crab is provided in Appendix A. The EFH source document contains a comprehensive description of the environment in which red crabs occur, as well as a detailed description of the life history and habitat characteristics of the red crab.

8.2.2 Habitat Condition

Due to the lack of current survey information and recent studies done in these areas, we have very little or no information on the current conditions that exist in the habitats utilized by deep-sea red crabs. The Council will request that NMFS, USGS, and NURC conduct or support surveys and studies in the near future that can provide information on the current conditions that exist in the habitats utilized by red crabs.

8.2.3 Threats to Habitat

The regulatory text of the Final Rule (67 FR 2343) directs the Council to assess the potential adverse effects of all fishing equipment types used in waters described as EFH. This assessment is to consider the relative impacts of all fishing equipment types used in EFH on different types of habitat found within EFH. The regulatory text of the Final Rule also directs the Council to identify non-fishing related activities that may adversely affect EFH. The FMP is to describe the EFH most likely to be adversely affected by these activities.

8.2.3.1 Fishing-Related Threats

The Council is required to identify and assess fishing activities that may adversely affect EFH. The Magnuson-Stevens Act defines fishing as:

Definition of Fishing [16 U.S.C. 1802 § 3]:

(15) The term "fishing" means -- any activity, other than scientific research conducted by a scientific research vessel, that involves

(1) the catching, taking, or harvesting of fish;
(2) the attempted catching, taking, or harvesting of fish;
(3) any other activity that can reasonably be expected to result in the catching, taking, or harvesting of fish; or
(4) any operations at sea in support of, or in preparation for, any activity described in subparagraphs (A) through (C).

Such term does not include any scientific research activity which is conducted by a scientific research vessel.

Adverse effects from fishing may include physical, chemical, or biological alterations of the substrate, and loss of, or injury to, benthic organisms, prey species and their habitat, and other components of the ecosystem.

The effects of fishing, such as the direct effects of gear on seafloor habitats (e.g., direct removal of epifauna, smoothed bedforms) and the indirect effects of fishing (e.g., producing shifts in the benthic community because of initial removals of fauna), and other habitat related fishing activities that can be controlled by the Council are considered in this assessment. NMFS recommends that the assessment include, if known: a description of the mechanisms or processes of fishing gear causing adverse effects on habitat; the particular portion of EFH that is affected; a description of known or potential habitat functions disturbed or disrupted by these effects and the extent of such disturbance or disruption; options the Council will consider to minimize adverse effects from fishing practices; and mitigation measures to conserve and enhance EFH adversely affected by fishing activities, if appropriate. According to NMFS, a gear assessment should consider the relative impact of the gear and rate gear types according to their relative impact on different types of EFH, and the Council should consider the severity of the effect, the amount of EFH affected, and the duration/lasting impact of the adverse effect. NMFS suggests the Council also take into account the sensitivity, rarity, resistance, and resilience of different habitat types.

The first fishing activity to assess is the effect the red crab fishery may have on those habitats identified as EFH for red crabs. Since the directed red crab fishery (that which is being directly regulated through this FMP) currently uses only traps, this is the only fishing gear type we need to examine.[25] There is very little information on the effects of pots and traps on benthic habitats. The primary source of information on the effects of this gear type are found in Eno et al. (1999).

Eno et al. (1999) described very few direct impacts to benthic habitats associated with the use of traps. They conducted several studies on the effects of lobster and crab pots on different types of habitat. Observations of pots being hauled from a variety of

[25] The FMP proposes to restrict the directed fishery for red crab to be a trap-only fishery. If, at some time in the future, this should change, we will have to examine additional gear types.

habitat types revealed that the habitats and their communities "appeared relatively unaffected by the fishing activity" (Eno et al. 1999). A review of the potential impacts to habitat from a variety of fishing gear types found that the only indications of adverse impacts to habitat resulting from the use of pots and traps were associated with corals and hard-bottom habitats (Barnette 2001). The hardbottom habitats in the canyons may be affected by the red crab fishery, although there is no information to determine one way or another whether these effects may be occurring.

While based on the Eno et al. report and other information it does not appear that the use of pots in the red crab fishery has an adverse effect on red crab EFH, there is little direct information on the subject and no data or direct research to determine the impacts to benthic habitats from deep-water pot fisheries. If new information becomes available that would change the conclusions reached for this gear type, additional action may be appropriate. It is also important to examine the potential impacts of the red crab fishery to the habitats of the deep-water canyons and determine whether this is a concern, especially in the hardbottom habitats.

The second aspect of the gear assessment is to assess the potential impacts of the red crab fishery on all EFH (for species besides red crab). First, we can extend the conclusions of the above paragraphs summarizing recent work on this issue. We can also develop a working context for the fishing gear used by the red crab fishery to determine the total area covered by the gear used in the fishery. The total area covered reflects the total area subject to any potential impacts. This is a much smaller fishery than most others in the New England and Mid-Atlantic areas.

Unlike mobile gear fisheries, where the total area covered depends upon many variables including the size of the gear (e.g., the sweep of a trawl net), the total area covered by a fixed gear trap fishery can be simply derived from the size of the trap and the number of traps used in the fishery. The fishery uses a fairly standard trap design, and the traps are wood-based, 48" by 30" in size. Currently, the fleet average for traps fished per vessel is approximately 550. The FMP contains a trap limit that caps the traps used per vessel at 600.

The FMP proposes to implement a controlled access program for the directed red crab fishery that will limit the number of participants. The Council's proposed criteria (see Section 4.2.9) are expected to limit the number of qualified participants to five fishing vessels with a relatively significant history in the fishery prior to the March 1, 2000 control date. Thus, it is reasonable to assume that under the FMP, there will be no more than five vessels participating in the directed fishery (although it must be recognized that additional vessels may qualify). Based on this information, we can derive the following: (1) each trap has a 48" × 30" footprint, for a total area of 1,440 square inches or 10 feet square; (2) each vessel uses a maximum of 600 traps, for a total area per vessel of 6,000 square feet; (3) if we assume a maximum of 5 vessels active in the directed red crab fishery, then we can calculate that the total area for the fleet is 5 times 6,000 square feet, or 30,000 square feet. This suggests that the total area impacted by the red crab fishing fleet is 30,000 square feet. This can be represented by an area 300 feet in length by 100 feet in width. Or, put another way, the total area impacted by the fishing gear at any one time is only 62.5% of the size of a football field (a football field is 300’ × 160’ = 48,000 square feet).

Even if we assume that the direct area impacted by each trap (in setting and hauling) equates to three times its footprint (Auster and Langton 1999), then the total area impacted by the red crab fishery is 90,000 square feet = 1 ? football fields. This area represents the amount of area potentially affected by each complete set of red crab gear. The total number of complete sets made each year will depend upon many factors associated with the decisions made in this FMP, including: the number of vessels authorized to participate in the controlled access directed red crab fishery; the maximum number of traps allowed per vessel; and the overall effort or landings control implemented (such as the DAS or number of fishing trips allocated to each vessel, or the overall TAC established for the fishery). There may also be impacts associated with the groundlines between pots. The amount of impact may depend upon the length of the line between pots and whether sinking line is employed.

The third issue to consider is whether there are adverse impacts to habitats identified as EFH for red crab from any other fisheries. The Council’s Omnibus EFH Amendment (1998) describes the primary fishing gears used in the New England and Mid-Atlantic areas. This Amendment also provides an assessment of the potential adverse impacts to a variety of habitat types. The description of fishing gears and the assessment contained in the EFH Amendment are incorporated here by reference (NEFMC 1998). Because primary red crab habitat is so deep, the only fisheries that appear to intersect red crab habitat are for tilefish and for monkfish. Tilefish is primarily a longline fishery, and longlines are a gear type generally not associated with adverse impacts to benthic habitats, so this should not be a problem. Monkfish is a trawl and gillnet fishery, so there could be some adverse impacts associated with the trawl sector, but very little is known about the interactions between the monkfish fishery and red crab habitat. It will be a primary research and information need of this FMP to gain as much information as possible on any potential impacts to red crab habitat that may be associated with the monkfish fishery.

8.2.3.2 Non-Fishing-Related Threats

The Magnuson-Stevens Act requires the Council to identify and characterize activities other than fishing that potentially reduce the quantity and/or quality of essential fish habitat. This section of the FMP will serve as a reference of non-fishing related threats and activities for the Council, NMFS, habitat management action agencies, and other interested parties. Once EFH for red crab is designated, federal agencies must consult with NMFS regarding any proposed activities that may adversely affect its EFH. NMFS must provide federal and state agencies with conservation recommendations regarding any agency action that would adversely affect the EFH. The Council is also empowered to comment on any federal or state agency action that would affect the habitat, including EFH, of a species under the Council’s authority. To assist with these consultation and commenting activities, this section of the FMP addresses those activities most likely to reduce the quantity and/or quality of essential fish habitat for deep-sea red crab. This document is not meant to serve as an exhaustive review and analysis of the impacts of all potentially detrimental activities; yet, it should highlight notable threats and provide enough information to determine if further examination or monitoring of a proposed activity is necessary.

Habitats within the offshore region of New England and the Mid-Atlantic are found, generally, in deep waters with stable biological communities. There are also many high energy offshore habitats in which environmental conditions are continuously changing. Benthic and pelagic marine life may be disrupted by a number of threats within offshore waters. Contamination migrates away from the coast and potentially endangers the health of offshore habitats. Offshore waters are being looked to more frequently to supply new resources or resources that have been eliminated from coastal environments. Deep, stable waters and high energy offshore habitats may be disturbed by increasing amounts of non-fishing threats that may disrupt environmental conditions. Low levels of disturbance in deep, stable habitats may present serious implications on finfish and shellfish populations. Chemical, biological, and physical threats continue to grow in areas important for fishery resources in the offshore region.

Chemical Threats

Oil can have severe detrimental impacts on offshore habitat. Spills or blowouts can produce an oil slick on surface waters which can disrupt the entire pelagic community (i.e., phytoplankton, zooplankton, ichthyoplankton). Oil can interfere with reproduction, development, growth and behavior (e.g., feeding) of fishes, especially in early ontogenetic stages. Carcinogenic and mutagenic properties of oil compounds are receiving increasing attention around the world (Larsen 1992). Contaminated sediments may degrade benthic communities. Non-point and point sources of oil in offshore habitats originate from industrial shipping, recreational boating, marine transportation, energy and mineral exploration and transportation, and ocean disposal of contaminated dredged material.

Marine organisms can be contaminated or killed directly and indirectly from the stress of heavy metals discharged into offshore waters. Sediment accumulates the toxic metals, and fishes bioaccumulate contaminants which can cause health problems in human consumers of fish. Industrial and recreational shipping and atmospheric deposition are non-point sources of heavy metals. Ocean disposal of contaminated dredged material, energy and mineral exploration (e.g., drilling muds), and marine transportation (e.g., hull paint containing lead) introduce heavy metals into the environment (Larsen 1992; Buchholtz ten Brink 1996).

Localized eutrophic conditions, characterized by phytoplankton and filamentous algal blooms (HABs), high turbidity, low dissolved oxygen, and low denitrification rates, can occur in offshore habitats with unnaturally high concentrations of nutrients. Any increase in the nutrient levels of the open ocean will markedly effect the productivity of phytoplankton communities (Omori et al. 1994). Increasing the surface productivity may increase the flux of material from the sea surface to the deep sea benthos (Omori et al. 1994). The stable, deep sea environment is trophically linked to the surface waters and an increase flux of organic matter may have notable impacts on bottom habitats (Omori et al. 1994). Other toxic organisms may be implicated with the blooms of noxious algae causing outbreaks of disease or fish kills. Nutrients enter offshore waters from non-point sources such as industrial shipping, recreational boating, and atmospheric deposition, and point sources, including ocean disposal of contaminated dredged material, and energy and mineral exploration and transportation.

Fish and invertebrate populations may be impacted by the input of pesticides into offshore habitats. Contaminated sediments can accumulate in the benthos providing a potential source of stress through trophic levels. Pesticides enter offshore habitats through atmospheric deposition illustrating a potential non-point source, and ocean disposal of dredged material illustrating a point source. Herbicides and fungicides can alter marine habitats by hindering phytoplankton growth and possibly leading to lasting community structure change. Alteration of the photosynthetic plankton community can alter fishery dynamics by replacing natural plankton species composition with new species. The change in the planktonic community may change the lower trophic structure so cascade effects may hinder fish populations (e.g., bottom-up process). Herbicides can be released into offshore habitats from atmospheric deposition and disposal of dredged material.

Unnatural levels of suspended particles in offshore habitats can increase turbidity, smother benthic habitat, hinder respiration, disrupt water transport rates, and reduce filtering efficiency of organisms. Other problems associated with suspended solids include sorption of toxic metals and organic materials, reduction of egg buoyancy, disruption of ichthyoplankton development, reduction of growth and survival of filter feeders, and decreased foraging efficiency of sight-feeders (Barr 1993). The functions (e.g., photosynthesis) and properties (e.g., dissolved oxygen) of the entire water column may be frequently disrupted. Long-term flux of suspended sediments to offshore waters may provide a source of nutrients that stimulate primary production and contribute to increased turbidity and altered nutrient cycles. Continued high levels of suspended material within offshore waters can lead to fragmentation and alteration of localized community of benthic and pelagic organisms. Suspended particles enter the offshore environment from ocean disposal of dredged material and mining practices.

Biological Threats

Nonindigenous species and reared species potentially impact natural populations by transmitting diseases (exotic or natural), increasing competition with indigenous species, increasing predation on natural organisms, and altering the natural genetic pool (e.g., less genetic heterogeneity). These deleterious impacts can potentially lead to lower fitness of stocks and change the natural community structure and dynamics. Human activities are closely associated with exotic introductions. Shipping (e.g., ballast water), aquariums, and biotechnology are potential sources of nonindigenous species in offshore waters. Dredged material disposal may introduce algal species that degrade habitat conditions.

An increase in natural levels of nutrients induced by human activities can stimulate population explosions of nuisance and toxic algae [harmful algal blooms (HABs)] which have detrimental impacts to habitat and toxic effects on organisms and humans (see

O'Reilly 1994; Boesch et al. 1997). Organisms responsible for HABs have occurred naturally in the environment for a long time, so an apparent increase in bloom events may simply reflect better detection of natural phenomena (NSF and NOAA 1998). However, the current increased intensity and frequency of HABs compared to the past appears to indicate more toxic algal species, more algal toxins, more areas affected, more fishery resources affected, and higher economic losses (Boesch et al. 1997; NSF and NOAA 1998). Nonindigenous algal species may be introduced to the environment from ballast water of commercial vessels, recreational boating, shellfish transfer (e.g., seeding), dredging, and disposal of sediments (Boesch et al. 1997), adding to the potential problem of blooms. HABs can indicate eutrophic conditions, alter, impair, or kill plankton and fish communities, and lower dissolved oxygen (NOAA 1997). Certain toxic organisms (e.g., *Pfiesteria* spp.) are associated with HABs and have caused major outbreaks of disease and fish kills within inshore waters (NCSU 1998); however, these outbreaks may spread to offshore habitats. These short-term impacts can eventually cause a change in the natural processes of habitat reducing viable fish and shellfish populations.

Pathogens can be a serious problem in offshore waters by spreading disease and possibly impacting the long-term success, health, and fitness of fish and invertebrate populations. Shellfish area closures may be required as a result of the spread of diseases (i.e., paralytic, amnesic, and neurotoxic shellfish poisoning) which have impacts on human health. For example, paralytic shellfish toxins have been detected in Atlantic surfclams (*Spisula solidissima*), Atlantic sea scallops (*Placopecten magellanicus*), northern horse mussels (*Modilus modiolus*), and ocean quahogs (*Arctica islandica*) within areas of Georges Bank at levels exceeding the public health safety threshold (White et al. 1993). Potential origins for pathogens in the environment include non-point sources of discharge such as industrial shipping, recreational boating, and point sources of discharges such as aquariums and biotechnology (NOAA 1994). Localized regions of high nutrients may trigger outbreaks in harmful organisms that may hinder the health and success of fish and shellfish populations.

Red crabs may also be susceptible to shell disease, which may be caused by pathogens in the environment (Young 1989). These disease-causing pathogens, if present in the environment, would degrade the quality of the habitat for red crabs and increase red crab mortality.

Physical Threats

There is an increasing demand for good-quality sand and gravel aggregate and an increasing exploration for oil, and offshore habitats are being seen as a possible source (Messieh et al. 1991). Mining presents potential direct and indirect problems to habitat of the mining site and surrounding regions such as issues related to toxicity of operational chemicals, accidental discharge of wastes, removal of benthic flora and fauna, changes in substrate character, and the suspension of sediments (ICES 1991). Structures are also built within habitats to assist in mining and transporting materials. In a review by Pearce (1994), the effects of mining have been listed as: (1) "destruction" of existing benthic biotic community; (2) resuspension of sediments with negative impacts on fishes; (3) changes in bottom topography and sediment composition; and (4) consequences related to the sediment transport from the site by currents. Gravel, mineral, and oil mining occur in marine environments which are essential for fisheries, and operational and accidental discharges are an environmental concern (Messieh et al. 1991).

