New England Fishery Management Council

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Habitat Area of Particular Concern Candidate Proposal Submission Form

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Title of HAPC Proposal: Georges Bank Juvenile Cod Habitat Areas of Particular Concern (HAPC) on Western Georges Bank

Signature of Petitioner:

Abstract / Brief Statement of Proposal:

Oceana proposes to designate areas on Georges Bank and west of the Great South Channel that are (1) known Essential Fish Habitat (EFH) for the Georges Bank stock of juvenile cod or (2) gravel with emergent epifauna as Habitat Areas of Particular Concern. Oceana proposes that the use of all mobile fishing gear that intentionally or inadvertently tends bottom be prohibited in these HAPCs to protect juvenile cod habitat[1].

These areas are highly productive and particularly vulnerable to adverse impacts from bottom-tending fishing gear. (NEFMC Omnibus EFH Amendment, at 41 1998). Scientists have documented two key services that juvenile cod derive from structurally complex habitat – shelter from predation and more benthic invertebrates to eat. When this living structure is damaged, degraded, or removed the benefits provided to juvenile cod decline significantly and recovery can take over a decade. When the underlying foundation (such as a boulder ridge) is also disrupted, the habitat may never return to its former state.

[1] The intent of this proposal is to complement the existing juvenile cod HAPCs on eastern Georges Bank with additional HAPCs in inshore areas on the western portion of Georges Bank and west of the Great South Channel. In no way does this proposal intend to modify, reduce, or eliminate, the existing juvenile cod HAPC. Oceana supports the expansion of the cod HAPC and its protections to all known gravel habitat on the northern edge of Georges Bank.

Topic 1: Brief Statement of Proposal

Scientists and fishermen have advocated for HAPC designation of these areas since 1999. In its 1999 Habitat Annual Review Report, the NEFMC's Essential Fish Habitat Technical Team reviewed thirty years of trawl survey data on juvenile cod abundance and identified these areas as some of the most productive areas for Georges Bank cod. At the same time, members of the commercial groundfish industry highlighted the same areas for HAPC designation. This combination led the Habitat Technical Team to nominate these areas as HAPCs for Atlantic cod in its 1999 Habitat Annual Report. In support of HAPC designation, the report provides an extensive description of the proposed areas, and a thorough review of over thirty scientific studies documenting the habitat requirements of juvenile cod. (NEFMC, EFH Technical Team, 1999 Habitat Annual Review Report, April 1999, at 102-139.)

It is well-documented that juvenile cod rely on structurally-complex gravel habitat with emergent epifauna for food and shelter from predators. Juvenile cod EFH is rare and consists predominantly of large-grained sediments with emergent epifauna that provide important shelter for post-settlement cod and are highly susceptible to long-term damage by bottom-tending mobile gear. Such damage significantly reduces the two key ecological functions of this habitat type for post-settlement juvenile cod (abundant prey and increased survivorship). Loss of this habitat could limit recruitment of Georges Bank juvenile cod into the fishery (Lough et al. 1989).

The status of Georges Bank cod has not significantly improved since its collapse in the mid-1990s and scientists continue to witness record lows in recruitment of juvenile cod (Rosenberg 2003). Identifying critical habitat such as nearshore cobble patches and protecting it from anthropogenic impacts by risk-averse management measures is an important step toward improving juvenile survivorship. 1999 HAR at 120.

For these reasons, the proposed areas meet the criteria for HAPC designation. They (1) provide significant ecological functions for juvenile cod; (2) are extremely sensitive to anthropogenic stress; (3) are a rare habitat type; and (4) are adversely affected by various types of fishing activity. A full discussion of how these areas meet each of these criteria for HAPC designation is provided below.

Proposed Areas for HAPC Designation

This proposal identifies prime gravel nursery habitats west of the Great South Channel and on western Georges Bank for HAPC designation to protect the Georges Bank stock of juvenile cod. All of these areas contain structurally complex gravel, cobble, and boulder habitat, which, if not trawled or dredged, supports a wide array of emergent epifauna that juvenile cod rely on for food and shelter from predation. These habitat types are found in four general areas in and around Georges Bank, as described in the 1999 Habitat Annual Report at 102-104:

Area A: These areas represent deep water spots (45 - 75 fathoms) of hard bottom which are fished for groundfish and include a greater diversity of species than shallow areas. The bottom is covered by boulders of glacial origin. Benthic fauna such as sea squirts are not as abundant as in shoal areas and tend to be smaller in size. The tide in these areas moves more slowly which may account for these smaller sizes. Common fishing area names in this region include: (1) East Southeast Ridge; (2) Figs; (3) Jim Dwyers Ridge; (4) The Sixty-sixes; and (5) Pimple Ridges.

