

5.0 DESCRIPTION OF AFFECTED ENVIRONMENT

This section includes descriptions of biological, physical, economic, and social features that are likely to be affected by the alternatives, focusing on features in the Georges Bank groundfish closed areas. Broader descriptions of these features that coincide or are correlated with scallop management were presented in the FSEIS for Amendment 10 (NEFMC 2003).

5.1 *Biological Environment*

5.1.1 Scallops

The FSEIS for Framework Adjustment 14 and Amendment 10, and the EA for Framework Adjustment 15 compare and contrast the scallop resource history inside and outside of the closed areas. These areas include the areas proposed by access in this framework adjustment. A previous stock assessment (NEFSC 1999) furthermore examined the potential differences of recruitment within these areas and the potential effect of spawning biomass in the areas on recruitment elsewhere.

Scallop growth and meat yield is generally higher on the shallow portions of Georges Bank than elsewhere. These productive areas include the three proposed access areas as well as the cod HAPC and adjacent areas. Food supply is often very good, enhanced by clear water and moderate water movement around the bank. If natural mortality is the same as in other areas, these effects on scallop growth and meat yield increase yield-per-recruit, making the areas productive for sea scallops even though recruitment here is historically unremarkable.

On the other hand, scallop recruitment that was observed in the 2000 survey was exceptional. At the time, this year class was the highest observed in the 23-year survey time series. Subsequent sampling of this year class has suggested that the size of this year class is less than had been previously thought, but it remains among the highest on record. The cause of this strong year class is unknown, because it occurred before the large increases in scallop biomass in the Georges Bank areas and after fishing occurred there during 1999 and 2000. Year class strength since 2000 in this and other areas of the Georges Bank region have been below average, despite high spawning stock biomass.

The scallops in the southern part of Closed Area II have grown to optimum size, between 100 and 130 mm shell height. More importantly however is that the 2003 resource surveys observed higher clapper ratios (an indicator of natural mortality) and higher abundance of predatory starfish. It is not known whether the decline in biomass, compared with previous projections, is due to a potential increase in natural mortality and predation, or a result from sampling variability. If due to natural mortality and predation, potential yield could decline as the biomass growth of this large year class slows.

Scallops in the proposed access areas for Closed Area I and the Nantucket Lightship Area are primarily from the large scallops that existed in 2000, when the areas were last fished. Due to some management effects, which are explained in Section 3.2.1.2, the fishery did not land the TACs that were associated with the target fishing mortality rates. As a result, many of the scallops in these areas are between 130 and 150 mm shell-height, growth has slowed dramatically, and little increases in biomass would occur if unfished.

5.1.2 Groundfish

The groundfish closed areas were originally established to reduce the effects of fishing on spawning cod and haddock, in particular Closed Areas I and II. Peak spawning activity occurs in February to April, coinciding with the original seasonal closures. After spawning, these fish often disperse to other areas during their annual migration. Yellowtail flounder is another species that was intended to be protected by the groundfish closed areas. The Georges Bank stock is predominately found on the southeastern and northwestern portions of Georges Bank, overlapping the proposed access areas in Closed Areas I and II. Unlike spawning cod and haddock, however, yellowtail flounder tend to remain in these locations year around. The Southern New England stock of yellowtail flounder was one of the primary intended beneficiaries of the Nantucket Lightship Area. Most of this stock occurs in the portions of the Nantucket Lightship Area that will remain closed to scallop fishing, or in other areas of Southern New England and the Mid-Atlantic region where scallop fishing occurs in open areas. More details about the biological characteristics of groundfish species in the closed areas is provided in the FSEIS for Amendment 13 to the Multispecies FMP.

5.1.3 Other species

The biological characteristics of other species found in the groundfish closed areas and the proposed access areas can be found in the Skate FMP and Monkfish FMP EIS documents. In general, several skate species are often found in the proposed access areas, including winter, little, and barndoor skate. The Skate FMP identified the conservation associated with the groundfish closed areas to be an important component of limiting mortality on skates, which is a major reason why a skate baseline review (Section 7.1.4) was initiated for this framework adjustment. Although monkfish inhabit and are caught in the groundfish closed areas, the center of the monkfish distribution is in the Gulf of Maine to the north, and in deeper waters off Southern New England to the west.

5.2 *Physical Environment*

A description of the physical characteristics of the Georges Bank closed areas was included in the FSEIS for Amendment 7 to the Multispecies FMP and in the EFH assessment in Amendment 13 to the Multispecies FMP. In general, the areas are characterized by a clockwise gyre that often retains larvae in the productive zone around Georges Bank. The access areas include shallower areas of Georges Bank with a mix of bottom substrates, primarily including sand and gravelly sand. These areas do not include the more complex habitats and harder substrates found in the southern part of Closed Area I and in the northern part of Closed Area II. Some of these more complex areas include cobble and boulder substrates that are believed to be essential for early growth and survival of cod and other groundfish species. More details about these aspects are provided in the section below.