Gravel aggregates are abundant throughout the Gulf of Maine and are a potential source for mining (Messieh et al. 1991). Gravel/mineral mining is associated with an increase in stress to the surrounding habitat and removal and disturbance of substrate (Scarrat 1987). The alteration to the mining site can fragment habitat, negatively impacting fish and shellfish populations. Long-term mining sites potentially can change natural habitats and associated fish and shellfish populations (Wilk and Barr 1994).

Oil mining has similar impacts as gravel/mineral mining with more risk associated with accidental spills and blow-outs which can disrupt habitat (Wilk and Barr 1994). Oil wells are in the initial stage of exploration in offshore New England waters. Drilling muds and well cuttings are potential wastes of oil exploration. Drilling muds (either water-based or oil-based muds) are complex and variable mixture of fluids, suspended solids, and chemical additives (Messieh et al. 1991). If exploration results in notable amounts of resources, industrial development may occur in offshore waters; leading to larger amounts of drilling wastes and discharge (Messieh et al. 1991)

Debris discharged or transported offshore may degrade and disrupt benthic and pelagic habitats (see Coe and Rogers 1997). Debris within offshore habitat can smother benthic communities or be ingested by fish (Hoagland and Kite-Powell 1997). Reduction of habitat by destroying the benthos can alter community structure and hinder the sustainability of fisheries. Debris non-point sources include industrial shipping and recreational boating, and a point source includes ocean disposal of garbage and mineral exploration (USEPA 1994).

Disposal of dredged material can disrupt and degrade natural habitat and biotic communities. The associated stresses of dredged material (i.e., oil, heavy metals, nutrients, suspended particles, etc.) potentially threaten the habitat of the dump site and adjacent areas. Providing a flux of nutrients to offshore habitats from dredged material may be a notable source contributing to algal blooms. Along with contaminating the habitat, direct disturbance of the benthic and pelagic communities occurs with disposal. Benthic communities are smothered, associated physicochemical conditions are altered, and increased turbidity may hinder pelagic processes (e.g., photosynthesis of algae) by material settling to the bottom. The potential deleterious impacts of dredged material disposal can alter local and surrounding community structure.

In spite of the many potential threats to offshore habitats, in general, due to the very deep nature of red crab habitat, there are very few, if any, direct threats from non-fishing related activities expected to cause an adverse impacts to red crab EFH. The only non-fishing activities identified as potential significant concerns are offshore oil and mineral exploration and extraction, the installation of fiber optic and electrical cables, and contamination by toxic chemicals. There are no known plans or proposals for any offshore oil and mineral exploration and/or extraction that would have an effect on red crab habitat. Should this status change, the Council would examine the information and participate in the project review to the extent allowed under the Magnuson-Stevens Act. On a case-by-case basis, the installation of any fiber optic and/or electrical cables would not be expected to have a significant effect, but the cumulative effects of multiple projects should be tracked and considered in the future. Toxic chemical contaminants are not currently known to be an issue effecting red crab habitat, but this issue bears attention, should the distribution and/or concentration of chemicals of concern change.

8.2.4 Habitat Conservation Recommendations

The Magnuson-Stevens Act requires all FMPs to identify actions to promote the conservation and management of fishery resources. Prior to the concept of EFH, conservation primarily involved management measures to reduce overfishing and rebuild overfished stocks. Such measures embraced the need to minimize and avoid the mortality of bycatch. While these issues remain very important in fishery management, the EFH provisions of the Magnuson-Stevens Act will strengthen the role of the Council and NMFS to further conserve and enhance EFH and related fishery resources.

The regulatory text of the Final Rule directs the Council to describe options to avoid, minimize, or compensate for the adverse effects of activities identified in the non-fishing threats section of this amendment. The Final Rule also directs the Council to promote the conservation and enhancement of EFH, especially in habitat areas of particular concern. The Council has the discretion to provide comments on non-fishing activities authorized by federal and state agencies which impact the EFH of non-anadromous fish species. The conservation and enhancement options promoted by the Council include, as directed in the Final Rule: the enhancement of rivers, streams, and coastal areas; improving water quality and quantity; watershed analysis and planning; and habitat creation.

The enhancement of rivers, streams, and coastal areas may include reestablishing endemic trees or other appropriate native vegetation on riparian areas adjacent to EFH, restoring natural bottom characteristics, removing unsuitable materials from areas affected by human activities, or adding gravel or substrate to stream areas to promote spawning. Improving water quality and quantity may include the use of best land management practices, improved treatment of sewage, proper disposal of waste materials, and providing appropriate in-stream flows. Watershed analysis and planning may include encouraging local and state efforts to minimize destruction/degradation of wetlands, restore and maintain the ecological health of watersheds, and encourage the restoration of native species. Habitat creation may be considered as a means of replacing lost or degraded EFH. Any future ocean dumping or dredge disposal sites should avoid impacting areas designated as EFH.

Specific to red crab habitat, there are few conservation recommendations necessary due to the lack of information and the lack of activities with direct impacts occurring in or around red crab habitat. The only specific recommendations appropriate for this FMP are the following:

- continue all existing prohibitions on oil, gas and mineral exploration and extraction that may be proposed on or near red crab EFH; and

- carefully monitor all projects related to the installation of fiber optic and/or electrical cables that may be associated with red crab habitat and to track any potential cumulative effects of such projects.

8.2.5 Habitat Information and Research Needs

The regulatory text of the Final Rule directs the Council to include recommendations, preferably in priority order, for research efforts that the Council and NMFS view as necessary for carrying out their EFH management mandate. The need for additional research is to make available sufficient information to support a higher level of description and identification of EFH. Additional research may also be necessary to identify and evaluate actual and potential adverse effects on EFH including, but not limited to, direct physical alteration, impaired habitat quality/functions, cumulative impacts from fishing, or indirect adverse effects such as sea level rise, global warming and climate shifts, and non-equipment related fishery impacts. The need for additional research on the effects of fishing equipment on EFH is also included. The research needed to quantify and mitigate adverse effects on EFH identified in this amendment and determined to be an impediment to maintaining a sustainable fishery and the contribution of the managed species to a healthy ecosystem is identified.

The habitat research recommendations include expanded life history information that will result in the comprehensive identification of the habitat requirements of the species or species assemblages, including all life history stages, as well as habitat-related information that defines the interrelationship between the species, the environment and the food web. The identified research needs also include information on adverse impacts from both non-fishing and fishing activities. Fishing activities include both recreational and commercial fishing equipment or practices.

One specific issue requiring more information is the interaction of the monkfish trawl fishery with red crabs and their habitat. This requires the collection of observer data from the monkfish trawl fishery to document any bycatch of red crabs. Significant bycatch of red crabs could be used as a proxy indicator of interactions between the monkfish gear and red crab habitat. A second component of this need is for information on the sex and mortality of red crabs caught in the monkfish trawl fishery.

Another specific research and information need associated with this FMP is to identify the potential impacts of a deep-water trap fishery on a variety of benthic habitats, including the habitats contained in the deep-water canyons. This would essentially be an extension of the Eno et al. (1999) report, but focused on deep-water habitats most likely subjected to fishing by the red crab fishery.

A third specific research and information need to assist the Council and NMFS better understand the habitat requirements of red crabs requires expanded survey data to include more of the range of this species to assist with the identification and description of EFH. Information is also required on the relationships between red crabs and water temperatures and explore the use of bottom water temperature data as a tool to delineate and identify EFH for this species. Lastly, studies are needed to determine the trajectories of red crab larvae, from release into the water column to settlement as juveniles. This may be suitable for a modeling project. It will be very important to determine the length of time red crabs remain as larvae and how long they stay in the plankton.

8.3 Description of the Fishery

8.3.1 History of Exploitation

In the 1950's, commercial concentrations of American lobsters were found in offshore waters south of New England and whenever these lobsters were targeted in waters deeper than 200 fathoms, red crabs were caught as by-catch (Holmsen 1978). Throughout the 1960's and into the 1970's, red crabs were considered an under-utilized species and several studies and reports were conducted to explore the potential for developing a directed red crab fishery (Holmsen 1978; Holmsen and McAllister 1974; Meade and Gray 1973). Success in efforts to create a directed red crab fishery were limited initially by two factors: (1) high harvest-related mortality of the crabs, the meat quality of which degraded soon after death; and (2) lack of economical processing (Holmsen 1978; Meade and Gray 1973).

In the early 1970's, there were several new developments that allowed the directed fishing for red crab to become economical. First, the use of traps and pots became the preferred harvesting technique, and vessels began experimenting with different refrigeration and butchering techniques to preserve the quality of the red crab meat prior to shore-side processing. Second, several processing firms entered the market and provided opportunities for fishermen to sell red crabs at a good price. Coincidentally, these developments occurred at about the same time as declines in the blue crab and king crab fisheries (Hastie 1995).

In New England, red crab has been the target of a directed fishery since the 1970's, although the landings have not been consistent and have varied considerably through the years. In 1973, the first lobster vessel changed over to fish red crab exclusively and another vessel entered in 1976. There were another three to four vessels which landed minor quantities of red crab on an experimental basis during the 1970's. Throughout the 1980's there appears to have been a fairly consistent fishery for red crab, with reported landings averaging over 5.5 million pounds per year. In the early 1990's landings appear to have fluctuated somewhat, but have been steadily increasing since about 1995.

Red crab was harvested commercially in significant volume in the mid and late-1970's, with reported landings reaching 1.1 million pounds in 1974 and increasing to approximately 2.7 million pounds in each year between 1977 and 1979. Documented landings increased significantly in 1980, remaining high throughout much of the 1980's, averaging 5.8 million pounds per year. Reported landings in any one year varied from a high of 8.5 million pounds in 1984 to a low of 2.7 million pounds in 1986.

In 1990, reported landings decreased to 3.36 million pounds, and throughout the

1990's the landings were less than reported in the 1980's, averaging 2.7 million pounds per year (less than half of what was landed in the 1980's). In the late 1990's, reported landings increased from 1.26 million pounds in 1995 to 4.1 million pounds in 1999. Anecdotal industry reports suggest that landings exceeded 7 million pounds in 2000. Since the mid-1990's, and until late 2000, there were between four and five vessels fishing exclusively for red crab.

Prior to the March 1, 2000 control date for the red crab fishery, the largest vessel in the fishery was 120 feet in length overall and the average hold capacity of the fleet was 70,000 pounds of whole crab product. As of the control date, no vessel fished more than 600 pots and none had the ability to completely process crabs on-board. All but one of these vessels landed their crabs whole and alive. The remaining vessel butchered the crabs on board, which means they cut the crab in half and removed the carapace. The principal method of fishing is to steam to the fishing grounds, set and haul baited traps, and return to port quickly in order to ensure fresh product. Trips are limited in length principally by the hold capacity of the vessel and the need to keep the product fresh and, for most vessels, alive.

In early 2001, two additional vessels entered the red crab fishery. One vessel relocated from the North Pacific and the other vessel relocated from the Gulf of Mexico. Both were catcher-processor vessels over 150 feet in overall length. Although they may fish with fewer pots, both reportedly have the capacity to fish approximately 1,000 crab pots. Vessel hold capacity may be a more important indicator of overall fishing power than either vessel size or the number of pots fished. The hold capacities of the two additional vessels are reported to be in the range of 185,000 to 300,000 pounds of red crab product. The equivalent amount of red crab in whole weight depends on the degree of processing that occurs on-board the vessel. If the crabs are simply butchered (split into half sections with the carapace removed), the whole weight equivalent is approximately 1.76 times the butchered weight (Lux et al. 1982). This indicates that the two additional vessels may be able to land the equivalent of 325,000 to 528,000 pounds of red crab per trip. Even if we assume the lower bound of this range, each of these new vessels individually possesses the capacity to harvest more per trip than the entire fleet suggested by Holmsen and McAllister (1974).

8.3.2 Description of the Fishing Gear

The directed fishery is currently entirely a trap fishery. There are a variety of crab pot/trap technologies available, but most of the gear used in this fishery is fairly uniform. In 1974, Holmsen and McAllister (1974) suggested that a large 4' by 4' square pot with upward pointing funnel eyes to be a "good red crab pot" but this trap design was never used in the deep-sea red crab fishery. Holmsen and McAllister (1974) also suggest that it would be economically prohibitive to fish single traps in deep water, and that trap trawls containing 40 to 70 traps would be the most efficient solution. Pots used in the offshore lobster fishery also work well to catch red crab, but likely need at least some minor modifications to improve their efficiency (Holmsen and McAllister 1974).

In a report to the New England Fishery Management Council, Holmsen (1978) describes the evolution of the red crab pot design, including trying igloo shaped pots, large pots similar to the West Coast king crab pot, and modifications to the offshore lobster pot. His report indicates that in the late 1970's, the most prevalent pots used in the fishery were 47" by 32" by 28" and that 60-75 pots were fished per trawl (Holmsen 1978). In 2000, several red crab fishermen reported that the most common trap used was a wood and wire trap 48" by 30" with top entry. Currently, trawls with 90 - 120 traps per trawl are the most common. Escape vents are reportedly used when fishing in areas with relatively high concentrations of females and spacing the wooden laths two inches apart in the construction of the traps allows for the escapement of juveniles. Other traps being used may vary the configuration or materials, but are approximately the same size and weight. These traps may include a wire base construction rather than wood and other than rectangular shapes, including a conical-type trap sometimes used. The large 7' by 7' king crab traps are currently not used in the northeast red crab fishery.

There is an unspecified amount of bycatch of red crab in the offshore lobster fishery, and these crabs are obviously harvested with standard offshore lobster pot technology. The types and numbers of lobster pots used in this fishery are described in the Final Environmental Impact Statement and Regulatory Impact Review for Federal Lobster Management in the Exclusive Economic Zone (EEZ), prepared by NMFS (1999).

There is also an unspecified amount of bycatch of red crab in other offshore fisheries, such as the northeast multispecies fishery. The principle gear types believed to be capable of catching red crab in the multispecies fishery (as well as other fisheries such as that for monkfish) include otter trawls and scallop dredges. The types and configurations of otter trawls and scallop dredges are described in the Northeast Multispecies and Sea Scallop Fishery Management Plans, respectively.

Because this was an unregulated fishery, prior to implementation of the emergency regulations in May 2001, there were no restrictions on the fishing gear that may be used to harvest red crab. Although the directed fishery currently uses very similar traps and harvesting techniques, prior to this FMP there were no regulations preventing new trap designs or configurations, including the use of much larger and heavier traps or the use of more traps per trawl. There were also no regulations preventing the use of otter trawls, dredges, or other bottom-tending mobile gear for the directed red crab fishery.

8.3.3 Domestic Activities

8.3.3.1 Recreational and Subsistence Fishery

There is no recreational or subsistence fishery for deep-sea red crabs due to the depth of the water (greater than 320 meters) where red crabs occur and the gear necessary to harvest red crabs (red crab pots and large hydraulic pot haulers).

8.3.3.2 Commercial Fishery

The red crab commercial fishery is a relatively small fishery (traditionally less than six vessels) of medium to large fishing vessels (90 - 150 feet in length) that fish in deep water (400 - 800 meters, see Figure 23). The nature and extent of the current commercial fishery for deep-sea red crab has been described in previous sections of this FMP (see Background and Purpose), so this section will focus on the operational aspects of the commercial fishery. Much of the following description of the operational aspects of the red crab fishery is taken from a report on social and economic baseline information for the red crab fishery. This report in its entirety is provided as Appendix B.

Most commercial red crab fishing vessels currently spend a significant amount of time on the water engaged in the red crab fishery (up to 300 days per year). Barring mechanical problems or weather-related issues, vessels traditionally take anywhere from 28 to 35 fishing trips per year. If the red crab vessels participate in any other fisheries, they appear to do so only while also on a red crab trip. Red crab fishing trips are reported to last at least a week, ranging from seven to ten days and averaging just over eight days per trip. While on a red crab fishing trip, work days range from 17 to 20 hours per day.

Red crab fishing vessels employ between 480 and 600 crab pots in their fishing operations, with an industry average of 560 pots. All vessels arrange their crab pots in strings (also called pot trawls), with 75 to 180 pots on each string. Each vessel uses approximately the same number of pots on each string and sets the number of pots per string based on vessel characteristics and fishing technique. Once baited and set on the bottom, the pots are allowed to soak between 18 and 36 hours before being hauled (the average soak time reported is 22 ½ hours). The pots are hauled on-board the vessel one at a time and the crabs removed. The crabs are sorted for size and sex immediately and the females and undersized males are returned to the water, usually through a return chute built into the sorting tray.

The retained crabs are then either deposited in the vessel's live wells or are butchered and processed (depending on the individual vessel's capabilities and practice). Vessels that land their product whole maintain tanks of refrigerated sea water (RSW) where the crabs are kept alive for processing on land. The duration of each fishing trip is constrained by the time the crabs can be kept alive in the RSW tanks. Mortality of red crabs will start to increase after approximately seven days. Upon landing, the crabs are removed from the RSW tanks and packed on ice for transport to the processing facility.

Crabs that are butchered first have the carapace removed and then are cut in half laterally. Some vessels leave the remaining crab carcass intact, while others further process the carcass by cleaning off the gills and other viscera. Next, one of two processes is employed on the vessels: (1) the crab sections are placed in mesh bags, dipped in a mild preservative solution, and stored on ice (but not frozen); or (2) the crab sections are quick frozen, boxed for shipping, and stored in an on-board freezer.