Area B: This area consists of relatively shallow waters (15 - 40 fathoms). This area is streaked with rock and gravel with flourishing benthic organisms, large quantities of horse mussels, sea "lemons" and sponges. The tide flows rapidly here which may stimulate the growth of these communities. Common fishing area names in this area include: (1) Lemons and (2) Mussels.

Area C: An unusual combination of shoal water (15 - 45 fathoms), strong tides, and rocky bottom makes this an ideal habitat for cod and haddock. The benthic species are similar to those in Area B, but everything seems to have higher growth rates. The catch in this area is similar to that in Area B except that a greater proportion of the catch is cod or haddock (primarily cod). Common fishing area names in this area include: (1) Crushed Shells; (2) East of Pollock Hole; (3) Codfish Grounds; (4) Big Mussels Cove; (5) Middle Rip; and (6) Pumpkins.

Area D: This is an area of rocky bottom close to the beach which supports cod and pollock, particularly in the winter months (1999 Habitat Annual Report at 102-103).

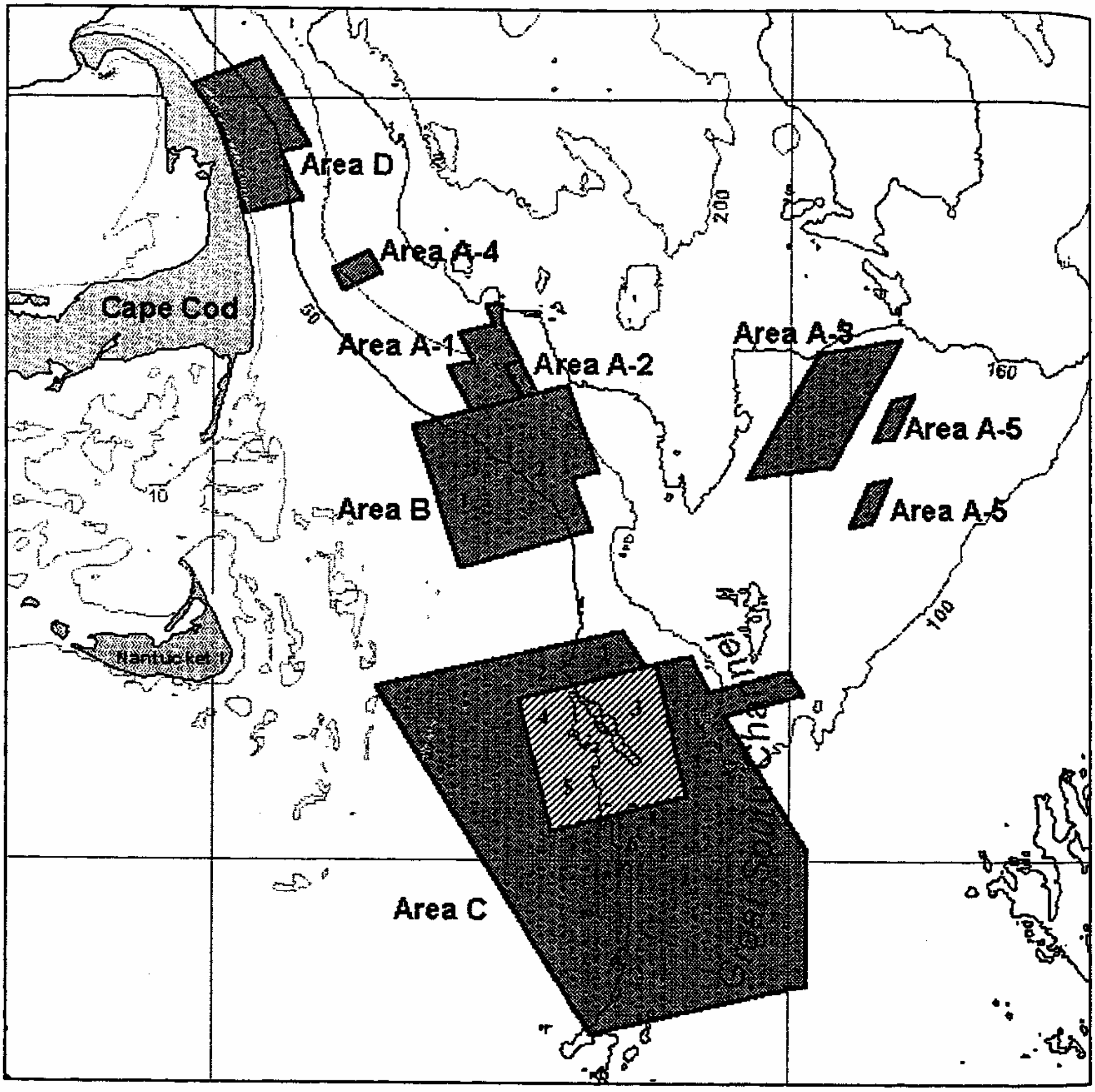


Figure 1. Proposed HAPCs for Georges Bank juvenile cod. Reproduced from the 1999 Habitat Annual Report at 104.

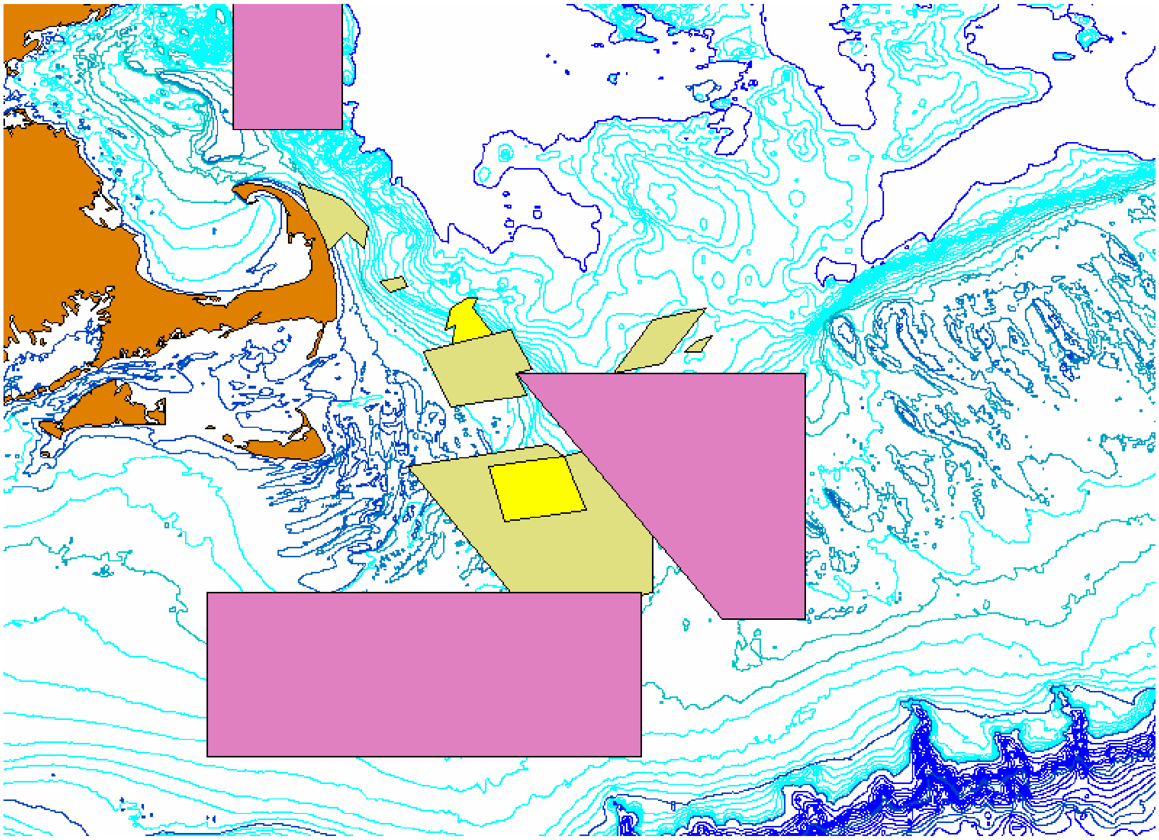


Figure 2. Proposed Juvenile Cod HAPC Areas. Oceana 2005.