Scallop recruitment is influenced by the retention of pelagic scallop larvae in the Georges Bank water circulation pattern, temperature, and substrates when the larvae settle as spat. Scallop larvae are difficult to identify in field samples and routine monitoring does not occur. Biologists believe however that scallop larvae are often retained in the Georges Bank water circulation pattern, with some leakage of scallop larvae to the west of the Great South Channel (NEFSC 1999). Heaviest recruitment appears to occur in the Great South Channel, along the northern edge of Georges Bank that passes through the northern part of Closed Area II and the cod HAPC, and along the southeastern part of Georges Bank (partially overlapping the southern part of Closed Area II). A comparison of the biomass trends within open and closed areas in the Georges Bank region shows little evidence of remarkably strong year classes within the closed areas, unlike the Hudson Canyon and VA/NC Areas in the Mid-Atlantic region (NEFMC 2000).

5.3 Habitat

5.3.1 Background

A number of authors have reviewed, to varying extents, existing scientific literature on the effects of fishing on habitat (e.g., Auster et al. 1996, Cappelletti et al. 1998, Collie 1998, Jennings and Kaiser 1998, Rogers et al. 1998, Auster and Langton 1999, Hall 1999, Collie et al. 2000, Lindeboom and de Groot 2000, Barnette 2001, National Research Council 2002). The following summary of the conclusions reached by these authors is extracted from a recent NOAA report (Johnson 2002).

A number of review papers have focused specifically on the physical effects of bottom trawls. In Europe, an ICES working committee (ICES 1973) concluded that otter trawls, beam trawls and dredges all have similar effects on the seabed, but the magnitude of disturbance increases from shrimp to beam trawls with tickler and stone guards, to Rapido trawls, to mollusc (e.g., scallop) dredges. Kaiser et al. (1996) and Collie et al. (2000) state that, because beam trawls are used almost exclusively in areas that are adapted to frequent wave/tidal action, they are less likely to adversely affect bottom habitats. As mentioned elsewhere in this DEIS, scallop dredges used in Europe and Australia are designed differently than the sweep dredge used in the Northeast region of the U.S. Specifically, they have a row of teeth that penetrate several inches into the bottom and therefore have a greater impact on benthic habitats than the sweep dredge. Beam trawls and Rapido trawls are not used in the U.S. groundfish fishery.

Auster et al. (1996) conducted three studies of mobile fishing gear in the Gulf of Maine and concluded that mobile fishing gear alters the seafloor and reduces habitat complexity, sedimentary structures, and emergent epifauna. Collie (1998) reviewed studies from New England and concluded that hard bottom benthic habitats (e.g., boulders and gravel pavement) experience significant impacts of mobile bottom-tending fishing gear, while mobile sand habitats are less vulnerable. Jennings and Kaiser (1998) concluded that fishing activities lead to changes in the structure of marine habitats and influence the diversity, composition, biomass, and productivity of the associated biota. They further concluded that these effects vary according to gears used, habitats fished, and the magnitude of natural disturbance, but tend to increase with depth and the stability of the substrate. Auster and Langton (1999) reviewed 22 studies from a wide geographic range and concluded that mobile fishing gear reduces habitat complexity by: (1) directly removing epifauna or damaging epifauna leading to mortality, (2) smoothing sedimentary bedforms and reducing bottom roughness, and (3) removing taxa which produce structure (i.e., taxa which produce burrows and pits). They also concluded that for fixed gear, the area impacted per unit effort is smaller than for mobile gear, but the types of damage to emergent benthos appear to be similar (but not necessarily equivalent per unit effort).

Collie et al. (2000) analyzed 39 published studies to compile and evaluate current findings regarding fishing gear effects on different types of benthic habitat. They found: (1) 89% of the studies were undertaken at depths less than 60 m; (2) otter trawl gear is the most frequently studied; (3) most studies have been done in Northern Europe and Eastern North America. The authors reached several conclusions regarding the effects of fishing: (1) intertidal dredging and scallop dredging have the greatest initial effects on benthic biota, followed by otter trawling and then beam trawling (although beam trawling studies were conducted in dynamic sandy areas, where effects might be less apparent); (2) fauna in stable gravel, mud and biogenic habitats are more adversely affected than those in less consolidated coarse sediments; (3) recovery appears most rapid in less physically stable habitats (inhabited generally by more opportunistic species); (4) we may accurately predict recovery rates for small-bodied taxa, but communities often contain one or two long-lived, vulnerable species; (5) large-bodied organisms are more prevalent before trawling; and (6) the mean initial response to fishing impacts is negative (55% reduction of individual taxa). Based on these findings, the authors suggested that the scientific community abandon

short-term small-scale experiments and undertake larger scale experiments that mimic the timing and frequency of disturbance typical of commercial fishing activities.

A working committee of the International Council for the Exploration of the Seas (ICES) issued, in November 2000, a report on the “Effects of Different Types of Fisheries on North Sea and Irish Sea Benthic Ecosystems.” This report (ICES 2000) was a summary of findings based on a comprehensive report of the same title edited by Lindeboom and de Groot (1998).

Direct habitat effects of fishing have also been summarized by Johnson (2002) in four categories: alteration of physical structure, sediment suspension, chemical modifications, and benthic community changes.