On a given fishing trip, each vessel may haul between 1,600 and 4,200 pots (the average is reported to be 2,900 pots hauled per trip). The wide range is a result of the combination of the number of traps used and the soak time favored by each vessel. There is some amount of gear loss or damage on almost every fishing trip, as many as 50 pots per trip. The reported average for pot loss or damage is just over ten pots per trip.

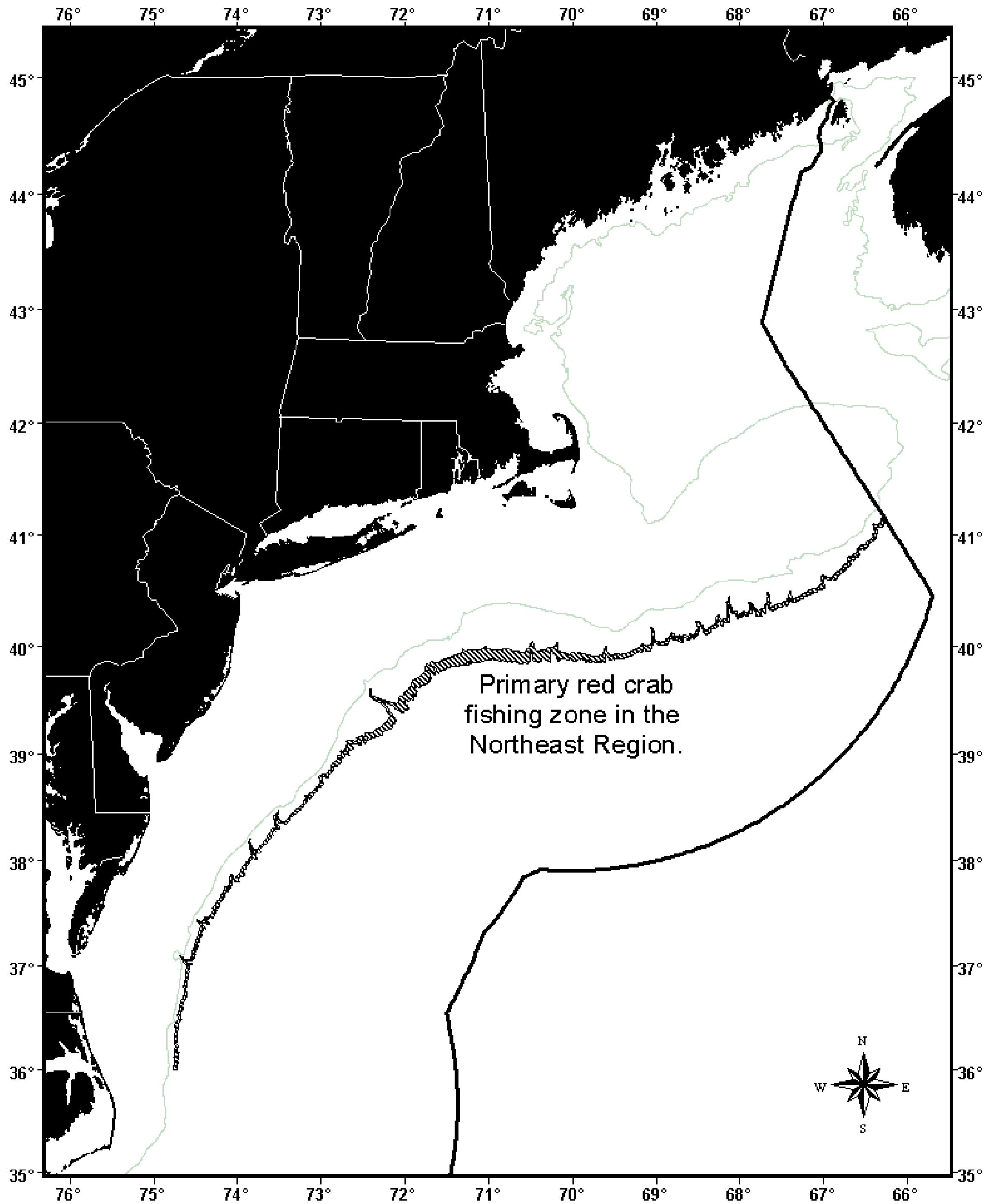

Figure 23: Map of the primary fishing zone for red crab. The area is delineated by the minimum and maximum depths of the fishery as reported by members of the fishing industry (400 - 800 meters).

All pots fished in the red crab fishery are baited before being set. The most common bait used in the fishery includes herring and pogies, and as much as 10,000 pounds of bait may be used in a single fishing trip. Most fishing trips in the red crab fishery target different areas. Vessels will move their gear up and down the coast rather than resetting in the same place again. Many factors are used to determine where to fish on a given trip, including current and recent effort in an area, the movement of other vessels, the time of year, areas with typically the best fishing, and the traditional fishing grounds of the vessel.

The fishing vessels currently operating in the commercial red crab fishery come from a variety of areas and fishing ports in New England and the Mid-Atlantic. Table 26 lists those ports reported to serve as the primary ports of operation and mooring for red crab vessels participating in the commercial fishery.

Port	State
Fall River	MA
Gloucester	MA
New Bedford	MA
Bristol	ME
Portsmouth	RI
Tiverton	RI
Norfolk	VA

Table 26: Primary ports of operations and mooring.

8.3.3.3 Conflict and Competition

As described above, red crab pots are set in strings of 75 - 180 pots per string and are set in very deep water. Red crab habitat is very limited, especially in some areas (see Figure 23), and when combined with increasing fishing effort, the potential for conflict and competition increases. Reports of limited gear conflicts have surfaced since the number of fishing vessels prosecuting the directed red crab fishery increased in early 2001.

8.3.3.4 Domestic Annual Harvesting Capacity

As described in previous sections of the FMP, the current capacity of the domestic harvesting sector greatly exceeds all estimates of MSY. The Council concluded that the capacity of the domestic fleet exceeds the amount of the available resource and is proposing to control access to the directed red crab fishery to better match the capacity of the domestic fishing fleet and the resource.

8.3.3.5 U.S. Harvest of Optimum Yield

Given that the Council has identified the need to control access to the fishery in order to match the capacity of the domestic fishing fleet and the amount of the available resource and reduce the likelihood of overfishing, the domestic fleet will harvest all of the optimum yield.

8.3.3.6 Domestic Annual Processing Capacity

Based on information provided by representatives of the processing companies, there are four U.S.-based wholesale and processing companies involved in the red crab fishery and red crab product delivered by the domestic red crab fishing fleet is sold to these domestic processors and/or wholesalers. The processing capacity represented by these companies exceeds all estimates of MSY for this resource. Representatives of these companies report processing between 100,000 and 400,000 pounds of red crab each month, for an industry-wide total of as much as 700,000 pounds per month. This alone would exceed MSY, (12 months $\times$ 700,000 pounds/month = 8.4 million pounds per year), and all processors report having additional processing capacity that could be utilized. If the reported full capacities of the red crab processors were utilized, they would be able to process more than 1.3 million pounds per month, which would equate to an annual processing capacity of 15.6 million pounds (250% of the current estimate of MSY). None of these companies are solely dependent upon red crab, as they all process other fishery products in addition to red crab. On average, red crab accounts for 11.5% of the total fishery-related processing operations of these companies, with no one company depending upon red crab for more than 25% of their processing operations.

8.3.4 Foreign Activities

There is no foreign fishing activity for deep-sea red crab within the U.S EEZ. There has been a commercial fishery for red crabs in Canadian waters from eastern Georges Bank along the Scotian Shelf. The Canadian fishery began in the late 1960's, but historical catch records are sparse and probably do not accurately reflect actual landings (Lawton and Duggan 1998). In 1998, there were five exploratory licenses being used to harvest red crabs, but reported landings had never exceeded 1.6 million pounds, despite an annual TAC of over 2.8 million pounds (Lawton and Duggan 1998). Even with this limited amount of fishing effort, a Canadian stock status report suggests that the Canadian fishery is not viable.

8.3.5 Interactions Between Domestic and Foreign Participants in the Fishery

There are no foreign fishermen using the U.S. stock of the deep-sea red crab, therefore there are no interactions between domestic and foreign fishermen. There are no reports of foreign fishermen taking any red crab as incidental catch in another fishery, but if there is such incidental catch, the foreign fishermen will be subject to the incidental catch restrictions of this FMP. There are no existing joint ventures involving red crab, and due to the capacities of the domestic harvesting sector and the domestic-based processing sector, there are unlikely to be any joint ventures in the future.

8.4 Identification of the Social and Cultural Entities Involved in the Fishery

Much of the following information is taken from a report on social and economic baseline information for the deep-sea red crab fishery. This report is provided in its entirety as Appendix B. The following is provided only as a summary of the information provided in the report.

8.4.1 Fishing Vessel Owners and Operators

The directed commercial fishery for deep-sea red crab is a small fishery with relatively few participants. There are only five vessels that have been involved full-time in the fishery for more than four years, although with the addition of new entrants over in 2001, the number of full-time vessels has increased to seven. With so few vessels participating in the fishery, the number of vessel owners and/or operators is also very few.

All participants in the fishery surveyed (see Appendix B for background) identified themselves as being white or Caucasian and all are male. Almost all are married and most have at least one child. Level of education is varied, but the majority have some college or are college graduates. They range in age from 39 to 56 years old, with an average of just over 47 years old. All have been involved in commercial fishing of some type for a significant period of time, ranging from 14 to 40 years and an average of over 27 years. Their involvement in the red crab fishery is more variable, ranging from just two years to more than 20, and an average of almost 9 years.

8.4.2 Fishing Vessel Crew

The individuals who serve as crew on commercial fishing vessels are often an overlooked component when analyzing potential impacts on the fishing industry and fishing communities, but they can be affected by regulations and/or changing conditions. The number of crew members involved in the red crab fishery is relatively few, based largely on the size of the fishery and its few participants. The number of crew employed on each vessel ranges from six to almost twenty, with an average of just over eight crew per vessel. There is no direct information on the crew members of red crab fishing vessels, but some information was provided by the vessel owners and operators.

Almost all crew members of red crab vessels are male, but one vessel reported having at least one female crew member. Most are or have been married, but a moderate percentage (38%) have never been married. Most crew are reported to have children, with an average of just under two children per crew member with children. Level of education is somewhat varied, but the vast majority are reported to be high school graduates (over 70%). A significant, but smaller, percentage are reported to have attended some college, and a small percentage have completed college.

The ethnicity and racial make-up of red crab crew members is much more diverse than the owners and operators. Almost all vessels report having at least one minority crew member, and these include African-Americans, Hispanics, and Native Alaskans. The ethnicity of the crew members varies and includes Hondurans, Irish, Mexicans, and Portuguese, as well as other unspecified (by the vessel owners and operators) ethnic groups.

The age of vessel crew is reported to range from 18 years old to 56 years old, with an average for all vessel crew members reported to be just over 28 years old. All vessel crew members are reported to have been involved in commercial fishing for several years, averaging over 10 years per crew member. Not all of this time has been in the red crab fishery, however, as the average time that vessel crew have been involved in the red crab fishery is reported to be only 3 ½ years. Most of the time these crew members have been involved in the red crab fishery has apparently been on the same vessels, as the average time that crew have been employed on their vessels is over 3 years (only slightly less time than they would have been involved in the red crab fishery).

8.4.3 Processors

The small size of the harvesting sector of this fishery is carried over to the processing sector which is also relatively small. There are four wholesale and/or processing entities reportedly involved with the red crab fishery. The surveys described above that were completed by the vessel owners and operators were also completed by the owners and/or presidents of the four wholesale and/or processing companies. These companies are based in New Bedford and Fall River, MA, Portland, ME, and Warren, RI.

No information is available on the employees of these companies, but some demographic information is available on the executives who participated in the survey. All are male and all identify themselves as white or Caucasian and they average just under 48 years old. All report having at least one child and most are married. Most have been involved in commercial fishing-related activities for more than 30 years; their average involvement in the red crab fishery is less than 10 years, although one individual reports being involved in the red crab industry for 30 years.

8.4.4 Fishery-Dependent Service Industries

There is no information available directly on any fishery-dependent service industries that may be involved with the red crab fishery. The type of service industries used by the red crab fishery and their general locations was reported by some vessel owners and operators. The types of services used include: fuel, ice, food and groceries, bait, gear, oil/lubrication, water, hull maintenance, engine maintenance, electronics, insurance, accounting, legal advice, and dockage. These needs are met by services provided in Lower Mid-Coast Maine, Gloucester and the Massachusetts North Shore, Boston and the Massachusetts South Shore, Cape Cod and the Islands, the New Bedford, MA area, Rhode Island, some non-coastal areas of New England, and some areas outside of New England. Of these, the fishery-related service industries in the New Bedford, MA area provide more support to the red crab fishery than the other locations combined. Due to the small size of the fishery, and the small number of fishing vessels involved, however, it is unlikely that providing these services to red crab vessels accounts for more than a very minor component of any service industry's overall fishery-related revenue.

8.4.5 Fishing Communities

There are several ways to consider the communities related to the red crab fishery: (1) the communities in which the vessel owners and operators live; (2) the communities which serve as the primary ports of vessel operations and mooring; and (3) the communities in which the fishing-related support services are obtained.

The vessel owners and operators participating in the survey identified ten communities in which they live, including: Windsor Locks, CT; Fall River, Gloucester, Hamilton, New Bedford, and South Dartmouth, MA; Westport, ME; Adamsville and Tiverton, RI; and Seattle, WA. Red crab fishermen have lived in these communities for over 17 years, on average, and some fishermen report having lived in their communities for as long as 44 years.

When asked whether they considered these communities to be fishing communities, it was interesting to find that the majority do not consider them to be fishing communities and even fewer consider them to be significantly dependent on commercial fishing. Only three vessel owners or operators consider their communities to be significantly dependent on fishing. Those reporting that their towns were not fishing communities suggested this was due to few fishermen living there, the town being located inshore, or the town being a bedroom community. Of those who consider their towns to be fishing communities, they suggested this was due to the amount of fishing activities based in them.

Six ports were identified as the primary ports of vessel operations and mooring, including: Fall River, Gloucester, and New Bedford, MA; Bristol, ME; and Portsmouth and Tiverton, RI. The communities identified as providing fishing-related support services were identified in the previous section and include: Lower Mid-Coast Maine; Gloucester and the Massachusetts North Shore; Boston and the Massachusetts South Shore; Cape Cod and the Islands; the New Bedford, MA area; Rhode Island; some non-coastal areas of New England; and some areas outside of New England.

8.5 Description of the Baseline Economic Characteristics of the Fishery

Much of the following information is taken from a report on social and economic baseline information for the deep-sea red crab fishery. This report is provided in its entirety as Appendix B. The following is provided only as a summary of the information provided in the report.

8.5.1 Harvesting Sector

8.5.1.1 Dependence on the Fishery

Owners and operators of red crab fishing vessels provided information on their dependence on commercial fishing, and the red crab fishery in particular, for their annual household income (see Table 27). Note that on average the respondents report greater than 90% reliance on commercial fishing-related income to support themselves and their families. The red crab fishery is less important on average, but still most respondents report 100% dependence on the red crab fishery for their annual income.

Question	Minimum	Maximum	Average	Median	*n*
Percent income from commercial fishing	75%	100%	93.3%	100%	9
Percent income from red crab fishery	25%	100%	76.1%	100%	9

Table 27: Harvesters' economic dependence upon commercial fishing and red crab fishery for annual household income.

The majority of harvesters surveyed report being actively involved with no other commercial fisheries. The respondents that are involved in other fisheries report being involved with groundfishing, Alaskan crab, king crab, tanner crab, cod, black cod, halibut and salmon. In spite of a majority reporting to be involved with no other fisheries, only one respondent reports having no state or federal fishing permits. Permits listed for the others include tuna, lobster, groundfish, surfclam, squid, and Gulf of Mexico red crab.

When asked if the fishermen in their households have ever worked outside of the fishing industry, a slight majority report that the fishermen in their households have worked outside the fishing industry and the rest report that they have not. When asked how much they could earn if they were not fishing, one respondent reports that they would expect to earn the same, but the rest all report that they would expect to earn less or much less, with most expecting to earn less. The majority of respondents did not know what type of job they might have if they were not fishing. Some non-fishing-related jobs they might pursue include consulting, sales, technology, or some other marine-related employment.

8.5.1.2 Vessel characteristics

Owners and operators of red crab fishing vessels provided basic information on the characteristics of red crab fishing vessels (see Table 28). The average length of vessels in the red crab fishery is 105 feet, ranging from 72 to 150 feet in length. The hold capacity of these vessels is variable, ranging from 60,000 pounds to approximately 320,000 pounds, and averaging just over 122,000 pounds whole weight equivalent. For some vessels, hold capacity was reported in whole weight, but for other vessels the hold capacity was reported in section weight. To convert the section weight data into whole weight equivalents in order to average the hold capacities of all vessels, the fully-cleaned recovery rate conversion formula of 58% (1.72 to 1) provided by NMFS in the emergency regulations was used (66 FR 23182).