Justification and Supporting Data for HAPC Designation

CRITERON 1B – Importance of Current Ecological Function

Do gravel habitats provide an important ecological function for juvenile cod?

Yes. These areas proposed for juvenile cod HAPC designation contain structurally complex rocky-bottom habitat that supports a wide variety of emergent epifauna and benthic invertebrates. This habitat type provides two key ecological functions for juvenile cod: increased survivorship and readily available prey.

Benthic organisms provide a major food source for many commercially-managed groundfish, including juvenile cod. Benthic invertebrates are the main source of nutrition for many demersal fishes and abundant prey is particularly critical for the starvation-prone early life history stages of fish (Omnibus EFH Amendment, Atlantic cod EFH Source Document, at 11-16) (Hermsen et al. 2003).

Shrimps, polychaetes, brittle stars, and mussels are commonly found in association with the emergent epifauna (bryozoans, hydroids, worm tubes) that is prevalent in undisturbed gravel habitats (Collie et al. 1997). Several studies of the food habits of juvenile cod identify these associated species as important prey items (Hacunda 1981; Lilly and Parsons 1991; Witman and Sebens 1992; Casas and Paz 1994; NEFSC 1998). The removal of these benthic organisms has a significant and negative effect on commercial groundfish, including cod (Hermsen et al. 2003).

In addition to benefiting from readily available prey, post-settlement juvenile cod experience increased survivorship in gravel habitats with biogenic structure. Gravel, cobble and boulder habitats provide significantly greater three-dimensional structure (e.g. mounds, ridges, crevices) compared to sand or mud habitats.

The complexity of these rocky bottoms is further enhanced by the growth of biogenic structure-forming emergent epifauna (Lindholm et al. 1999, 2001). The living communities of invertebrates (food for juvenile cod) depend on stable piles of boulders that are not disturbed too frequently. Natural levels of disturbance determine which epifauna are found on these boulders (Sousa 1979).

The importance of benthic habitat complexity was discussed by Auster (1998) and Auster and Langton (1999) in the context of providing a conceptual model to visualize patterns in fishing gear impacts across a gradient of habitat types. Based on this model, habitat value increases with increased structural complexity, from the lowest value in flat sand and mud to the highest value in piled boulders.

The first field study linking survival of juvenile cod to habitat type on Georges Bank was by Lough et al. (1989). Using submersibles, the scientists observed that recently-settled 0-group juvenile cod were primarily found in pebble-gravel habitat at 70-100 m depths on eastern Georges Bank. They hypothesized that the gravel enhanced survival through predator avoidance. The authors considered increased prey abundance to be another explanation for the abundance of juvenile cod on gravel.

In the first study suggesting an added value of emergent epifauna on Georges Bank gravel, Valentine and Lough (1991) observed from submersibles that attached epifauna was much more abundant in areas of eastern Georges Bank that had not been fished. They concluded that the increased bottom complexity provided by the epifauna might be an important component of fisheries habitat.

Tupper and Boutilier (1995a), examined four habitat types (sand, seagrass, cobble, rock reef) in St. Margaret’s Bay, Nova Scotia, and reported that cod settlement was equal in all habitats, but survival and juvenile post-settlement densities were higher in the more complex habitats. Juvenile survival was highest on rock reef and cobble. In another study in St. Margaret’s Bay, Tupper and Boutilier (1995b) found that cod settling on a rocky reef inhabited crevices in the reef, and defended territories around the crevices.

Kaiser et al. (1999) analyzed beam trawl catch data from a number of stations in the English Channel and reported that small gadoid species were present in deeper (>30m), structurally-complex habitats with rocks, soft corals, bryozoans, hydroids, and sponges. These results suggested that depth and the amount of cover provided by certain types of emergent epifauna were the most important factors affecting habitat utilization by gadoid species.

Geologists and biologists of the U.S. Geological Survey (USGS), the National Marine Fisheries Service (NMFS) and National Marine Sanctuaries System (NMSS) of the National Oceanic and Atmospheric Administration (NOAA), the University of Rhode Island, and the University of Connecticut have been conducting joint studies of the seabed geology and biological habitats of Georges Bank for several years. These studies have shown, among other things, that:

• Juvenile cod survive best on gravel habitat, especially where sponges, tube worms, and other attached species (known as epifauna) increase the complexity of the seabed.
• Attached species are not able to colonize gravel habitat that is buried occasionally by moving sand

• Dredging and trawling on gravel habitat remove epifauna and decrease habitat complexity, but fishing gear apparently has less long-term impact on sand habitat, especially where sand is moved by bottom currents

USGS Fact Sheet FS–061–01, July 2001

Information on the effects of habitat complexity on juvenile cod survival is also available from several laboratory studies. Gotceitas and Brown (1993) compared substrate preferences of juvenile cod from among sand, gravel-pebble, and cobble, before and after introduction of a larger cod. In the presence of the predator, juvenile cod chose cobble if available, and the cobble reduced predation. The experiment did not test effects of emergent epifauna, which would provide even greater habitat complexity.