For the purposes of this evaluation, recovery refers to the return of the seafloor or benthic communities to pre-disturbance conditions and was evaluated as the time required for this to happen.

5.3.2 Types of Gear Effects

Alteration of Physical Structure

Physical effects of fishing gear can include scraping, plowing, burial of mounds, smoothing of sand ripples, removal of stones or dragging and turning of boulders, removal of taxa that produce structure, and removal or shredding of submerged aquatic vegetation (Fonseca et al. 1984, Messieh et al. 1991, Black and Parry 1994, Gordon et al. 1998, Kaiser et al. 1998, Lindeboom and de Groot 1998, Schwinghamer et al. 1998, Auster and Langton 1999, Kaiser et al. 1999, Ardizzone et al. 2000). These physical alterations reduce the heterogeneity of the sediment surface, alter the texture of the sediments, and reduce the structure available to biota as habitat. As mobile gear is dragged across the seafloor, parts of some gears can penetrate up to 5-30 cm into the substrate under usual fishing conditions, and likely to greater depths under unusual conditions (Drew and Larsen 1994). This action can leave tracks or even trenches in the seafloor, depending on the sediment type. It is unknown whether or to what extent these human-made features might compensate for the sediment smoothing actions of the gear.

Sediment Suspension

Re-suspension of sediments occurs as fishing gear is dragged along the seafloor. Effects of sediment suspension can include reduction of light available for photosynthetic organisms, burial of benthic biota, smothering of spawning areas, and negative effects on feeding and metabolic rates of organisms. If re-suspension occurs over a large enough area it can actually cause large scale re-distribution of sediments (Messieh et al. 1991, Black and Parry 1994). Re-suspension may also have important implications for nutrient budgets due to burial of fresh organic matter and exposure of deep anaerobic sediment, upward flux of dissolved nutrients in porewater, and change in metabolism of benthic infauna (Mayer et al. 1991, Pilskaln et al. 1998).

Effects of sediment re-suspension are site-specific and depend on sediment grain size and type, water depth, hydrological conditions, faunal influences, and water mass size and configuration (Hayes et al. 1984, LaSalle 1990, Barnes et al. 1991, Coen 1995). Effects are likely more significant in waters that are normally clear compared with areas that are already highly perturbed by physical forces (Kaiser 2000). Schoellhamer (1996) concluded that re-suspension by natural mechanisms in a shallow estuary in west-central Florida was less frequent and of smaller magnitude than anthropogenic mechanisms (e.g., fishing) and that sediments disturbed by fishing were more susceptible to re-suspension by tidal currents. Modeling by Churchill (1989) revealed that re-suspension by trawling is the primary source of suspended

sediment over the outer continental shelf of the eastern U.S., where storm-related stresses are weak. In the Kattegat Sea (Sweden), sandy sediments above the halocline were more affected by wind-induced impacts than by fishing, but mud sediments below the halocline experienced an increase in frequency of 90% in the spring and summer and of 75-85% in the autumn and winter due to fishing (Floderus and Pihl 1990). Thus, even when recovery times are fast, persistent disturbance by fishing could lead to cumulative impacts. In contrast, Dyekjaer et al. (1995) found that in Denmark, although local effects of short duration might occur, annual release of suspended particles by mobile fishing gear is relatively unimportant compared with that resulting from wind and land runoff.

Chronic suspension of sediments and resulting turbidity can also affect aquatic organisms through behavioral, sublethal and lethal effects, depending on exposure. Species reaction to turbidity depends on life history characteristics of the species. Mobile organisms can move out of the affected area and quickly return once the disturbance dissipates (Simenstad 1990, Coen 1995). Even if species experience high mortality within the affected area, species with short life history stages and high levels of recruitment or high mobility can repopulate the affected area quickly. However, if effects are protracted and occur over a large area, recovery through recruitment or immigration will be hampered. Furthermore, chronic re-suspension of sediments may lead to shifts in species composition by favoring those species that are better suited to recover or those that can take advantage of the pulsed nutrient supply as nutrients are released from the seafloor to the euphotic zone (Churchill 1989).

Changes in Chemistry

Fishing can produce changes to the chemical makeup of both the sediments and overlying water mass through mixing of subsurface sediments and porewater. In shallow water this mixing might be insignificant in relation to that produced by tidal and storm surge and wave action, but in deeper, more stable waters, this mixing can have significant effects (Rumohr 1998). In a shallow, eutrophic sound in the North Sea, fishing caused an increase in average ammonia content (although horizontal variations prevented interpretations of these increases) and a decrease in oxygen due to the mixing of reduced particles from within the sediments (Riemann and Hoffman 1991). Also in the North Sea, fishing enhances the phosphate released from sediment by 70-380 metric tons per year for otter trawls and by 10,000-70,000 metric tons per year for beam trawlers (ICES 1992). These pulses are partially compensated by lower fluxes after the trawl passes. It is important to remember that these releases recycle existing nutrients, rather than adding new nutrients, such as nutrients derived from rivers and land runoff (ICES 1992). During seasons when nutrients are low, mixing of the sediments could cause increased primary production and/or eutrophication.