Vessels in the red crab fishery range in age from 9 to 36 years old and average 23 years old. The number of crew reported to be employed by each vessel ranged from 5 to 20 and averaged 8.2 crew per vessel. At least two vessels reported the total number of crewmen employed by them, but a portion of the crew rotates their time off (i.e., one vessel reports employing 9 crewmen but only takes 6 out on each fishing trip, allowing 3 a trip off). Most vessels report no seasonal differences in the number of crew they employ, although one respondent indicated that the number of crew varies with catch.

Question	Minimum	Maximum	Average	Median	*n*
Vessel Length (feet)	72	150	105.0	95	8
Hold Capacity (pounds)	60,000	320,000	122,312	70,000	8
Age of Vessel (years)	9	36	23.0	19	7
Number of Crew	5	20	8.2	7	8

Table 28: Vessel characteristics for red crab fishing vessels. Vessel hold capacity is provided in pounds of whole weight equivalent, converted where necessary from section weight into whole weight equivalent using the fully-cleaned recovery rate formula provided in the Secretarial Emergency Action for the Red Crab Fishery (66 FR 23182).

Other information collected on the characteristics of the red crab fishing vessels includes the construction and overall condition of the vessels participating in the red crab fishery. All but one vessel is reported to be constructed of a steel hull, the other constructed of a fiberglass hull. Half the vessels are reported to be in "good" condition (described in the survey as a vessel needing very little attention with a recent overhaul). One vessel was reported in "excellent" condition (described in the survey as a vessel new or very recently overhauled needing no attention). Three vessels were reported in "fair" condition (described in the survey as a vessel needing some attention and needing to be overhauled soon). No vessels were reported in "poor" condition (described in the survey as a vessel needing immediate attention including an overhaul).

Vessel owners and operators were also questioned about some economic aspects of their businesses, focusing on the fixed and variable costs associated with the red crab fishery. Owners and operators of four vessels responded to survey questions on the economics of the red crab fishery, and the results of these questions are summarized here. To protect the confidentiality of the responses to the maximum extent possible, only the mean of the responses to each question will be provided.

8.5.1.3 Catch and Revenue

Vessel owners and operators were asked to provide an average red crab catch and gross revenue per trip for the years 1998 - 2000, inclusive. On average, red crab vessels landed approximately 63,000 pounds of red crab per trip during these years. On average during this time, red crab vessels received an average of approximately $42,000 per trip in gross revenue. Vessel owners and operators also reported their minimum gross revenue needed to break-even, with an average of approximately $4,600 per day of fishing.

8.5.1.4 Trip Expenses

Vessel owners and operators were asked to provide information on their trip expenses for each fishing trip. Information was requested on costs of fuel, oil and lubrication, water, ice, bait, food and groceries, gear expenses and repairs, and any other trip expenses. The average price paid per pound for their bait is reported to be $0.20, with a range from $0.12 per pound to $0.25 per pound. On average, red crab fishing vessels spend approximately $12,600 per trip on the above types of expenses.

Vessel owners and operators also provided information on the division of revenue between the vessel and the crew. All owners and operators reported calculating the boat and crew shares after deducting trip expenses from the gross ex-vessel revenue. On average, 48% of proceeds are paid out as crew shares of the revenue (including the captain's share).

8.5.1.5 Annual Expenses

In addition to the questions on trip expenses, vessel owners and operators were asked about their annual expenses to maintain their business, vessel, and participation in the fishery. Information was requested on such things as interest on any loans, insurance, docking fees, vessel permits and license fees, administrative overhead, association fees, employee benefits, other shore-side expenses, and the depreciation of their vessel and gear. Red crab vessel owners and operators report spending an average of approximately $397,000 per year on these types of annual expenses.

8.5.1.6 Total Variable and Fixed Costs

The information summarized above was used to calculate the total variable and fixed costs for a fishing vessel in the red crab fishery. Variable costs include all per trip expenses, plus half of the annual vessel repair costs divided by the average number of fishing trips taken per year. Fixed costs include all annual expenses plus the other half of the annual vessel repair costs. For the red crab fishery, based on the responses summarized here, the variable costs average $15,000 per trip and the fixed costs average $470,000 per year.

8.5.1.7 Relationship with Processors

The survey completed by red crab vessel owners and operators also included questions on the relationships with red crab processors. They indicated that most use only a single processor, although one owner reports occasionally using a second. Five respondents report that they do not have any contracts with the processors they use, but three report that they do. Respondents indicate that their contracts include processing, marketing, off-loading, and moorage. Some contracts may also include annual and sometimes weekly landings commitments. The survey included a question as to why the red crab fishermen choose to use a particular processor. Most respondents indicated that they choose to sell their red crab to a particular processor in large part out of loyalty to that processor. Offering the best price and developing the best markets were also reasons given for choosing to sell to a particular processor.

8.5.2 Processing Sector

None of the respondents identified as processors report processing red crab exclusively. Other commercial fishery products processed include: clams, dogfish, Jonah crab, lobster, monkfish, mussels, rock crab, scallops, skates, snow crab, and squid.

Processors report that they obtain red crab product from vessels from a variety of ports, including Fall River and New Bedford, Massachusetts, as well as other ports in Massachusetts and Rhode Island. The processors report obtaining red crab product from between one and four vessels each, with an average of two vessels per processor. One respondent indicates that they purchase the red crabs from the vessels and then contract with a third party to actually process red crab, although they do process other fishery-related products.

8.5.2.1 Employees

The number of employees currently employed by the processors varies significantly, from 5 to 1000 with an average of over 300 employees per processor. According to the respondents, the majority of these employees are seasonal in nature, with an average of 146.5 year-round employees per processor. As would be expected given the responses summarized above, most processing employees work either on other fishery-related products or at least do not work exclusively on red crab. On average, less than 13% of processing employees work exclusively on red crab.

8.5.3 Wholesale and Retail Sector

The people and businesses that sell red crab product at the wholesale or retail level are an important component of the fishing industry and of fishing communities. These people and businesses may also be affected by regulations or when conditions change in the fishery. The questions in this section of the survey were an attempt to collect information on the dependence on the red crab fishery of the people and businesses in this sector of the industry. These questions focused on the dependence of wholesalers and retailers on the red crab fishery, their employment, and the products they sell.

8.5.3.1 Business operations

None of the survey respondents identified as wholesalers or retailers report selling red crab exclusively. Other commercial fishery products sold include: calamari, clams, dogfish, groundfish, Jonah, rock and snow crab, lobster, monkfish, mussels, scallops and skates.

Table 29 provides summary information on the characteristics of red crab wholesalers and retailers, based on the responses of those who participated in the survey. They reported that although the majority of their business revenue is derived from commercial fishing-related products (averaging 90%), a smaller proportion of this business revenue is derived from the sale of red crab products. The percentage of their business revenue that comes from the sale of red crabs ranges from less than 1% to 33% and averages slightly more than 25%. The number of employees retained by the respondent red crab wholesalers and retailers ranges from 2 to 150 and averages 32.8 per business operation.

Question	Minimum	Maximum	Average	Median	*n*
Percent revenue from fishing-related products	50%	100%	90.0%	100%	5
Percent revenue from red crab products	< 1%	33%	25.8%	25%	5
Total number of employees	2	150	32.8	3.5	5

Table 29: Characteristics of red crab wholesalers and retailers.

8.5.4 Fishery-Dependent Service Industries

There are no data available on the baseline economic characteristics of the fishery-dependent service industries that provide support services to the red crab fishery. All information known about these industries is provided in the section of the FMP identifying the social and cultural entities involved in the red crab fishery.

8.5.5 International Trade

There are no data available on the economic characteristics of any international trade related to the red crab fishery. The only information available is that at least two wholesalers and/or retailers of red crab products sell between 10% and 15% of their red crab product to foreign enterprises.

8.5.6 Business and Markets

8.5.6.1 <u>Red crab products sold by processors</u>

Three processors report selling between 50 and 75% of their red crab to food service companies, three report selling between 10 and 30% to retail centers, one reports selling 40% to distributors, and one reports selling 100% of their red crab product to a wholesaler. Three respondents report selling only frozen red crab product, in a mixture of whole crabs, claws, sections, and picked meat. Of these, only one respondent reports selling whole crabs and the majority crab product of these respondents appears to be picked meat. A fourth respondent reports selling 100% of their red crab product in the form of fresh picked meat.

8.5.6.2 <u>Red crab products sold by wholesalers and retailers</u>

Three wholesalers and retailers report selling only frozen red crab product, in a mixture of whole crabs, claws, sections, and picked meat. Of these, only one respondent reported selling whole crabs and the majority of all crab product by these respondents appears to be picked meat. A fourth respondent reports selling 100% of their red crab product in the form of fresh picked meat. A fifth respondent reports selling a variety of fresh and frozen red crab. They report selling fresh crabs as whole, claws, sections, and picked meat. They also report selling frozen crabs whole, claws, and sections. Three respondents report selling between 60 and 100% of their red crab product to companies in the U.S. but not in New England; three report selling between 5 and 100% of their red crab product to companies in New England; and two report selling between 10 and 15% or their red crab product to foreign enterprises.

8.6 Description of the Baseline Social Characteristics of the Fishery

Much of the following information is taken from a report on social and economic baseline information for the deep-sea red crab fishery. This report is provided in its entirety as Appendix B. The following is provided only as a summary of the information provided in the report.

8.6.1 Harvesting Sector

8.6.1.1 Family involvement in fishing

All of the harvesters responding to the survey report that their parents and grandparents were not involved in commercial fishing. Three-quarters of the respondents report being the first generation of their family involved in commercial fishing, the rest report being the second generation. Most report that no other members of their families are involved in commercial fishing, although one respondent did report as many as four other family members are involved in commercial fishing. Of the other family members involved in fishing, responses included wives, brothers, and sons.

When asked about their interest in having their children pursue a career in commercial fishing, only two report being interested. Six respondents report being not interested in having their children become involved in commercial fishing, and answers for why they are not interested ranged from a belief that there is no future in fishing to a preference that they attend college. Other reasons included children being female, too many variables in fishing, and the suggestion that the decision was the choice of their children. When asked about whether their children themselves are interested in commercial fishing, only two report their children are interested. Five respondents report that their children are not interested in commercial fishing. Reasons given for why their children are not interested in commercial fishing include that they are too young, they have other interests, they are attending or planning to attend college, and that it is their choice.

Respondents were asked about their family work practices and the amount of time they and their spouses spend in a typical week on various activities. Spouses appear to be primarily responsible for household finances and some record-keeping. The fishermen themselves are primarily responsible for vessel operations, supervising crew, repairing and maintaining the vessel, and sales operations. No one reports any non-fishing related employment by either themselves or their spouses.

Most respondents indicate that they would not have to move from their communities if fishing became more difficult with only two respondents reporting that they would have to move. When asked what they might be able to do to earn a living in the area in which they live (if they were no longer fishing for red crab), suggestions included employment in carpentry, some other boating-related activity, or lobster fishing. Two respondents report not knowing what they could do if they were not fishing and one reported that there would not be much that they could do.

Most respondents report belonging to at least one fishing-related organization and most of these individuals report active participation in the organizations. About half the respondents report that either they or members of their household participate in community organizations, including school and church groups. A majority of respondents report they would not advise young people to go into the fishing industry. Only two suggested that they would advise young people to enter the fishing industry.

The owners and operators of red crab fishing vessels were asked about their time not fishing ("down time") spent on fishing-related activities (gear repair, vessel maintenance, trip planning, attending meetings, etc.). All respondents indicate that they spend more than 10% of their down time on fishing-related activities. The largest percentage of respondents report spending more than half of their down time on fishing-related activities. Five respondents report that the amount of down time they spend on fishing-related activities has increased over time, while four report that this has not increased.

8.6.2 Processing Sector

Other than the information already provided on this sector of the fishery, there is no information available on the baseline social characteristics of the processing and wholesale sectors of the red crab fishery.

8.6.3 Fishery-Dependent Service Industries

There is no information available on the baseline social characteristics of the fishery-dependent service industries that provide support services to the red crab fishery. All information known about these industries is provided in the section of the FMP identifying the social and cultural entities involved in the red crab fishery.

8.7 Protected Species

The primary geographic area affected by the red crab fishery includes Northeast and Mid-Atlantic waters of the United States Exclusive Economic Zone. Although the red crab trap/pot gear is very similar to that used in the American lobster fishery, the deep sea red crab fishery is geographically limited by the narrow shelf edge habitat of the red crab as shown in Figure 23. Red crabs are only found on the continental shelf and slope seabed from the Scotian Shelf to Cape Hatteras in the Northeast waters, although their range extends at similar depths into the Gulf of Mexico. Depth preferences for red crab may be dictated by temperature and salinity and can range between 200 and 1,800 meters. Red crab size may be in inverse proportion to the depth, with larger crabs found in the shallower water (200-400m).

8.7.1 Identification of Protected Species

The Council has determined that the following list of species protected either by the Endangered Species Act of 1973 (ESA), or the Marine Mammal Protection Act of 1972

(MMPA) may be found in the environment utilized by the deep sea red crab fishery under the proposed FMP.

8.7.1.1 Cetaceans

Northern right whale (*Eubalaena glacialis*)	Endangered
Humpback whale (*Megaptera novaeangliae*)	Endangered
Fin whale (*Balaenoptera physalus*)	Endangered
Blue whale (*Balaenoptera musculus*)	Endangered
Sei whale (*Balaenoptera borealis*)	Endangered
Sperm whale (*Physeter macrocephalus*)	Endangered
Minke whale (*Balaenoptera acutorostrata*)	Protected
Beaked whales (*Ziphius* and *Mesoplodon* spp.)	Protected
Risso's dolphin (*Grampus griseus*)	Protected
Pilot whale (*Globicephala* spp.)	Protected
White-sided dolphin (*Lagenorhynchus acutus*)	Protected
Common dolphin (*Delphinus delphis*)	Protected
Spotted and striped dolphins (*Stenella* spp.)	Protected
Bottlenose dolphin (*Tursiops truncatus*)	Protected

8.7.1.2 Sea Turtles

Leatherback sea turtle (*Dermochelys coriacea*)	Endangered
Kemp's ridley sea turtle (*Lepidochelys kempii*)	Endangered
Green sea turtle (*Chelonia mydas*)	Endangered
Hawksbill sea turtle (*Eretmochelys imbricata*)	Endangered
Loggerhead sea turtle (*Caretta caretta*)	Threatened

8.7.1.3 Fish

Shortnose sturgeon (*Acipenser brevirostrum*)	Endangered
Atlantic salmon (*Salmo salar*)	Endangered

8.7.1.4 Birds

Roseate tern (*Sterna dougallii dougallii*)	Endangered
Piping plover (*Charadrius melodus*)	Endangered

8.7.1.5 Critical Habitat Designations

Right whale	Cape Cod Bay Great South Channel

8.7.2 Protected Species Not Likely Affected by this FMP

The Council has reviewed the current information available on the distribution and habitat needs of the endangered, threatened, and otherwise protected species listed above in relation to the action being considered in the Red Crab FMP. Following this review, the Council has made an assessment that deep sea red crab fishing operations, as managed by the Red Crab FMP, are not expected to affect the shortnose sturgeon *(Acipenser brevirostrum*), the Gulf of Maine distinct population segment (DPS) of Atlantic salmon (*Salmo salar*), the roseate tern (*Sterna dougallii dougallii*), the piping plover (*Charadrius melodus*) or the Kemp's ridley *(Lepidochelys kempii)*, green (*Chelonia mydas*) and hawksbill sea turtles (*Eretmochelys imbricata*), all of which are listed species under the Endangered Species Act of 1973.

There are several cetaceans protected under the Marine Mammal Protection Act of 1972 (MMPA) that are found in the waters fished by the deep-sea red crab fishery, namely the minke whale (*Balaenoptera acutorostrata*), beaked whales (*Ziphius* and *Mesoplodon* spp.), Risso's dolphin (*Grampus griseus*), pilot whale (*Globicephala* spp.), Atlantic white-sided dolphin (*Lagenorhynchus acutus*), common dolphin (*Delphinus delphis*), spotted and striped dolphins (*Stenella* spp.), and Atlantic bottlenose dolphin (*Tursiops truncatus*).

However the red crab fishery is not expected to adversely affect these populations in any way that may compromise their ability to maintain optimum sustainable population levels, or cause their serious injury and mortality levels to exceed the potential biological removal (PBR) levels allowed for commercial fisheries. In addition, the Council believes that the red crab fishing operations will not adversely affect the right whale critical habitat areas listed above. The Council will be asking the NMFS and USFWS for concurrence in these assessments.

8.7.2.1 Shortnose Sturgeon

Shortnose sturgeon are benthic fish that mainly occupy the deep channel sections of large rivers. They can be found in large rivers along the western Atlantic coast from St. Johns River, Florida (possibly extirpated from this system), to the Saint John River in New Brunswick, Canada. The species is considered to be anadromous and individuals have been captured in otter trawl gear on the continental shelf. The deep sea habitat of the red crab is likely to be beyond the foraging range of sturgeon. There have been no documented cases of shortnose sturgeon taken in red crab trap/pot gear, or fisheries using similar gear types.

8.7.2.2 Atlantic Salmon

The recent ESA-listing for Atlantic salmon covers the wild population of Atlantic salmon found in rivers and streams from the lower Kennebec River north to the U.S.-Canada border. These include the Dennys, East Machias, Machias, Pleasant, Narraguagus, Ducktrap, and Sheepscot Rivers and Cove Brook. Atlantic salmon are an anadromous species with spawning and juvenile rearing occurring in freshwater rivers followed by migration to the marine environment. Juvenile salmon in New England rivers typically migrate to sea in May after a two to three year period of development in freshwater streams, and remain at sea for two winters before returning to their U.S. natal rivers to spawn from mid October through early November. While at sea, salmon generally undergo an extensive northward migration to waters off Canada and Greenland.

Data from past commercial harvest indicate that post-smolts overwinter in the southern Labrador Sea and in the Bay of Fundy.

The numbers of returning wild Atlantic salmon within the Gulf of Maine Distinct Population Segment (DPS) are perilously small with total run sizes of approximately 150 spawners occurring in 1999 (Baum 2000). Although capture of Atlantic salmon has occurred in commercial fisheries (usually otter trawl or gillnet gear) or by research/survey, no salmon have been reported captured in red crab trap/pot gear, or fisheries using similar gear types.

8.7.2.3 Roseate Tern and Piping Plover

The roseate tern and piping plover inhabit the Northeast coastal waters and nest on the coastal beaches of the Northeast. These birds rely on small schooling fishes (terns) or shoreline invertebrates and other small fauna (plovers) for food. The trap/pot fishing gear and vessel operations conducted by the deep sea red crab fishery poses no threat to these species or their forage species.

8.7.2.4 Kemp's Ridley, Green, Hawksbill, and Loggerhead Sea Turtles

The endangered Kemp's ridley, green, and hawksbill and the threatened loggerhead can be found within the red crab management unit. The deep sea red crab fishery takes place along the continental shelf edge at depths and in oceanographic areas that are beyond the foraging zones of these sea turtle species. Therefore, based on the distribution and foraging patterns, Kemp's ridley, green, hawksbill and loggerhead sea turtles are not likely to interact with red crab trap/pot gear.

8.7.2.5 Minke Whale

Minke whales have a cosmopolitan distribution in polar, temperate, and tropical waters. The Canadian east coast population is one of four populations recognized in the North Atlantic. Minke whales off the eastern coast of the U.S are considered to be part of this population that extends from Davis Strait off Newfoundland to the Gulf of Mexico. The species is common and widely distributed along the U.S continental shelf. They show a certain seasonal distribution with spring and summer peak numbers, falling off in the fall to very low winter numbers. Like all baleen whales, the minke whale generally occupies the continental shelf proper, rather that the continental edge region where the red crab fishery largely occurs. For these reasons minke whales are not likely to interact with red crab pot/trap gear.

8.7.2.6 Beaked Whales

The two genus of beaked whale that inhabit the continental shelf edge of the U.S are *Mesoplodon and Ziphius* are known from strandings to be distributed from Nova Scotia around the Gulf of Mexico into the Caribbean. The population level of these genera are unknown, although a minimum population estimate of 2,419 has been derived for U.S waters (NMFS 2000) from limited survey estimates. Beaked whales are deep diving animals feeding on squid and other deep water fishes. Beaked whales have been observed taken in the pelagic drift gillnet fishery, but not in any other fishery observed by the NMFS. Although their habitat and feeding behavior may bring them to depths where the red crab fishery occurs, their external physiology (narrow body shape with small pectoral flippers and flukes) make it less likely for them to become entangled in buoy or groundlines between traps. Therefore, it is unlikely that the take in this fishery will be at levels that compromise their ability to maintain optimum sustainable population levels, or cause their serious injury and mortality levels to exceed the PBR levels allowed for commercial fisheries.

8.7.2.7 Risso's Dolphin and Pilot Whale

The Risso's dolphin and pilot whale are two odontocetes with similar distribution and feeding patterns. Both species are distributed along the continental shelf edge of North America from Cape Hatteras to Georges Bank. Minimum population estimates for the Risso's dolphin and pilot whale of 22,916 and 11,343 respectively have been derived for U.S waters (NMFS 2000) from limited survey estimates. Both species have been observed taken in the pelagic drift gillnet fishery, pelagic longline, and mid-water trawl fisheries, but have never been reported in any pot/trap gear. Although their feeding habitat overlaps the distribution of the red crab fishery, their pelagic prey species (squid and schooling fishes) would make it unlikely that they would encounter the bottom tending pot/trap gear of the red crab fishery. Therefore, it is unlikely that the take in this fishery will be at levels that compromise their ability to maintain optimum sustainable population levels, or cause their serious injury and mortality levels to exceed the PBR levels allowed for commercial fisheries.

8.7.2.8 Atlantic White-Sided Dolphin

White-sided dolphins are found in the temperate and sub-polar waters of the North Atlantic, primarily on the continental shelf waters out to the 100 m depth contour. The species is distributed from central western Greenland to North Carolina, with the Gulf of Maine stock commonly found from Hudson Canyon to Georges Bank and into the Gulf of Maine to the Bay of Fundy. A minimum population estimate for the white-sided dolphin 19,196 has been derived for U.S waters (NMFS 2000) from limited survey estimates. White-sided dolphins have been observed taken in the multispecies sink gillnet fishery, the pelagic drift gillnet fishery, and several mid-water and bottom trawl fisheries, but have never been reported in any pot/trap gear. Their feeding habitat and range is at the shallow end of the red crab fishery, and their pelagic prey species (squid and schooling fishes) and small size would make it unlikely that they would encounter the bottom tending pot/trap gear of the red crab fishery. Therefore, it is unlikely that the take in this fishery will be at levels that compromise their ability to maintain optimum sustainable population levels, or cause their serious injury and mortality levels to exceed the PBR levels allowed for commercial fisheries.

8.7.2.9 Pelagic Delphinids (Common, Spotted, Striped, and Bottlenose Dolphins)

The pelagic delphinid complex is made up of small odontocete species that are broadly distributed along the continental shelf edge, where depths range from 200 - 400 meters. They are commonly found in large schools feeding on surface or near surface schools of fish. The minimum population estimates for each species number in the tens of thousands. They are known to be taken in pelagic and sink gillnets gear as well as mid-water and bottom trawl gear, but never in pot/trap gear. Their pelagic prey species and small size would make it unlikely that they would encounter the bottom tending pot/trap gear of the red crab fishery. Therefore, it is unlikely that the take in this fishery will be at levels that compromise their ability to maintain optimum sustainable population levels, or cause their serious injury and mortality levels to exceed the PBR levels allowed for commercial fisheries.

8.7.2.10 Right Whale Critical Habitat

The Council has also assessed the potential for deep sea red crab fishing operations adversely affecting critical habitat that has been designated for the right whale. NMFS evaluated the potential effects of the proposed Federal lobster fisheries on the critical habitats that have been designated in the Great South Channel and Cape Cod Bay in the Biological Opinion issued for that fishery on June 14, 2001. In that Opinion NMFS found no evidence that suggest that the operation of the Federal lobster fishery had any adverse effects on the value of critical habitat designated for the right whale. The deep sea red crab fishery does not occur in the Cape Cod Bay area and is prevented from fishing in the Great South Channel during the right whale high use period for that area (April 1 until June 30) under the existing ALWTRP regulations. Therefore, the Council does not believe the red crab fishery, as operated under the Red Crab FMP, will affect right whale critical habitat.

8.7.3 Status of Protected Species Potentially Affected by this FMP

The potential impacts of the management alternatives and measures being considered under this FMP on protected species are described within Section 5.3 and Section 5.4. This remainder of this section will focus on the status of the various species listed above that inhabit the red crab fishing area and may adversely be affected by the fishing operations occurring under the Red Crab FMP. Additional background information on the range-wide status of these species and a description of the critical habitat can be found in a number of published documents, including sea turtle status reviews (NMFS and USFWS 1995, Marine Turtle Working Group - TEWG 1998, 2000) and biological reports (USFWS 1997), recovery plans for the humpback whale (NMFS 1991a), right whale (NMFS 1991b), loggerhead turtle (NMFS and USFWS 1991) and leatherback turtle (NMFS and USFWS 1992) and the 2000 and Draft 2001 Marine Mammal Stock Assessment Reports (Waring et al. 2000).

8.7.3.1 Right Whale

Right whales have occurred historically in all the world's oceans from temperate to subarctic latitudes. NMFS recognizes three major subdivisions of right whales: North Pacific, North Atlantic, and Southern Hemisphere. NMFS further recognizes two extant subunits in the North Atlantic: eastern and western. A third subunit may have existed in the central Atlantic (migrating from east of Greenland to the Azores or Bermuda), but this stock appears to be extinct (Perry et al. 1999). Because of our limited understanding of the genetic structure of the entire species, the most conservative approach to this species would treat these right whale subunits as recovery units whose survival and recovery is critical to the survival and recovery of the species.

Of all of the large whales, the North Atlantic right whale has the highest risk of extinction. The scarcity of right whales is the result of an 800-year history of whaling that continued into the 1960s (Klumov 1962). In the North Atlantic, records indicate that right whales were subject to commercial whaling as early as 1059. Between the 11th and 17th centuries an estimated 25,000-40,000 right whales are believed to have been taken. The size of the western North Atlantic right whale population at the termination of whaling is unknown. The stock was recognized as seriously depleted as early as 1750. However, right whales continued to be taken in shore-based operations or opportunistically by whalers in search of other species as late as the 1920's. By the time the species was internationally protected in 1935 there may have been fewer than 100 right whales in the western North Atlantic (Hain 1975; Reeves et al. 1992; Kenney et al. 1995 in Waring et al. 2000).

Intense whaling was likely the first step toward the critically endangered status of North Atlantic and North Pacific right whales. Currently, the North Pacific population is so small that no reliable estimate can be given, and the eastern subpopulation of the North Atlantic population may already be extinct. The western North Atlantic subpopulation is the most numerous of the North Atlantic right whales but is only estimated to number approximately 300 animals. North Atlantic right whales have been protected for more than 50 years from the pressures of whaling, yet most stocks show no evidence of recovery. In contrast, the southern right whale is recovering with a growth rate of 7% in many areas.

Right whales appear to prefer shallow coastal waters, but their distribution is also strongly correlated to the distribution of their prey (zooplankton). In both northern and southern hemispheres, right whales are observed in the lower latitudes and more coastal waters during winter, where calving takes place, and then tend to migrate to higher latitudes during the summer. The distribution of right whales in summer and fall in both hemispheres appears linked to the distribution of their principal zooplankton prey (Winn et al. 1986). They generally occur in western North Atlantic waters west of the Gulf Stream and are most commonly associated with cooler waters (21º C). They are not found in the Caribbean and have been recorded only rarely in the Gulf of Mexico.

Right whales feed on zooplankton through the water column, and in shallow waters may feed near the bottom. In the Gulf of Maine they have been observed feeding on zooplankton, primarily copepods, by skimming at or below the water's surface with open mouths (NMFS 1991b; Kenney et al. 1986; Murison and Gaskin 1989; and Mayo and Marx 1990). Research suggests that right whales must locate and exploit extremely dense patches of zooplankton to feed efficiently (Waring et al. 2000). New England waters include important foraging habitat for right whales and at least some portion of the North Atlantic right whale population is present in these waters throughout most months of the year. They are most abundant in Cape Cod Bay between February and April

(Hamilton and Mayo 1990; Schevill et al. 1986; Watkins and Schevill 1982) and in the Great South Channel in May and June (Kenney et al. 1986; Payne et al. 1990) where they have been observed feeding predominantly on copepods, zooplankton commonly found in that area (Waring et al. 2000). Right whales also frequent Stellwagen Bank and Jeffrey's Ledge, as well as Canadian waters including the Bay of Fundy and Browns and Baccaro Banks, in the spring and summer months. Mid-Atlantic waters are used as a migratory pathway from the spring and summer feeding/nursery areas to the winter calving grounds off the coast of Georgia and Florida.

NMFS designated right whale critical habitat on June 3, 1994 (59 FR 28793) to help protect important right whale foraging and calving areas within the U.S. These include the waters of Cape Cod Bay and the Great South Channel off the coast of Massachusetts, and waters off the coasts of southern Georgia and northern Florida. In 1993, Canada's Department of Fisheries declared two conservation areas for right whales; one in the Grand Manan Basin in the lower Bay of Fundy, and a second in Roseway Basin between Browns and Baccaro Banks (Canadian Recovery Plan for the North Atlantic Right Whale 2000).

There is, however, much about right whale movements and habitat that is still not known or understood. Approximately 85% of the population is unaccounted for during the winter (Waring et al. 2000). Telemetry technology, used to track whales, has shown lengthy and somewhat distant excursions into deep water off of the continental shelf (Mate et al. 1997). In addition, photographs of identified individuals have documented northern movements as far as Newfoundland, the Labrador Basin and southeast of Greenland (Knowlton et al. 1992). During the winter of 1999/2000, appreciable numbers of right whales were recorded in the Charleston, SC area. Because survey efforts in the mid-Atlantic have been limited, it is unknown whether this is typical or whether it represents a northern expansion of the normal winter range, perhaps due to unseasonably warm waters. Sixteen satellite tags were attached to right whales in the Bay of Fundy, Canada, during summer 2000 in an effort to further elucidate the movements and important habitat for North Atlantic right whales. The movements of these whales varied, with some remaining in the tagging area and others making periodic excursions to other areas before returning to the Bay of Fundy. Several individuals were observed to go to the coastal waters of Maine, while others traveled to the Scotian Shelf. One individual was successfully tracked throughout the fall, and was followed on her migration to the Georgia/Florida wintering area.

Recognizing the precarious status of the right whale, the continued threats present in its coastal habitat throughout its range, and the uncertainty surrounding attempts to characterize population trends, the International Whaling Commission (IWC) held a special meeting of its Scientific Committee from March 19-25, 1998, in Cape Town, South Africa, to conduct a comprehensive assessment of right whales worldwide. The workshop's participants reviewed available information on the North Atlantic right whale. The conclusions of Caswell et al. (1999) were particularly alarming. Using data on reproduction and survival through 1996, Caswell determined that the western North Atlantic right whale population was declining at a rate of 2.4% per year, with one model suggesting that the mortality rate of the right whale population has increased five-fold in less than one generation. According to Caswell, if the mortality rate as of 1996 does not decrease and the population performance does not improve, extinction could occur in 191 years and would be certain within 400 years.

The IWC Workshop participants expressed “considerable concern” in general for the status of the western North Atlantic right whales. Based on recent (1993-1995) observations of near-failure of calf production, the significantly high mortality rate, and an observed increase in the calving interval, it was suggested that the slow but steady recovery rate published in Knowlton et al. (1994) may not be continuing. Workshop participants urgently recommended increased efforts to reduce the human-caused mortality factors affecting this right whale population.

In addition to the concerns of the high mortality rate for North Atlantic right whales, there has been concern over the decline in birth rate. In the three calving seasons following Caswell’s analysis, only 10 calves are known to have been born into the population, with only one known right whale birth in the 1999/2000 season. However, the 2000/2001 calving season had 31 right whale calves sighted, with 27 surviving. Although these births are encouraging, biologists recognize that there may be some natural mortality with these calves and cautious optimism is necessary because of how close the species is to extinction. In addition, efforts to reduce human-caused mortality must be accelerated if these individuals are to survive to sexual maturity and help reverse the population decline.

One question that has repeatedly arisen is the effect that “bottlenecking” may have played on the genetic integrity of right whales. Several genetics studies have attempted to examine the genetic diversity of right whales. Results from a study by Schaeff et al. (1997) indicate that North Atlantic right whales are less genetically diverse than southern right whales; a separate population that numbers at least four times as many animals with an annual growth rate of nearly seven percent. A recent study compared the genetic diversity of North Atlantic right whales with the genetic diversity of southern right whales. The researchers found only five distinct haplotypes (a maternal genetic marker) exist amongst 180 different North Atlantic right whales, versus 10 haplotypes amongst just 16 sampled southern right whales. In addition, one of the five haplotypes found in the North Atlantic right whales was observed in only four animals; all males born prior to 1982 (Malik et al. 2000). Because this genetic marker can be passed only from female to offspring, there is an expectation that it will be lost from the population. The last known female with this type was the animal killed by the shore fishery at Amagansett, Long Island in 1907. Interestingly, this haplotype is basal to all others worldwide (i.e., it is the most ancient).

While such low genetic diversity is of concern, there is a lack of information on how this limited genetic variation might affect the reproduction or survivability of the North Atlantic right whale population. It has been suggested that North Atlantic right whales have been at a low population size for hundreds of years and, while the present population exhibits very low genetic diversity, the major effects of harmful genes are thought to have occurred well in the past, effectively eliminating those genes from the population (Kenney 2000). To help determine how long North Atlantic right whales have exhibited such low genetic diversity, researchers have analyzed DNA extracted from museum specimens. Although the sample size was small (n=6), Rosenbaum et al. (2000) found these samples represented four different haplotypes, all of which are still present in the current population. This study suggests that there has not been a significant loss of genetic diversity within the last 191 years and any significant reduction in genetic diversity likely occurred prior to the late 19th century.