Changes to Benthic Communities

Benthic communities are affected by fishing gear through damage to the benthos in the path of the gear and disturbance of the seafloor to a depth of up to 30 cm. Many kinds of epibenthic animals are crushed or buried, while infauna is excavated and exposed on the seabed. This is in addition to smothering addressed above.

Specific impacts from fishing depend on the life history, ecology and physical characteristics of the biota present (Bergman and Van Santbrink 2000). Mobile species that exhibit high fecundities and rapid generation times will recover more quickly than non-mobile, slow-growing organisms. In Mission Bay, California, polychaetes with reduced larval phases and postlarval movements had small-scale dispersal abilities that permitted rapid re-colonization of disturbed patches that maintained high infaunal densities (Levin 1984). Those with long-lived larvae were only available for successful re-colonization if the timing of disturbance coincided with periods of peak larval abundance; however, these species were able to colonize over much larger distances. Rijnsdorp and Van Leeuwen (1996) found that increased

growth in the smallest size classes of plaice in the North Sea correlated to eutrophication and seabed disturbance caused by beam trawls. The authors hypothesized that trawling caused a shift in the benthic community from low-productive, long-lived species to high-productive, short-lived species that benefited from increased nutrient availability. This potentially could have led to increased prey availability, and thus, higher growth rates for the juvenile plaice.

The physical structure of biota also affects their ability to sustain and recover from physical impacts with fishing gear. Thin-shelled bivalves and starfish show higher damage than solid-shelled bivalves in fished areas (Rumohr and Krost 1991). Animals that are able to retract below the surface of the seafloor or live below the penetration depth of the fishing gear will sustain much less damage than epibenthic organisms that inhabit the sediment surface. Animals that are more elastic and can bend upon contact with fishing gear will suffer much less damage than those that are hard and inflexible (Eno et al. 2001). Kaiser et al. (2000) found that chronic fishing around the Isle of Man, in the Irish Sea, has removed large-bodied fauna such that benthic communities are now dominated by smaller-bodied organisms that are less susceptible to physical disturbance. Off the northwest shelf of Australia, a switch of dominant fish species from lehrinids and lutjanids (which are almost exclusively associated with habitats supporting large epibenthos) to saurids and nemipterids (which were found on open sand) occurred after removal of epibenthic fauna by trawling (Sainsbury et al. 1993, 1994) has been documented.

Increased fishing pressure can also lead to changes in distribution of species, either through movement of animals away from or towards the fished area (Kaiser and Spencer 1993, 1996, Ramsay et al. 1996, Kaiser and Ramsay 1997, Ramsay et al. 1998, Bradshaw et al. 2000, Demestre et al. 2000). Frid and Hall (1999) found higher prevalence of fish remains and scavengers and a lower abundance of sedentary polychaetes in stomach contents of dabs in the North Sea in areas of higher fishing effort. Kaiser and Spencer (1994) document that gurnards and whiting aggregate over beam trawl tracks and have higher numbers of prey items in their stomachs shortly after trawling. Based on these studies, researchers have speculated that mobile fishing may lead to increased populations of species that exhibit opportunistic feeding behavior. Fonds and Groenewold (2000) modeled results for the southern North Sea indicating that the annual amount of food supplied by beam trawling is approximately 7% of the food demand of common benthic predators. This level could help maintain populations but is insufficient to support further population growth.

The most recent and comprehensive summary of gear effects on benthic marine habitats was prepared by the National Research Council. This report, entitled "Effects of Trawling and Dredging on Seafloor Habitat" (NRC 2002) reiterated four general conclusions regarding the types of habitat modifications caused by trawls and dredges.

1. Trawling and dredging reduce habitat complexity.
2. Repeated trawling and dredging result in discernable changes in benthic communities.
3. Bottom trawling reduces the productivity of benthic habitats.
4. Fauna that live in low natural disturbance regimes are generally more vulnerable to fishing gear disturbance.

The NRC report also summarized the indirect effects of mobile gear fishing on marine ecosystems. It did not consider the effects of all gear types, only the two (trawls and dredges) that are considered to most affect benthic habitats. It also provided detailed information from only a few individual studies.

An additional source of information used in this DEIS is the report of a gear effects workshop sponsored by the New England and Mid-Atlantic Fishery Management Councils in October 2001 (NREFHSC 2002). This report includes

conclusions reached by a panel of experts on the effect of different gears on benthic habitat types in the Northeast U.S.