The role of contaminants or biotoxins in reducing right whale reproduction has also been raised. Contaminant studies have confirmed that right whales are exposed to and accumulate contaminants, but the effect that such contaminants might be having on right whale reproduction or survivability is unknown.

It has been suggested that competition for food resources may be impacting right whale reproduction. Researchers have found that North Atlantic right whales appear to have thinner blubber than right whales from the South Atlantic (Kenney 2000). However, there is no evidence at present to demonstrate that the decline in birth rate and increase in calving interval is related to a food shortage. It has also been suggested that oceanic conditions affecting the concentration of copepods may in turn have an effect on right whales since they rely on dense concentrations of copepods to feed efficiently (Kenney 2000). Once again, however, evidence is lacking to demonstrate the relationship between oceanic conditions and copepod abundance to right whale fitness and reproduction rates.

General human impacts and entanglement

Right whales may be adversely affected by habitat degradation, habitat exclusion, acoustic trauma, harassment, or reduction in prey resources due to trophic effects resulting from a variety of activities including the operation of commercial fisheries. However, the major known sources of anthropogenic mortality and injury of right whales clearly are ship strikes and entanglement in commercial fishing gear.

Based on photographs of catalogued animals from 1959 and 1989, Kraus (1990) estimated that 57% of right whales exhibited scars from entanglement and 7% from ship strikes (propeller injuries). Hamilton et al. (1998) updated this work using data from 1935 through 1995. The new study estimated that 61.6% of right whales exhibit injuries caused by entanglement, and 6.4% exhibit signs of injury from vessel strikes. These data may be misleading as a ship strike may be less of a “recoverable” event than entanglement in rope. It is also known that several whales have apparently been entangled on more than one occasion, and that some right whales that have been entangled were subsequently involved in ship strikes. These numbers are primarily based on sightings of free-swimming animals that initially survive the entanglement. Because some animals may drown or be killed immediately, the actual number of interactions may be higher.

It should be noted that no information is currently available on the response of the right whale population to recent (1997-1999) efforts to mitigate the effects of entanglement and ship strikes. However, as noted above, both entanglements and ship strikes have continued to occur. Therefore, it is not possible to determine whether the declining trend reported by Caswell et al. (1999) is continuing. Furthermore, results reported by Caswell suggest that it is not possible to determine that anthropogenic mortalities alone are responsible for the decline in right whale survival. However, the IWC concluded that reduction of anthropogenic mortalities would significantly improve the species' survival probability.

The best available information makes it reasonable to conclude that the current death rate exceeds the birth rate in the western North Atlantic right whale population. The nearly complete reproductive failure in this population from 1993 to 1995 and again in 1998 and 1999 suggests that this pattern has continued for almost a decade, though the 2000/2001 season appears the most promising in the past five years in terms of calves born. Because no population can sustain a high death rate and low birth rate indefinitely, this combination places the North Atlantic right whale population at high risk of extinction. Coupled with an increasing calving interval, the relatively large number of young right whales (0-4 years) and adults that are killed, by human-related factors, the likelihood of extinction is clear. The recent increase in births gives rise to optimism, however these young animals must be provided with protection so that they can mature and contribute to future generations in order to be a factor in stabilizing of the population.

8.7.3.2 Humpback Whale

Humpback whales calve and mate in the West Indies and migrate to feeding areas in the northwestern Atlantic during the summer months. Six separate feeding areas are utilized in northern waters after their return (Waring et al. 2000). Only one of these feeding areas, the GOM, lies within U.S. waters and is within the action area of this consultation. Most of the humpbacks that forage in the GOM visit Stellwagen Bank and the waters of Massachusetts and Cape Cod Bays. Sightings are most frequent from mid-March through November between 41º N and 43º N, from the Great South Channel north along the outside of Cape Cod to Stellwagen Bank and Jeffreys Ledge (CeTAP 1982), and peak in May and August. Small numbers of individuals may be present in this area year-round. They feed on a number of species of small schooling fishes, particularly sand lance and Atlantic herring, by targeting fish schools and filtering large amounts of water for their associated prey. Humpback whales have also been observed feeding on krill (Wynne and Schwartz 1999).

Various papers (Barlow and Clapham 1997; Clapham et al. 1999) summarized information gathered from a catalogue of photographs of 643 individuals from the western North Atlantic population of humpback whales. These photographs identified reproductively mature western North Atlantic humpbacks wintering in tropical breeding grounds in the Antilles, primarily on Silver and Navidad Banks, north of the Dominican Republic. The primary winter range also includes the Virgin Islands and Puerto Rico (NMFS 1991a). In general, it is believed that calving and copulation take place on the winter range. Calves are born from December through March and are about 4 meters at birth. Sexually mature females give birth approximately every 2 to 3 years. Sexual maturity is reached between 4 and 6 years of age for females and between 7 and 15 years for males. Size at maturity is about 12 meters.

Humpback whales use the mid-Atlantic as a migratory pathway, but it may also be an important feeding area for juveniles. Since 1989, observations of juvenile humpbacks in the mid-Atlantic have been increasing during the winter months, peaking January through March (Swingle et al. 1993). Biologists theorize that non-reproductive animals may be establishing a winter feeding range in the mid-Atlantic since they are not participating in reproductive behavior in the Caribbean. Those whales using this mid-Atlantic area that have been identified were found to be residents of the GOM and Atlantic Canada (Gulf of St. Lawrence and Newfoundland) feeding groups, suggesting a mixing of different feeding stocks in the mid-Atlantic region.

In concert with the increase in mid-Atlantic whale sightings, strandings of humpback whales have increased between New Jersey and Florida since 1985. Strandings were most frequent during September through April in North Carolina and Virginia waters, and were composed primarily of juvenile humpback whales of no more than 11 meters in length (Wiley et al. 1995). Six of 18 humpbacks for which the cause of mortality was determined were killed by vessel strikes. An additional humpback had scars and bone fractures indicative of a previous vessel strike that may have contributed to the whale's mortality.

New information has become available on the status and trends of the humpback whale population in the North Atlantic. Although current and maximum net productivity rates are unknown at this time, the population is apparently increasing. It has not yet been determined whether this increase is uniform across all six feeding stocks (Waring et al. 2000). For example, the overall rate of increase has been estimated at 9.0% (CV=0.25) by Katona and Beard (1990), while a 6.5% rate was reported for the Gulf of Maine by Barlow and Clapham (1997) using data through 1991. The rate reported by Barlow and Clapham (1997) may roughly approximate the rate of increase for the portion of the population within the red crab management area.

A variety of methods have been used to estimate the North Atlantic humpback whale population. However, a photographic mark-recapture analyses from the Years of the North Atlantic Humpback (YONAH) project gave a North Atlantic basin-wide estimate of 10,600 (95% c.i. = 9,300 - 12,100) is regarded as the best available estimate for the North Atlantic population.

General human impacts and entanglement

The major known sources of anthropogenic mortality and injury of humpback whales include entanglement in commercial fishing gear and ship strikes. Based on photographs of the caudal peduncle of humpback whales, Robbins and Mattila (1999) estimated that at least 48% --- and possibly as many as 78% --- of animals in the Gulf of Maine exhibit scarring caused by entanglement. Several whales have apparently been entangled on more than one occasion. These estimates are based on sightings of free-swimming animals that initially survive the encounter. Because some whales may drown immediately, the actual number of interactions may be higher. In addition, the actual number of species-gear interactions is contingent on the intensity of observations from aerial and ship surveys.

Humpback whales may also be adversely affected by habitat degradation, habitat exclusion, acoustic trauma, harassment, or reduction in prey resources due to trophic effects resulting from a variety of activities including the operation of commercial fisheries.

8.7.3.3 Fin Whale

Fin whales inhabit a wide range of latitudes between 20-75° N and 20-75° S (Perry et al. 1999). Fin whales spend the summer feeding in the relatively high latitudes of both hemispheres, particularly along the cold eastern boundary currents in the North Atlantic and North Pacific Oceans and in Antarctic waters (IWC 1992). Most migrate seasonally from relatively high-latitude Arctic and Antarctic feeding areas in the summer to relatively low-latitude breeding and calving areas in the winter (Perry et al. 1999).

As was the case for the right and humpback whales, fin whale populations were heavily affected by commercial whaling. However, commercial exploitation of fin whales occurred much later than for right and humpback whales. Although some fin whales were taken as early as the 17th century by the Japanese using a fairly primitive open-water netting technique (Perry et al. 1999) and were hunted occasionally by sailing vessel whalers in the 19th century (Mitchell and Reeves 1983), wide-scale commercial exploitation of fin whales did not occur until the 20th century when the use of steam power and harpoon-gun technology made exploitation of this faster, more offshore species feasible. In the southern hemisphere, over 700,000 fin whales were landed in the 20th century. More than 48,000 fin whales were taken in the North Atlantic between 1860 and 1970 (Perry et al. 1999). Fisheries existed off of Newfoundland, Nova Scotia, Norway, Iceland, the Faroe Islands, Svalbard (Spitsbergen), the islands of the British coasts, Spain and Portugal. Fin whales were rarely taken in U.S. waters, except when they ventured near the shores of Provincetown, MA, during the late 1800's (Perry et al. 1999).

Various estimates have been provided to describe the current status of fin whales in western North Atlantic waters. Based on the catch history and trends in Catch Per Unit Effort, an estimate of 3,590 to 6,300 fin whales was obtained for the entire western North Atlantic (Perry et al. 1999). The latest (Waring et al. 2001) SAR gives a best estimate of abundance for fin whales of 2,814 (CV = 0.21). This is currently an underestimate, as too little is known about population structure, and the estimate is derived from surveys over a limited portion of the western North Atlantic.

In the North Atlantic today, fin whales are widespread and occur from the Gulf of Mexico and Mediterranean Sea northward to the edges of the arctic pack ice (NMFS 1998a). A number of researchers have suggested the existence of fin whale subpopulations in the North Atlantic. Mizroch et al. (1984) suggested that local depletions resulting from commercial overharvesting supported the existence of North Atlantic fin whale subpopulations. Others have used genetics information to provide support for the belief that there are several subpopulations of fin whales in the North Atlantic and Mediterranean (Bérubé et al. 1998). In 1976, the IWC's Scientific Committee proposed seven stocks for North Atlantic fin whales. However, it is uncertain whether these stock boundaries define biologically isolated units (Waring et al. 2000). The NMFS has designated one stock of fin whale for U.S. waters of the North Atlantic (Waring et al. 1998) where the species is commonly found from Cape Hatteras northward.

During 1978-1982 aerial surveys, fin whales accounted for 24% of all cetaceans and 46% of all large cetaceans sighted over the continental shelf between Cape Hatteras and Nova Scotia (Waring et al. 1998). Underwater listening systems have also demonstrated that the fin whale is the most acoustically common whale species heard in the North Atlantic (Clark 1995). The single most important area for this species appeared to be from the Great South Channel, along the 50 meter isobath past Cape Cod, over Stellwagen Bank, and past Cape Ann to Jeffrey's Ledge (Hain et al. 1992).

Despite our broad knowledge of fin whales, less is known about their life history as compared to right and humpback whales. Age at sexual maturity for both sexes ranges from 5-15 years. Physical maturity is reached at 20-30 years. Conception occurs during a 5 month winter period in either hemisphere. After a 12 month gestation, a single calf is born. The calf is weaned between 6 and 11 months after birth. The mean calving interval is 2.7 years, with a range of between 2 and 3 years (Agler et al. 1993). Like right and humpback whales, fin whales are believed to use northwestern North Atlantic waters primarily for feeding and migrate to more southern waters for calving. However, the overall pattern of fin whale movement consists of a less obvious north-south pattern of migration than that of right and humpback whales. Based on acoustic recordings from hydrophone arrays, Clark (1995) reported a general pattern of fin whale movements in the fall from the Labrador/Newfoundland region, south past Bermuda, and into the West Indies. However, evidence regarding where the majority of fin whales winter, calve, and mate is still scarce.

The overall distribution of fin whales may be based on prey availability. This species preys opportunistically on both invertebrates and fish (Watkins et al. 1984). The predominant prey of fin whales varies greatly in different geographical areas depending on what is locally available. In the western North Atlantic fin whales feed on a variety of small schooling fish (i.e., herring, capelin, sand lance) as well as squid and planktonic crustaceans (Wynne and Schwartz 1999). As with humpback whales, fin whales feed by filtering large volumes of water for their prey through their baleen plates. Photo identification studies in western North Atlantic feeding areas, particularly in Massachusetts Bay, have shown a high rate of annual return by fin whales, both within years and between years (Seipt et al. 1990).

As discussed above, fin whales were the focus of commercial whaling, primarily in the 20^{th} century. The IWC did not begin to manage commercial whaling of fin whales in the North Atlantic until 1976. In 1987, fin whales were given total protection in the North Atlantic with the exception of a subsistence whaling hunt for Greenland. In total, there have been 239 reported kills of fin whales from the North Atlantic from 1988 to 1995.

General human impacts and entanglement

The major known sources of anthropogenic mortality and injury of fin whales include ship strikes and entanglement in commercial fishing gear. However, many of the reports of mortality cannot be attributed to a particular source. Of 18 fin whale mortality records collected between 1991 and 1995, four were associated with vessel interactions, although the proximal cause of mortality was not known. These numbers should be viewed as absolute minimum numbers; the total number of mortalities and injuries cannot be estimated but is believed to be higher since it is unlikely that all carcasses will be observed. In general, known mortalities of fin whales are less than those recorded for right and humpback whales. This may be due in part to the more offshore distribution of fin whales where they are either less likely to encounter entangling gear, or are less likely to be noticed when gear entanglements or vessel strikes do occur. Fin whales may also be adversely affected by habitat degradation, habitat exclusion, acoustic trauma, harassment, or reduction in prey resources due to trophic effects resulting from a variety of activities including the operation of commercial fisheries.

8.7.3.4 Sei Whale

Sei whales are a widespread species in the world's temperate, subpolar and subtropical and even tropical marine waters. However, they appear to be more restricted to temperate waters than other balaenopterids (Perry et al. 1999). Mitchell and Chapman (1977) suggested that the sei whale population in the western North Atlantic consists of two stocks, a Nova Scotian Shelf stock and a Labrador Sea stock. The Nova Scotian Shelf stock includes the continental shelf waters of the northeastern United States, and extends northeastward to south of Newfoundland. The IWC boundaries for this stock are from the U.S. east coast to Cape Breton, Nova Scotia and east to longitude 42° (Waring et al. 2000). This is the only sei whale stock within the red crab management area.

Sei whales became the target of modern commercial whalers primarily in the late 19^{th} and early 20^{th} century after stocks of other whales, including right, humpback, fin and blues, had already been depleted. Sei whales were taken in large numbers by Norway and Scotland from the beginning of modern whaling (NMFS 1998a). In the western North Atlantic, sei whales were originally hunted off of Norway and Iceland, but from 1967-1972, sei whales were also taken off of Nova Scotia (Perry et al. 1999). A total of 825 sei whales were taken on the Scotian Shelf between 1966-1972, and an additional 16 were taken from the same area during the same time by a shore based Newfoundland whaling station (Perry et al. 1999). There is no estimate for the abundance of sei whales prior to commercial whaling. Based on whaling records, approximately14,295 sei whales were taken in the entire North Atlantic from 1885 to 1984 (Perry et al. 1999).

Sei whales winter in warm temperate or subtropical waters and summer in more northern latitudes. In the northern Atlantic, most births occur in November and December when the whales are on the wintering grounds. Conception is believed to occur in December and January. Gestation lasts for 12 months and the calf is weaned at 6-9 months when the whales are on the summer feeding grounds (Draft Recovery Plan, NMFS 1998a). Sei whales reach sexual maturity at 5-15 years of age. The calving interval is believed to be 2-3 years (Perry et al. 1999).

Sei whales occur in deep water throughout their range, typically over the continental slope or in basins situated between banks (Draft Recovery Plan, NMFS 1998a). In the northwest Atlantic, the whales travel along the eastern Canadian coast in autumn, June and July on their way to and from the Gulf of Maine and Georges Bank where they occur in winter and spring. The sei whale is most common on Georges Bank and into the Gulf of Maine/Bay of Fundy region during spring and summer, primarily in deeper waters. Individuals may range as far south as North Carolina. It is important to note that sei whales are known for inhabiting an area for weeks at a time then disappearing for year or even decades; this has been observed all over the world, including in the southwestern GOM in 1986. The basis for this phenomenon is not clear.

Although sei whales may prey upon small schooling fish and squid in the action area, available information suggests that calanoid copepods and euphausiids are the primary prey of this species. There are occasional influxes of sei whales further into Gulf of Maine waters, presumably in conjunction with years of high copepod abundance inshore. Sei whales are occasionally seen feeding in association with right whales in the southern Gulf of Maine and in the Bay of Fundy. However, there is no evidence to demonstrate interspecific competition between these species for food resources. There is very little information on natural mortality factors for sei whales. Possible causes of natural mortality, particularly for young, old or otherwise compromised individuals are shark attacks, killer whale attacks, and parasites.