Table 52. Impacts of Scallop Dredges on Benthic Habitat from the Gear Effects Workshop Report (NREFHSC 2002).

| TYPE OF IMPACT | DEGREE OF IMPACT | DURATION | TYPE OF EVIDENCE | COMMENTS |
|---|--------------------|--------------------|------------------|---|
| MUD | | | | |
| Removal of Major Physical Features | N/A | | | |
| Impacts to Biological Structure | N/A | | | |
| Impacts to Physical Structure | N/A | | | |
| Changes in Benthic Prey | N/A | | | |
| SAND | | | | |
| Removal of Major Physical Features | Unknown | | | |
| Impacts to Biological Structure | XXX (L) X (H) | Months - Yrs | PR, GL, PJ | |
| Impacts to Physical Structure | XXX (H, L) | Days - Months | PR, GL, PJ | Cut (shucked) shell provides additional structure. |
| Changes in Benthic Prey | Unknown | | | Disposal of shucked scallop viscera may alter local food sources - impacts unknown. |
| GRAVEL | | | | |
| Removal of Major Physical Features | Unknown | | | |
| Impacts to Biological Structure | XXX (H) N/A (L) | Several Years (H) | PR, GL, PJ | (L)=deepwater banks, gravel ridges in GOM; fishery is not prosecuted here |
| Impacts to Physical Structure | XXX (H) N/A (L) | Months - Years (H) | PR, GL, PJ | (L)=deepwater banks, gravel ridges in GOM; fishery is not prosecuted here. Cut shell provides additional structure. |
| Changes in Benthic Prey | XXX (H) N/A (L) | Months - Years (H) | PR, GL, PJ | (L)=deepwater banks, gravel ridges in GOM; fishery is not prosecuted here |
| KEY: X = Effect can be present, but is rarely large; XX = Effect is present and moderate; XXX = Effect is often present and can be large; N/A = Effect is not present or not applicable; Unknown = effects are not currently known; (H) = High energy environment; (L) = Low energy environment; PR = Peer reviewed literature; GL = Grey literature; PJ = Professional judgement. For definitions of Substrate Type and Type of Impact see Appendix D. NOTE: Ongoing Canadian experiments will be able to provide additional information in the near future. | | | | |

The results of the workshop have been considered in the next section, which includes a review of the relevant fishing gear effects literature.

New Bedford Scallop Dredges - Sand

Three studies of the effects of New Bedford scallop dredges on sand substrate are summarized, all performed since 1990 (Table 53). One was conducted in an estuary on the Maine coast (3) and two on offshore banks in the Gulf of Maine (1,2). Two of them were observational in nature, but did not include any direct observations of dredge effects. The other one was a controlled experiment conducted in an unexploited area in which a single dredge was towed repeatedly over the same area of bottom during a single day. One study examined physical effects and two examined physical and biological effects. One of them included an analysis of geochemical effects to disturbed silty-sand sediments.

Physical effects

Dredging disturbed physical and biogenic benthic features (sand ripples and waves, shell deposits [1], and amphipod tube mats [2]), caused the loss of fine surficial sediment (3), and reduced the food quality of the remaining sediment (3). Sediment composition was still altered six months after dredging, but the food quality of the sediment had recovered by then.

Biological effects

There were significant reductions in the total number of infaunal individuals in the estuarine location immediately after dredging and reduced abundances of some species (particularly one family of polychaetes and photid amphipods), but no change in the number of taxa (3). Total abundance was still reduced four months later, but not after six months. The densities of two megafaunal species (a tube-dwelling polychaete and a burrowing anemone) on an offshore bank were significantly reduced after commercial scallop vessels had worked the area (2).

Table 53. Effects of New Bedford Scallop Dredges on Sand Habitat: Summary of Published Studies

S = statistically significant; U = undisturbed; D = disturbed; HT = heavily trawled; LT = lightly trawled

| No. | Reference | Location | Depth | Sediment | Effects | Recovery | Approach |
|-----|-------------------------|---------------------------------------|----------|---|---|----------|--|
| 1 | Auster et al. 1996 | Stellwagen Bank, Gulf of Maine (USA) | 20-55 m | Coarse sand | Disturbance of storm sand ripples and low sand waves, dispersal of shell deposits in wave troughs. | | Examined gear tracks in side-scan sonar images. |
| 2 | Langton & Robinson 1990 | Fippennies Ledge, Gulf of Maine (USA) | 80-100 m | Gravelly sand with some gravel, shell hash, and small rocks | Coarser substrate, disruption of amphipod tube mats, piles of small rocks and scallop shells dropped from surface, S reductions in densities of tube dwelling polychaete and burrowing anemone. | | Submersible observations made two years apart, before and after commercial dredging of area. |

| No. | Reference | Location | Depth | Sediment | Effects | Recovery | Approach |
|-----|---------------------|---------------------------------|-------|------------|--|--|---|
| 3 | Watling et al. 2001 | Damariscotta River, Maine (USA) | 15 m | Silty sand | Loss of fine surficial sediments, lowered food quality of sediment, reduced abundance of some taxa, no changes in number of taxa, S reductions in total number of individuals 4 months after dredging. | No recovery of fine sediments, full recovery of benthic fauna and food value within 6 mos. | Experimental study (23 tows in one day), effects on macrofauna (mostly infauna) evaluated 1 day and 4 and 6 mos after dredging. |

5.3.3 New Bedford Scallop Dredges - Mixed Substrates

Three studies have been conducted on mixed glacially-derived substrates, two of them over 20 years ago and one 10 years ago (Table 54). All were done in the northwest Atlantic (one in the U.S. and two in Canada) at depths of 8 to 50 m. Two observational studies examined physical effects and one experimental study examined effects on sediment composition to a sediment depth of 9 cm. The experimental study evaluated the immediate effects of a single dredge tow. None of these studies evaluated habitat recovery or biological effects, although one (3) examined geochemical effects.