There are insufficient data to determine trends of the sei whale population. Because there are no abundance estimates within the last 10 years, a minimum population estimate cannot be determined for NMFS management purposes (Waring et al. 2000). Abundance surveys are problematic not only because this species is difficult to distinguish from the fin whale but more significant is that too little is known of the sei whale's distribution, population structure and patterns of movement; thus survey design and data interpretation are very difficult.

General human impacts and entanglement

Few instances of injury or mortality of sei whales due to entanglement or vessel strikes have been recorded in U.S. waters. Entanglement is not known to impact this species in the U.S. Atlantic, possibly because sei whales typically inhabit waters further offshore than most commercial fishing operations, or perhaps entanglements do occur but are less likely to be observed. A small number of ship strikes of this species have been recorded. The most recent documented incident occurred in 1994 when a carcass was brought in on the bow of a container ship in Charlestown, Massachusetts. Other impacts noted above for other baleen whales may also occur. Due to the deep-water distribution of this species, interactions that do occur are less likely to be observed or reported than those involving right, humpback, and fin whales that often frequent areas within the continental shelf.

8.7.3.5 Blue Whale

Like the fin whale, blue whales occur worldwide and are believed to follow a similar migration pattern from northern summering grounds to more southern wintering areas (Perry et al. 1999). Blue whales range in the North Atlantic extends from the subtropics to Baffin Bay and the Greenland Sea (Aecium and Leatherwood 1985). The IWC currently recognizes these whales as one stock (Perry et al. 1999).

Blue whales were intensively hunted in all of the world's oceans from the turn of the century to the mid-1960's (NMFS 1998b). Blue whales were occasionally hunted by sailing vessel whalers in the 19th century. However, development of steam-powered vessels and deck-mounted harpoon guns in the late 19th century made it possible to exploit them on an industrial scale (NMFS 1998b). Blue whale populations declined worldwide as the new technology spread and began to receive widespread use (Perry et al. 1999).

In the North Atlantic, Norway shifted operations to fin whales as early as 1882 due to the scarcity of blue whales (Perry et al. 1999). In all, at least 11,000 blue whales were taken in the North Atlantic from the late 19th century through the mid-20th century. Blue whales were given complete protection in the North Atlantic in 1955 under the International Convention for the Regulation of Whaling. However, Iceland continued to hunt blue whales until 1960. There are no good estimates of the pre-exploitation size of the western North Atlantic blue whale stock but it is widely believed that this stock was severely depleted by the time legal protection was introduced in 1955 (Perry et al. 1999). Mitchell (1974) suggested that the stock numbered in the very low hundreds during the late 1960's through early 1970's (Perry et al. 1999). Photo-identification studies of blue whales in the Gulf of St. Lawrence from 1979 to 1995 identified 320 individual whales (NMFS 1998b). The NMFS recognizes a minimum population estimate of 308 blue whales for the western North Atlantic (Waring et al. 1999).

Blue whales are only occasional visitors to east coast U.S. waters. They are more commonly found in Canadian waters, particularly the Gulf of St. Lawrence where they are present for most of the year, and other areas of the North Atlantic. It is assumed that blue whale distribution is governed largely by food requirements (NMFS 1998b). In the Gulf of St. Lawrence, blue whales appear to predominantly feed on zooplankton (NMFS 1998b).

Compared to the other species of large whales, relatively little is known about this species. Sexual maturity is believed to occur in both sexes at 5-15 years of age. Gestation lasts 10-12 months and calves nurse for 6-7 months. The average calving interval is estimated to be 2-3 years. Birth and mating both take place in the winter season (NMFS 1998c), but the location of wintering areas is speculative (Perry et al. 1999). In 1992 the U.S. Navy and contractors conducted an extensive blue whale acoustic survey of the North Atlantic and found concentrations of blue whales on the Grand Banks and west of the British Isles. One whale was tracked for 43 days during which time it traveled 1,400 nautical miles around the general area of Bermuda (Perry et al. 1999).

There is limited information on the factors affecting natural mortality of blue whales in the North Atlantic. Ice entrapment is known to kill and seriously injure some blue whales, particularly along the southwest coast of Newfoundland, during late winter and early spring. Habitat degradation has been suggested as possibly affecting blue whales such as in the St. Lawrence River and the Gulf of St. Lawrence where habitat has been degraded by acoustic and chemical pollution. However, there is no data to confirm that blue whales have been affected by such habitat changes (Perry et al. 1999).

General human impacts and entanglement

Entanglements in fishing gear and ship strikes are believed to be the major sources of anthropogenic mortality and injury of blue whales. However, confirmed deaths or serious injuries from either are few. In 1987, concurrent with an unusual influx of blue whales into the Gulf of Maine, one report was received from a whale watch boat that spotted a blue whale in the southern Gulf of Maine entangled in gear described as probable lobster pot gear. A second animal found in the Gulf of St. Lawrence apparently died from the effects of an entanglement. In March 1998, a juvenile male blue whale was carried into Rhode Island waters on the bow of a tanker. The cause of death was determined to be due to a ship strike, although not necessarily caused by the tanker on which it was observed, and the strike may have occurred outside the U.S. EEZ (Waring et al. 2000). No recent entanglements of blue whales have been reported from the U.S. Atlantic. Other impacts noted above for other baleen whales may occur.

8.7.3.6 Sperm Whale

Sperm whales inhabit all ocean basins, from equatorial waters to the polar regions (Perry et al. 1999). In the western North Atlantic they range from Greenland to the Gulf of Mexico and the Caribbean. The sperm whales that occur in the western North Atlantic are believed to represent only a portion of the total stock (Blaylock et al. 1995). Total numbers of sperm whales off the U.S or Canadian Atlantic coast are unknown, although eight estimates from selected regions of the habitat do exist for select time periods. The best estimate of abundance for the North Atlantic stock of sperm whales is 4,702 (CV=0.36) (Waring et al. 2000). The minimum population estimate for the western North Atlantic sperm whale is 3,505 (CV=0.36).

The IWC estimates that nearly a quarter-million sperm whales were killed worldwide in whaling activities between 1800 and 1900 (IWC 1971). With the advent of modern whaling the larger rorqual whales were targeted. However as their numbers decreased, greater attention was paid to smaller rorquals and sperm whales. From 1910 to 1982 there were nearly 700,000 sperm whales killed worldwide from whaling activities (Clarke 1954).

Sperm whales were hunted in America from the 17th century through the early 20th century. In the North Atlantic, hunting occurred off of Iceland, Norway, the Faroe Islands, coastal Britain, West Greenland, Nova Scotia, Newfoundland/Labrador, New England, the Azores, Madeira, Spain, and Spanish Morocco (Waring et al. 1998). Some whales were also taken off the U.S. Mid-Atlantic coast (Reeves and Mitchell 1988; Perry et al. 1999), and in the northern Gulf of Mexico (Perry et al. 1999). There are no catch estimates available for the number of sperm whales caught during U.S. operations (Perry et al. 1999). Recorded North Atlantic sperm whale catch numbers for Canada and Norway from 1904 to 1972 total 1,995. All killing of sperm whales was banned by the IWC in 1988.

Sperm whales generally occur in waters greater than 180 meters in depth. While they may be encountered almost anywhere on the high seas, their distribution shows a preference for continental margins, sea mounts, and areas of upwelling, where food is abundant (Leatherwood and Reeves 1983). Sperm whales in both hemispheres migrate to higher latitudes in the summer for feeding and return to lower latitude waters in the winter where mating and calving occur. Mature males typically range to much higher latitudes than mature females and immature animals but return to the lower latitudes in the winter to breed (Perry et al. 1999). Waring et al. (1993) suggest sperm whale distribution is closely correlated with the Gulf Stream edge.

In the U.S. EEZ, sperm whales occur on the continental shelf edge, over the continental slope, and into the mid-ocean regions (Waring et al. 1993), and are distributed in a distinct seasonal cycle; concentrated east-northeast of Cape Hatteras in winter and shifting northward in spring when whales are found throughout the mid-Atlantic Bight. Distribution extends further northward to areas north of Georges Bank and the Northeast Channel region in summer and then south of New England in fall, back to the mid-Atlantic Bight (Waring et al. 2000). Sperm whale distribution may be linked to their social structure as well as distribution of their prey (Waring et al. 2000). Sperm whale populations are organized into two types of groupings: breeding schools and bachelor schools. Older males are often solitary (Best 1979). Breeding schools consist of females of all ages, calves and juvenile males.

In the Northern Hemisphere, mature females ovulate from April through August. During this season one or more large mature bulls temporarily join each breeding school. A single calf is born after a 15-month gestation. A mature female will produce a calf every 4-6 years. Females attain sexual maturity at a mean age of nine years, while males have a prolonged puberty and attain sexual maturity at about age 20 (Waring et al. 2000). Bachelor schools consist of maturing males who leave the breeding school and aggregate in loose groups of about 40 animals. As the males grow older they separate from the bachelor schools and remain solitary most of the year (Best 1979). Male sperm whales may not reach physical maturity until they are 45 years old (Waring et al. 2000). The sperm whales prey consists of larger mesopelagic squid and fish species (Perry et al. 1999). Sperm whales, especially mature males in higher latitude waters, have been observed to take significant quantities of large demersal and mesopelagic sharks, skates, and bony fishes (Clarke 1962, 1980).

General human impacts and entanglement

Few instances of injury or mortality of sperm whales due to human impacts have been recorded in U.S. waters. Because of their generally more offshore distribution and their benthic feeding habits, sperm whales are less subject to entanglement than are right or humpback whales.

Documented takes primarily involve offshore fisheries such as the offshore lobster pot fishery and pelagic driftnet and pelagic longline fisheries. The NMFS Sea Sampling program recorded three entanglements (in 1989, 1990, and 1995) of sperm whales in the swordfish drift gillnet fishery prior to permanent closure of the fishery in January 1999. All three animals were injured, found alive, and released. However, at least one was still carrying gear. Opportunistic reports of sperm whale entanglements for the years 1993-1997 include three records involving offshore lobster pot gear, heavy monofilament line, and fine mesh gillnet from an unknown source. Sperm whales may also interact opportunistically with fishing gear. Observers aboard Alaska sablefish and Pacific halibut longline vessels have documented sperm whales feeding on longline caught fish in the Gulf of Alaska (Perry et al. 1999). Behavior similar to that observed in the Alaskan longline fishery has also been documented during longline operations off South America where sperm whales have become entangled in longline gear, have been observed feeding on fish caught in the gear, and have been reported following longline vessels for days (Perry et al. 1999).

Sperm whales are also struck by ships. In May 1994 a ship struck sperm whale was observed south of Nova Scotia (Waring et al. 2000). A sperm whale was also seriously injured as a result of a ship strike in May 2000 in the western Atlantic. Due to the offshore distribution of this species, interactions that do occur are less likely to be reported than those involving right, humpback, and fin whales that more often occur in nearshore areas. Preliminary data for 2000 indicate that of ten sperm whales reported to the stranding network (nine dead and one injured) there was one possible fishery interaction, one ship strike (wounded with bleeding gash on side) and eight animals for which no signs of entanglement or injury were sighted or reported.

8.7.3.7 Leatherback Sea Turtle

Leatherback turtles are widely distributed throughout the oceans of the world, and are found in waters of the Atlantic, Pacific, Caribbean, and the Gulf of Mexico (Ernst and Barbour 1972). The leatherback sea turtle is the largest living turtle and ranges farther than any other sea turtle species, exhibiting broad thermal tolerances (NMFS and USFWS 1995). Evidence from tag returns and strandings in the western Atlantic suggests that adults engage in routine migrations between boreal, temperate and tropical waters (NMFS and USFWS 1992). In the U.S., leatherback turtles are found throughout the action area of this consultation. Located in the northeastern waters during the warmer months, this species is found in coastal waters of the continental shelf and near the Gulf Stream edge, but rarely in the inshore areas.

A 1979 aerial survey of the outer Continental Shelf from Cape Hatteras, North Carolina to Cape Sable, Nova Scotia showed leatherbacks to be present throughout the area with the most numerous sightings made from the Gulf of Maine south to Long Island. Shoop and Kenney (1992) also observed concentrations of leatherbacks during the summer off the south shore of Long Island and off New Jersey. Leatherbacks in these waters are thought to be following their preferred jellyfish prey. This aerial survey estimated the leatherback population for the northeastern U.S. at approximately 300-600 animals (from near Nova Scotia, Canada to Cape Hatteras, North Carolina).

Compared to the current knowledge regarding loggerhead populations, the genetic distinctness of leatherback populations is less clear. However, genetic analyses of leatherbacks to date indicate female turtles nesting in St. Croix/Puerto Rico and those nesting in Trinidad differ from each other and from turtles nesting in Florida, French Guiana/Suriname and along the South African Indian Ocean coast. Much of the genetic diversity is contained in the relatively small insular subpopulations. The most conservative approach would be to treat leatherback nesting populations as distinct populations whose survival and recovery is critical to the survival and recovery of the species.

Leatherbacks are predominantly a pelagic species and feed on jellyfish (Rebel 1974), medusae, siphonophores and salps. Time-Depth-Recorder data recorded by Eckert et al. (1998b) indicate that leatherbacks are night feeders and are deep divers, with recorded dives to depths in excess of 1000 meters. However, leatherbacks may come into shallow waters if there is an abundance of jellyfish nearshore. Leatherbacks also occur annually in places such as Cape Cod and Narragansett Bays during certain times of the year, particularly the fall.

Although leatherbacks are a long lived species (> 30 years), they are somewhat faster to mature than loggerheads, with an estimated age at sexual maturity reported as about 13-14 years for females, and an estimated minimum age at sexual maturity of 5-6 years, with 9 years reported as a likely minimum (Zug and Parham 1996) and 19 years as a likely maximum (NMFS 2001). In the U.S. and Caribbean, female leatherbacks nest from March through July. They nest frequently (up to 7 nests per year) during a nesting season and nest about every 2-3 years. During each nesting, they produce 100 eggs or more in each clutch and thus, can produce 700 eggs or more per nesting season (Schultz 1975). The eggs will incubate for 55-75 days before hatching. The habitat requirements for post-hatchling leatherbacks are virtually unknown (NMFS and USFWS 1992).

General human impacts and entanglement

Anthropogenic impacts to the leatherback population are similar to those discussed above for the loggerhead sea turtle, including fishery interactions as well as intense exploitation of the eggs (Ross 1979). Eckert (1996) and Spotila et al. (1996) record that adult mortality has also increased significantly, particularly as a result of driftnet and longline fisheries. Zug and Parham (1996) attribute the sharp decline in leatherback populations to the combination of the loss of long-lived adults in fishery related mortality, and the lack of recruitment stemming from elimination of annual influxes of hatchlings because of intense egg harvesting.

Poaching is not known to be a problem for U.S. nesting populations. However, numerous fisheries that occur in both U.S. state and Federal waters are known to negatively impact juvenile and adult leatherback sea turtles. These include incidental take in several commercial and recreational fisheries. Fisheries known or suspected to incidentally capture leatherbacks include those deploying bottom trawls, off-bottom trawls, purse seines, bottom longlines, hook and line, gill nets, drift nets, traps, haul seines, pound nets, beach seines, and surface longlines (NMFS and USFWS 1992). At a workshop held in the Northeast in 1998 to develop a management plan for leatherbacks, experts expressed the opinion that incidental takes in fisheries were likely higher than is being reported.

Leatherback interactions with the southeast shrimp fishery are also common. Turtle Excluder Devices (TEDs), typically used in the southeast shrimp fishery to minimize sea turtle/fishery interactions, are less effective for the large-sized leatherbacks. Therefore, the NMFS has used several alternative measures to protect leatherback sea turtles from lethal interactions with the shrimp fishery. These include establishment of a Leatherback Conservation Zone (60 FR 25260) established to restrict shrimp trawl activities from off the coast of Cape Canaveral, Florida to the Virginia/North Carolina Border. It allows the NMFS to quickly close the area or portions of the area to the shrimp fleet on a short-term basis when high concentrations of normally pelagic leatherbacks are recorded in more coastal waters where the shrimp fleet operates.

Leatherbacks are also susceptible to entanglement in lobster and crab pot gear, possibly as a result of attraction to gelatinous organisms and algae that collect on buoys and buoy lines at or near the surface, attraction to the buoys which could appear as prey, or the gear configuration which may be more likely to wrap around flippers. The total number of leatherbacks reported entangled from New York through Maine from all sources for the years 1980 - 2000 is 119; out of this total, 92 of these records took place from 1990-2000. Entanglements are also common in Canadian waters where Goff and Lien (1988) reported that 14 of 20 leatherbacks encountered off the coast of Newfoundland/Labrador were entangled in fishing gear including salmon net, herring net, gillnet, trawl line and crab pot line.

Spotila et al. (1996) describe a hypothetical life table model based on estimated ages of sexual maturity at both ends of the species' natural range (5 and 15 years). The simulations indicated that leatherbacks could maintain a stable population only if both juvenile and adult survivorship remained high, and that if other life history stages (i.e., egg, hatchling, and juvenile) remained static. Model simulations indicated that an increase in adult mortality of more than 1% above background levels in a stable population was unsustainable.