Physical effects

Direct observations in dredge tracks in the Gulf of St. Lawrence documented a number of physical effects to the seafloor, including bottom features produced by dredge skids, rings in the chain bag, and the tow bar (1,2). Gravel fragments were moved and overturned and shells and rocks were dislodged or plowed along the bottom (2). Sampling one day after a single dredge tow revealed that surficial sediments were re-suspended and lost and that the dredge tilled the bottom, burying surface sediments and organic matter to a depth of 9 cm, increasing the grain size of sediments above 5 cm, and disrupting a surface diatom mat (3). Microbial biomass at the sediment surface increased as a result of dredging.

Table 54. Effects of New Bedford Scallop Dredges on Mixed Substrate Habitat: Summary of Published Studies

S = statistically significant; U = undisturbed; D = disturbed; HT = heavily trawled; LT = lightly trawled

| No. | Reference | Location | Depth | Sediment | Effects | Recovery | Approach |
|-----|-------------------|---|---------|--|---|----------|--|
| 1 | Caddy 1968 | Northumberland Strait, Gulf of St. Lawrence, Canada | 20 m | Mud and sand | Drag tracks (3 cm deep) produced by skids, smooth ridges between them produced by rings in drag belly, dislodged shells in dredge tracks. | | Diver observations of physical effects of two tows. |
| 2 | Caddy 1973 | Chaleur Bay, Gulf of St. Lawrence, Canada | 40-50 m | Gravel over sand, with occasional boulders | Suspended sediment, flat track, marks left by skids, rings and tow bar, gravel fragments less frequent (many overturned), rocks dislodged or plowed along bottom. | | Submersible observations of tow tracks made less than 1 hr after single dredge tows. |
| 3 | Mayer et al. 1991 | Coastal Gulf of Maine (USA) | 8 m | Mud, sand and shell hash | Lowered sediment surface by 2 cm, injection of organic matter and finer sediment into lower 5-9 cm, increased mean grain size in upper 5 cm, disruption of surface diatom mat, increased microbial biomass at sediment surface. | | Experimental study, compared dragged and undragged sites before and 1 day after a single dredge tow. |

5.3.4 Summary

The following conclusions were reached in Amendment 10 to the Atlantic sea scallop FMP:

- Potentially adverse habitat impacts from bottom trawling occur throughout most of the NE region on a variety of substrates;
- High levels of fishing activity with scallop dredges occur primarily in the Mid-Atlantic region and secondarily on Georges Bank, according to the vessel trip report data from 1995 – 2001. Intense dredge activity from the same data show that the highest intensity of scallop fishing is in the Great South Channel and portions of the Mid-Atlantic region from Long Island to VA. The VMS data from 1998 confirms this assessment and also shows high scallop fishing intensity in the southern part of Closed Area II because the period included the area access program during the 1999 and 2000 fishing years which was intended to have high levels of effort to reduce impacts in open areas where smaller scallops existed.
- Potentially adverse habitat impacts from scallop dredging may occur in areas where scallop effort overlaps with areas where EFH has been designated for species with vulnerable EFH. According to the analysis within this document, scallop fishing effort is distributed in the same proportion as juvenile and adult EFH designations, but areas with more intense scallop fishing effort tend to be over areas with less EFH designations for species with vulnerable EFH.

5.4 Endangered and Other Protected Species

The following section is based largely on or is excerpted from the 2/24/2003 Biological Opinion (BO) on the continued implementation of the Sea Scallop FMP prepared by NOAA Fisheries as part of its responsibilities under Section 7 of the Endangered Species Act (ESA). While the subject of the consultation has changed since preparation of the BO --- Framework Adjustment 15 to the FMP has been implemented and Amendment 10 has been approved by the Council and submitted to NMFS --- the background information is still relevant. The major points provided here are intended to lend context to the discussion of the impacts of management measures proposed in Framework Adjustment 16/39 on threatened, endangered and other protected species.

Dredges and otter trawls are the primary gear types used in the Atlantic sea scallop fishery. The majority of full-time participants in the limited access fishery use dredge gear (approximately 255 of the 314 full-time permit holders), particularly in New England and the Georges Bank area. A large percentage of the part-time and occasional vessels fish in the Mid-Atlantic, use trawl gear and in recent years have concentrated fishing effort in the Delmarva area. Although they may use any gear type to harvest sea scallops, general category vessels primarily use dredge and bottom trawl gear to land up to 400 lbs. of scallops per trip, and generally use both dredge and trawl gear. In 2002 general category permits numbered 2,653.

Fishing patterns have shifted in the last several years as the result of several management programs allowing controlled access to areas of Georges Bank previously closed scallop vessels and to specific areas in the mid-Atlantic to take advantage of aggregations of larger scallops. With increased monitoring and observer coverage, it has become clear that protected species issues exist where there is an overlap with the distribution those species scallop fishing operations.

To focus the discussion in this document, it is necessary to acknowledge that NOAA Fisheries has determined that the scallop fishery is not likely to adversely affect shortnose sturgeon (*Acipenser*

brevirostrum), the Gulf of Maine distinct population segment (DPS) of Atlantic salmon (*Salmo salar*), hawksbill sea turtles (*Eretmochelys imbricata*), North Atlantic right whales (*Eubalaena glacialis*), humpback whales (*Megaptera novaengliae*), fin whales (*Balaenoptera physalus*), sei whales (*Balaenoptera borealis*), blue whales (*Balaenoptera musculus*), or sperm whales (*Physeter macrocephalus*) all of which are listed as endangered species under the ESA. The rationale for this determination is described in the February 24, 2003 BO and is incorporated herein by reference.

Similarly, other cetaceans not listed under the ESA, but protected by the Marine Mammal Protection Act, as well the pinniped species inhabiting the action area, do not appear to be vulnerable to scallop gear or negative fishery impacts because of scallop gear configuration and/or the lack of overlap between the fishery and the distribution of these species. This information was fully discussed in Amendment 10 to the Scallop FMP currently under review by NOAA Fisheries. At this writing, no new information has become available to change these conclusions.

Based on information known about the species and documented interactions with sea scallop gear, NOAA Fisheries has determined that the sea scallop fishery currently adversely effects loggerhead, Kemp's ridley, green and leatherback sea turtles --- all listed as threatened or endangered under the ESA. The following two sections "Summary of effects of gear interactions" and "Observed interactions between sea turtles and scallop gear" are excerpted from the 2/24/03 BO to establish a baseline for discussion of the management alternatives.

5.4.1 Summary of effects of gear interactions

The distribution of loggerhead, Kemp's ridley, and green sea turtles overlaps with the distribution of scallop gear from the southern boundary of the management area (North Carolina/South Carolina border) to Cape Cod. Leatherbacks have a broader distribution and are expected to overlap with operation of the scallop fishery throughout the area where the sea scallop fishery operates --- from the North Carolina/South Carolina border through the Gulf of Maine.

The distribution and concentration of all four sea turtle species within the management area is expected to be highest in summer months. Turtles are also expected to be present in spring and fall months as they move to and from foraging grounds. In general, none of the four species are expected to be present in the management area north of Cape Hatteras, North Carolina, during the winter. All four species are expected to be more prevalent in Mid-Atlantic as compared to New England waters. In addition, Kemp's ridley and green sea turtles are expected to occur predominantly in inshore waters although this conclusion may be biased by the difficulty of detecting these relatively small species during surveys of offshore continental shelf waters.

Based on the CeTAP study (1982) and Shoop and Kenney (1992), the distribution of loggerheads and leatherbacks are expected to overlap with scallop fishing gear throughout Mid-Atlantic continental shelf waters in the summer with lower concentrations in the spring and fall. Based on surveys (CeTAP 1982; Shoop and Kenny 1992), loggerhead sea turtles are considered to be the most abundant of these four turtle species in the action area. This is not unexpected given that the population of Atlantic loggerheads is more numerous than either Kemp's ridley, green or leatherback sea turtles.

Hard-shelled sea turtles have been injured and killed as a result of being captured in scallop dredge gear. There are currently no measures that have been proven to eliminate the risk of interaction between turtles and scallop dredge gear. Although tow times for scallop dredge gear would typically prevent sea turtles from drowning in scallop gear once they were captured, there are no enforceable restrictions limiting tow times. Tow times in excess of 60 minutes are not unusual and at least one turtle

was retrieved in a comatose condition after a tow of less than 60 minutes. Therefore, sea turtles caught in a scallop dredge can be killed or injured as a result of forced submergence during scallop tows.

In addition, hard-shelled sea turtles are also injured or killed as a result of injuries suffered during interactions when they struck by a dredge, crushed by debris, or as a result of being dropped onto a fishing vessel when a dredge is hauled and the catch is sorted. Given their large size and differences in prey and habitat preferences, leatherback sea turtles are not expected to be caught in dredge gear or struck by the gear when it is operating on the bottom.

There have been no known interactions between scallop trawl gear and sea turtles but interactions are reasonably likely to occur given the prevalence of this gear type in the Mid- Atlantic, the presence of sea turtles in Mid-Atlantic waters, and the known interactions between sea turtles in similar trawl gear used in other Mid-Atlantic fisheries. Loggerheads, Kemp's ridley, green, and leatherback sea turtles may suffer injuries or be killed as a result of capture (forced submergence) in scallop trawl gear. As described above, although tow times for scallop gear would typically prevent turtles from drowning, there are no enforceable restrictions limiting tow times and tow times in excess of 60 minutes are not unusual.

Given that there is a reasonable likelihood that the distribution of loggerhead, Kemp's ridley, green, and leatherback sea turtles will overlap with the distribution of gear used in the scallop fishery, it is NOAA Fisheries' opinion that loggerhead, Kemp's ridley, green, and leatherback sea turtles may be taken in the scallop fishery as a result of capture in or being struck by gear used in the fishery. Such interactions may occur throughout the area where distribution of these species and operation of the scallop fishery overlap. Although a complete analyses is required, more current information on takes of sea turtles in 2003 may clarify levels of takes by dredge gear both inside and outside of the Scallop Access Areas and elsewhere where the fishery overlaps with sea turtle distribution.