There are many human-related sources of mortality to leatherbacks. A tally of all leatherback takes anticipated annually under current biological opinions projected a potential for up to 801 leatherback takes, although this sum includes many takes expected to be nonlethal. Leatherbacks have a number of pressures on their populations including: injury or mortality in fisheries; degradation of nesting habitats; direct harvest of eggs, juvenile and adult turtles; the effects of ocean pollutants and debris; lethal collisions; and natural disturbances such as hurricanes (which may wipe out nesting beaches).

Spotila et al. (1996) recommended not only reducing mortalities resulting from fishery interactions, but also advocated protection of eggs during the incubation period and of hatchlings during their first day, and indicated that such practices could potentially double the chance for survival and help counteract population effects resulting from adult mortality. They conclude, “stable leatherback populations could not withstand an increase in adult mortality above natural background levels without decreasing . . . the Atlantic population is the most robust, but it is being exploited at a rate that cannot be sustained and if this rate of mortality continues, these populations will also decline.”

Status and Trends of Leatherback Sea Turtles

Estimated to number approximately 115,000 adult females globally in 1980 (Pritchard 1982) and only 34,500 by 1995 (Spotila et al. 1996), leatherback populations have been reduced worldwide, not only by fishery related mortality but, at least historically, primarily due to intense exploitation of the eggs (Ross 1979). On some beaches nearly 100% of the eggs laid have been harvested (Eckert 1996). Eckert (1996) and Spotila et al. (1996) record that adult mortality has also increased significantly, particularly as a result of driftnet and longline fisheries. Spotila (2000) states that a conservative estimate of annual leatherback fishery-related mortality (from longlines, trawls and gillnets) in the Pacific during the 1990s is 1,500 animals. He estimates that this represented about a 23% mortality rate (or 33% if most mortality was focused on the East Pacific population).

Nest counts are currently the only reliable indicator of population status available for leatherback turtles. The status of the leatherback population in the Atlantic is difficult to assess since major nesting beaches occur over broad areas within tropical waters outside the United States. Recent information suggests that Western Atlantic populations declined from 18,800 nesting females in 1996 (Spotila et al. 1996) to 15,000 nesting females by 2000. It appears that the western North Atlantic portion of the population is being subjected to mortality beyond sustainable levels, resulting in a continued decline in numbers of nesting females.

8.7.4 Protected Species Assessment

The current red crab fishery uses fixed trap gear that is slightly larger than traditional lobster traps, and is set in trawls of 90 to 120 traps per trawl. The configuration of the gear is very similar to the offshore sector of the American lobster fishery. The common method of red crab fishing is to set traps for a short time (<24 hours) to reduce the amount of crab mortality in the traps. The fixed trap gear used in the lobster fishery is known to cause serious injury and mortality to whales and certain species of sea turtles. Gear interactions may occur if gear is concentrated in high-use area/times for endangered whales or sea turtles. The common points of whale or sea turtle entanglement are in the pot warp gear that runs from the traps to the buoy at the surface and the groundline that connects the traps together along the ocean floor.

The American Lobster FMP has undergone consultation pursuant to Section 7 of the Endangered Species Act (ESA), with the most recent Biological Opinion (Opinion) dated June 14, 2001. The Opinion concluded that the lobster fishery is likely to jeopardize the continued existence of the North Atlantic right whale and has required NMFS to implement a Reasonable and Prudent Alternative (RPA) to remedy the jeopardy finding. The RPA's call for significant further action under the Atlantic Large Whale Take Reduction Plan (ALWTRP).

The ALWTRP contains a series of regulatory measures designed to reduce the likelihood of fishing gear entanglements of large whale species in the North Atlantic. The RPA's called for three key regulation changes: (1) new gear modifications; (2) implementation of a Dynamic Area Management system (DAM) of short-term closures to protect unexpected concentrations of right whales; and (3) establishment of a Seasonal Area Management system (SAM) of additional gear modifications to protect known seasonal concentrations of right whales. All of the above regulatory changes have now been implemented. The new gear modifications were published on January 10, 2002 (67 FR 1300), and were effective February 11, 2002. NMFS established the criteria for implementing the DAM restrictions in final form on January 9, 2002 (67 FR 1133) that became effective February 8, 2002. NMFS also published the interim final regulations for the SAM program on January 9, 2002 (67 FR 1142) that became effective on March 1, 2002, following a public comment period that ended on February 8, 2002.

Whereas lobster fishing effort is concentrated primarily in the Gulf of Maine, with 80% of the effort located within state waters, the deep sea red crab fishery is limited by the narrow shelf edge habitat of the red crab. Red crabs are primarily found on the continental shelf and slope seabed from the Scotian Shelf to Cape Hatteras in the Northeast, although their range extends at similar depths into the Gulf of Mexico. Depth preferences for red crab may be dictated by temperature and salinity and can range between 200 and 1,800 meters. Red crab size may be in inverse proportion to the depth, with larger crabs found in the shallower water (200-400m).

The majority of lobster fishing effort is concentrated in northeastern waters when right, humpback, minke and fin whales are present thus increasing the risk of gear interactions from traditional lobster gear during the summer and fall for these species. However, the physical location of red crab gear significantly lessens the likelihood of interaction for those species while increasing the risk for the blue, sei and sperm whales that frequent offshore waters. Therefore, adverse effects could occur because right, humpback, minke and fin whales are vulnerable to entanglement in red crab trap gear, but they also are not known to concentrate in the red crab fishing areas along the continental shelf.

Right and humpback whales are known to move through the continental shelf region usually in the spring and fall as they enter and leave the Gulf of Maine feeding areas. Minke and fin whales are broadly distributed along the shelf waters where their primary prey (small schooling fish) are commonly found. They are not known to frequent the shelf edge waters where the red crab fishery takes place.

The preferred foraging areas of blue and sei whales are unknown. However, the limited surveys that were conducted in those areas (by CeTAP surveys in 1979-81 and NMFS summer ship and aerial surveys conducted from 1990-98) did not locate significant sightings of either of these species in shelf edge waters. The known feeding behavior of blue and sei whales suggest they focus on plankton/zooplankton resources that are found in the upper water column. This could limit the threat of entanglement in red crab gear to encounters with the pot warp line that comes from the traps on the seabed to the surface buoys. Although these species may be affected by the operations of the red crab fishery, mitigation should be provided by the ALWTRP, which is anticipated to benefit all species of large whales. Specifically, risks should be reduced as the result of gear modifications that require weak links to be installed at each buoy.

8.7.4.1 Sperm Whales

Sperm whales are frequently found along the shelf edge throughout red crab habitat. Sperm whale feeding habits involve deep dives to feed on squid and fish that inhabit these deep ocean regions, and are known to have become entangled in deep-sea cables at great depth. Because of these characteristics, sperm whale encounters with both the buoy line and groundline of red crab gear are more likely than with other large whale species, thus posing potential adverse effects. However, the following factors make it unlikely that the red crab fishery will cause significant adverse impacts to the sperm whale population that inhabits the U.S. east coast offshore waters:

- The Red Crab FMP will prevent the amount of red crab fishing effort from expanding significantly beyond present levels;
- The red crab fishery utilizes large trap trawl sizes (average – 107 per trawl/560 total) thus reducing the number of vertical lines in the water column;
- Red crab fishing strategy encourages short soak times (average 22.5 hours) to reduce crab mortality and injury in the trap, thus increasing the likelihood that an entangled whale will be seen in the gear and disentanglement efforts initiated;
- All red crab fishermen must comply with any current ALWTRP regulations;
- One of the future measures that may be implemented under the MMPA to meet the RPAs contained in the ESA consultation for the Lobster FMP involves the use of neutrally buoyant buoy lines and potential modifications to groundlines --- measures that may be effective to protect sperm whales; and
- The sperm whale population that extends along the entire shelf edge is fairly robust.

8.7.4.2 Right Whales

In view of the northern right whale's apparent decline and high probability of extinction, any entanglement that causes serious injury and mortality reduces appreciably the likelihood of survival and recovery of this species. Documented entanglements underestimate the extent of the entanglement problem since not all entanglements are likely to be observed. Consequently, the total level of interaction between fisheries and right whales is unknown. However, recent studies have estimated that over 60% of right whales exhibit scars consistent with fishery interactions. The three key regulation changes to the ALWTRP mentioned above address this issue. New gear modifications will make the gear less of a threat to right whales. Implementation of the DAM program and SAM system will provide further separation of fixed gear and known seasonal concentrations of right whales. Therefore, although the red crab fishery continues to pose a risk of entanglement to northern right whales, it is not expected to cause irreversible impacts.

Given the known anthropogenic sources of right whale mortality, their low population size, and their poor reproductive rate, the loss of even one northern right whale as a result of operation of the red crab fishery may reduce appreciably the likelihood of both survival and recovery of this species by reducing the number of right whales and their ability to reproduce. The following factors suggest that the red crab fishery could affect, but by itself, is not likely pose jeopardy to the continued existence of the Northern right whale:

- The Red Crab FMP will prevent the amount of red crab fishing effort from expanding significantly beyond present levels;

- The red crab fishery utilizes large trap trawl sizes (average 107 per trawl; 560 total) thus reducing the number of vertical lines in the water column;

- The depth of water fished (200m - 1,800m) is likely to eliminate the likelihood of right whale encounters with groundlines;

- Red crab fishing strategy encourages short soak times (average 22.5 hr) to reduce crab mortality and injury in the trap, thus increasing the likelihood that an entangled whale will be seen in the gear and disentanglement efforts initiated;

- The restricted red crab distribution along the continental shelf edge precludes any overlap with known right whale high use foraging area or critical habitat; and

- All red crab fishermen must comply with any current ALWTRP regulations, including recent measures implemented under the MMPA to further separate fixed gear from known right whale concentrations.

8.7.4.3 Sea Turtles

Red crab fishing effort occurs along the Northeast and Mid-Atlantic shelf edge waters in depths that generally preclude encounters with benthic feeding sea turtles such as loggerhead, green, hawksbill, or ridleys. Little information exists detailing the encounters of sea turtles in the similarly prosecuted offshore lobster fishery. Of the offshore lobster trips that the NEFSC has observed from May 1994 through December 2000, there have been no observed takes of marine turtles associated with the lobster fishery. However, there have been 119 reported entanglements of leatherback sea turtles (1980-2000) in coastal lobster pot gear from Maine to New York. Leatherbacks are known (from encounters in swordfish longline gear) to inhabit the shelf edge areas in the spring and early summer and may encounter the pot warp lines of red crab gear. Given that they may be affected, there are factors that may reduce the likelihood of significant injuries or mortalities to leatherback sea turtles:

- The Red Crab FMP will maintain the red crab effort at a low level;
- The average red crab trawl size minimizes the number of vertical lines;
- The short soak times significantly reduce the likelihood of entanglement from that observed in the inshore lobster fishery; and
- Entangled leatherbacks are likely to be found and released before serious injury or death.

8.7.4.4 Birds

The roseate tern and piping plover inhabit the coastal waters and nest along the coastal beaches along the Northeast continental shelf. Bottom-tending trap/pot gear set at the typical depths of the red crab habitat would appear to make it impossible for the red crab fishing operations to result in any injury to either of these species.

8.7.4.5 Other Marine Mammals

It is recognized that the red crab fishery will be prosecuted in the continental shelf waters frequented by several species of offshore odontocetes including beaked whales (Mesoplodon and Ziphius genus), pilot whales, Risso's dolphin, offshore bottlenose dolphin, white-sided, spotted and striped dolphins. It appears unlikely that the deep-water trap/pot gear used by the red crab fishery will affect these odontocetes, given they are too small to become entangled in the typical large diameter line used in the buoy lines. In addition, the depth of the gear would place the traps and groundlines below the diving range of these species with the exception of the beaked whales. The small mouth and streamlined shape of these species would minimize any threat from this gear.

8.7.4.6 Conclusion

The Council prepared this document with the intent that it serve as a Biological Assessment for the Red Crab FMP, to meet the ESA mandates. The Council concludes that the Red Crab FMP, in combination with implementation of the RPA's contained in the recent Opinion for the American Lobster FMP, will affect, but is not likely to jeopardize the continued existence of right whales, humpback whales, fin whales, blue whales, sei whales, sperm whales or leatherback sea turtles. Furthermore, the Council has determined that the red crab fishery will not affect the endangered roseate tern, Piping plover, loggerhead, ridley, and hawksbill sea turtles, shortnose sturgeon or Atlantic salmon.

Given the current critical status of the right whale population and the aggregate effects of human-caused mortality that has led to the species current status, the Council understands that the right whale population cannot sustain additional incidental mortality. The Council also understands that the red crab fishery uses a gear type, which has been known to cause serious injury and mortality to right whales. The Council's assessment of no jeopardy is based on an understanding that the Red Crab FMP will maintain satisfactory control over expanding effort in a fishery that is restricted by the distribution of the target species to the fringe of the right whale's range. In addition, the red crab fishing gear will continue to be subject to regulations implemented under the ALWTRP to meet the mandate for further reduction in entanglement threat called for under the Biological Opinion issued for the American Lobster FMP to remove the likelihood of jeopardy in that fishery.

8.8 Safety Considerations

The potential impacts to the safety of human life at sea are discussed as part of the social impacts of each proposed management measure and alternative in Sections 5.3 and 5.4 of this FMP. This section of the FMP is concerned with the consideration of management adjustments for fishery access for vessels otherwise prevented from harvesting because of weather or other ocean conditions affecting the operational safety of the vessels.

8.8.1 Fishery Access and Weather-Related Vessel Safety

The primary vessel safety related concern identified for the red crab fishery is the distance from shore in which the fishery is prosecuted. Red crabs occur in deep water on the continental slope along the southern flank of Georges Bank, southern New England, and south to Cape Hatteras. Ocean conditions in the areas where the red crab fishery occurs are often more variable and more hazardous than in nearshore areas. One of the issues considered by the Council in the development of this FMP was to not exacerbate these safety concerns by selecting management measures that would increase risk-taking behavior by the members of the red crab fishery.

Measures initially considered by the Council for the Red Crab FMP included the use of a hard total allowable catch (TAC) as a primary control on fishing effort and landings. There was significant concern that any management approach that relied on a hard TAC as the primary management tool would encourage the development of a derby-style fishery for red crab. This concern was supported by the experience of the fishery under the emergency regulations. During the first emergency period, a six-month TAC was harvested in three months; during the second emergency period, a six-month TAC was harvested in two months. Even with trip limits and trap limits, the use of the hard TAC created a derby-style fishery where all participating vessels fished as hard as possible to harvest as much as possible before the TAC was reached and the fishery shut down. Under a hard TAC system, there would be periods of time when fishing vessels would have been precluded from participating in the fishery. These periods of time may or may not have occurred in conjunction with improved ocean conditions.

Instead of a hard TAC approach, the Council selected a management system that utilizes a target TAC and a day-at-sea (DAS) allocation. The intent of this system is to allocate a certain number of DAS to each vessel participating in the directed fishery, such that the total number of DAS allocated to the fleet will be approximately the correct number necessary to harvest the target TAC. If the target TAC is exceeded, however, the fishery will not shut down as it would under the hard TAC approach. With the assurance that the fishery will not be shut down, fishing vessels will be free to use their DAS at whatever time they deem appropriate. This approach should remove all incentive for the development of a derby-style fishery.

Management of this fishery does not include measures such as fishing seasons, in-season time or area closures or other restrictions, or frequency limits, which are believed to potentially affect the operation of fishing vessels and safety risks taken by vessel operators under adverse weather or ocean conditions. As a result of the management measures selected and proposed for this FMP, the relationship between the management measures and vessel safety is not considered a significant issue. The conclusion of this analysis is that the management measures do not pose additional safety risks. In addition, the U.S. Coast Guard reviewed the safety aspects of this management plan and concluded that there were no major safety issues associated with the proposed management measures.

8.8.2 Flexibility

Flexibility to adjust management measures for safety concerns is not a specific part of this FMP (e.g., weather and ocean conditions are not included as factors to consider in framework adjustments when making decisions such as in-season adjustments), but this is because the FMP, by virtue of the proposed management measures, already provides the vessel owners and operators with as much flexibility as possible to choose when and where to fish.

8.8.3 Procedures

The Council will continue to monitor safety issues related to the red crab fishery and will utilize its industry advisory panel (composed of many members of the directed red crab fishery) to evaluate and report on the effect of management measures, including their effect on vessel or crew safety, particularly under adverse weather or ocean conditions.

8.8.4 Other Safety Issues

To the extent possible, this FMP is intended to minimize the dangers to human life at sea while achieving the conservation and management objectives of the plan. Fishing is an inherently dangerous occupation; participants must constantly balance the risks imposed by weather and other natural conditions against the potential economic benefits. A management plan should be designed so that it does not encourage dangerous behavior by the participants. Certain measures, such as the hard TAC that could result in a derby-type fishery, could have had an adverse effect on the safety of human life at sea but were not selected by the Council, which decided instead to use a target TAC approach. Other measures proposed in this FMP, such as trip limits, trap limits, and DAS, are intended to reduce the potential for a derby-type fishery and, thus promote the safety of human life at sea. The potential impacts to the safety of human life at sea are discussed as part of the social impacts of each proposed management measure and alternative in Sections 5.3 and

5.4 of this FMP. The conclusion of this analysis is that the management measures do not pose additional safety risks. No specific comments were received during public hearings on this issue, and no written comments were received that identified concern for the impact of the proposed measures on vessel safety.