5.4.2 Observed interactions between sea turtles and scallop gear

Although three sea turtles had previously been observed to have been captured by scallop dredge gear in 1996, 1997 and 1999, this gear was not believed to pose a threat to sea turtles until the 2001 scallop fishing. Sea turtles generally avoid the low temperatures preferred by sea scallops (<50° F), a feature that was believed to protect sea turtles from interacting with mobile bottom gear used in the scallop fishery. As the result, the three turtles that had been captured between 1996 and 1999 were treated as anomalies.

From June through October 2001, however, 11 turtles were captured by scallop dredge vessels fishing in the reopened Scallop Access Areas. A scallop dredge vessel that had been fishing in the Hudson Canyon Area reported that they had captured two additional turtles (one live and one dead), although further information on these two interactions is not available. The condition of the 14 turtles that had been captured by scallop dredge vessels from 1996-2001 varied from dead animals to live animals with injuries, and live turtles with no apparent injuries.

Sea turtles were later captured in scallop dredge gear within the Hudson Canyon Closed Area in the 2002 fishing year despite substantially-reduced vessel participation, suggesting that the turtles captured in 2001 were not an anomaly. Based on preliminary reviews of the 2002 observer reports, 23 turtles were captured in scallop dredge gear for vessels operating in the Hudson Canyon Closed Area from July - October 2002. Two of these were decomposed carcasses. Since the cause of death could not determined and the decomposed condition of the turtles suggested that the deaths occurred well before the turtles were captured in the dredge, NOAA Fisheries did not attribute these two deaths to the scallop dredge fishery. One additional turtle was reported captured in scallop dredge gear by the crew of a vessel

fishing in the Hudson Canyon Area. As had been seen in 2001, the condition of the 23 turtles observed included uninjured turtles, alive/injured, and dead.

In all, of the 40 hard-shelled turtles observed or reported as captured in the scallop dredge fishery from 1996-October 31, 2002, 23 were reported to be alive with no apparent injuries, 6 were alive with injuries (includes one that died of the injuries after being hauled onto vessel), 6 were of unknown condition (includes the 3 turtles that were reported rather than observed), and 5 were dead (includes 2 that were decomposing carcasses and that NOAA Fisheries is not attributing to the scallop fishery).

There have been no documented interactions between sea turtles and scallop trawl gear. However, observer coverage for these vessels has been low and turtles captured in this gear may have gone unreported for various reasons. Based on fisheries statistics data for scallop fishing years 1999-2001 (March 1, 1999-February 28, 2002), the majority of the annual scallop trawl landings (89%, 77%, and 74%, respectively) were obtained from waters off of the Delmarva Peninsula. Scallop landings by trawl gear from the Delmarva area occur throughout the year but are highest from April-November, times when sea turtles are present in these Mid-Atlantic waters.

The number of documented interactions between sea turtles and otter trawls used in other fisheries has been extensive. These include the U.S. shrimp trawl fishery and the Mid-Atlantic summer flounder winter trawl fishery (TEWG 1998, 2000), the Delaware horseshoe crab fishery (Spotila et al. 1998), the whelk trawl fishery in South Carolina and Georgia (NOAA Fisheries SEFSC 2001), the long-finned squid bottom trawl fishery in waters off of Delaware (unpublished NOAA Fisheries Sea Sampling Observer Program data), and the North Carolina flynet trawl fishery for Atlantic croaker.

Since the completion of the BO in February, 2003, NOAA Fisheries has received new information identifying that 12 sea turtles were taken in the scallop fishery outside of the Mi-Atlantic Scallop Access Areas through October, 2003. Further information is not available at this writing, although this information is under review as part of the Section 7 consultation that has also been reinitiated for Amendment 10 to the Scallop FMP.

5.5 Human Environment

Because the proposed action includes scallop fishing access in the Georges Bank groundfish closed areas and would change the open area DAS allocations for fishing in open areas elsewhere, the human environment includes the scallop fishing industry throughout the range of management, including approximately 350 scallop vessels or people with limited access scallop permits (292 actively using scallop DAS), over 2,200 vessels and fishermen with general category scallop permits (about 200 that target sea scallops and might fish in the proposed access areas), dealers, processors, markets, suppliers, and fishing communities. Primary centers of fishing industry activities include coastal NC, the Hampton Roads area of VA, Cape May, Barnegat, and Point Pleasant, NJ, New Bedford, Provincetown/Chatham, and Gloucester, MA. The human environment was described in detail in Section 7.1 of the FSEIS for Amendment 10 (NEFMC 2003), which the Council recently submitted and is currently undergoing Secretarial review.

In addition, the proposed access program and reductions in finfish bycatch elsewhere could have impacts on vessels and fishermen with limited access and open access groundfish permits, dealers, processors, markets dealers, processors, markets, suppliers, and fishing communities, primarily ranging from NJ to ME. A detailed description of the human environment is presented in Section 9.4 of the FSEIS for Amendment 13 to the Multispecies FMP, which the Council recently submitted and is currently undergoing Secretarial review.