Gotceitas et al. (1995) conducted a similar study, but with either 1) sand, gravel, and 30 cm long strips of plastic to simulate kelp, or 2) sand cobble and "kelp." When exposed to an active predator, juvenile cod hid in cobble, if available, or kelp if there was no cobble. Both cobble and kelp significantly reduced predation.

Gotceitas et al. (1997) again used the same experimental system to compare use of sand, gravel, and cobble substrate, and three densities of eelgrass, by age-0 cod in the presence and absence of a predator (age-3 cod). When a predator was introduced and cobble was present, age-0 cod hid in the cobble or in dense eelgrass if present. With no cobble, age-0 cod hid in all three densities of eelgrass. Age-0 cod survival was highest in cobble or dense eelgrass. In other combinations, time to capture increased with both presence and density of vegetation.

Lindholm et al. (1999) tested effects of five habitat types, representing a gradient of complexity, on survival of age-0 cod in the presence of larger cod. Substrates were sand, cobble, sparse short sponge, dense short sponge, and tall sponge. Sponge presence significantly reduced predation compared to that on sand, with density of sponges being more important than sponge height. The authors concluded that loss of sponges and alteration of seafloor habitat by fishing could lower survival of juvenile cod.

The effects of habitat complexity on post-settlement survival of juvenile cod have also been examined via modeling (Lindholm et al. 1998, 2001). Data from the Lindholm et al. (1999) laboratory study described above were used to assign maximum values of 0.98 for juvenile mortality in the least complex habitats, and 0.32 in habitats of greatest complexity. Survival was tracked for twelve months after settlement. Reduction in habitat complexity by fishing had significant negative effects on survival of juvenile cod, and the use of area-based gear restrictions could preserve that complexity and improve survival.

In conclusion, these studies correlate increased post-settlement survivorship of Atlantic cod (*Gadus morhua*) with increased complexity of the seafloor where cod first settle. Survival is greater in habitats of higher complexity where cover provides shelter from predators (e.g., pebble-cobble with emergent epifauna > pebble-cobble > sand). Both scientific field studies and laboratory experiments show that gravel and hard bottom substrate provide greater habitat complexity than most other benthic substrates. These substrates make possible the development of epifauna and biogenic structure, which has been shown to enhance survivorship of juvenile cod.

The research discussed in this proposal demonstrates that habitat complexity affects cod survival from the post-settlement pelagic stage well into the demersal juvenile stage. Survival or failure of these stages translates into the population as a whole, and may be more important than pre-settlement survival (Sissenwine 1984). Lack of nearshore bottom habitat for a particular year-class could lead to a bottleneck in later recruitment to the fishery on Georges Bank (Lough et al. 1989).

The Omnibus EFH Amendment recognized this scientific evidence identifying the habitat associations between juvenile cod and gravel beds. This association is well known compared to the level of information for other managed species. Of all the various species and life stages with EFH designations, juvenile cod is the only life stage that has Level 3 information. (NEFMC Omnibus EFH Amendment, at 30.)

Additional data illustrates the strength of this link between juvenile cod and complex habitats. Thirty years of density-dependence data from the NEFSC trawl survey recognize this ecological function and were used to identify EFH for commercially-managed species. Figure 3, a map of NMFS survey trawls catches from 1970-2003, represents the most current information regarding the location of juvenile cod. The habitat description is according to the map prepared by the Conservation Law Foundation.

As seen in Figures 4-5, the proposed HAPC overlaps significantly with the top 50th percentile of both juvenile and adult cod abundance. These areas also overlap with the top 25th percentile of adult cod abundance (1999 HAR at 105.) The fact that the proposed HAPC areas overlap areas of significantly higher cod abundance further supports the importance of these areas to Georges Bank cod and their qualification for HAPC designation.

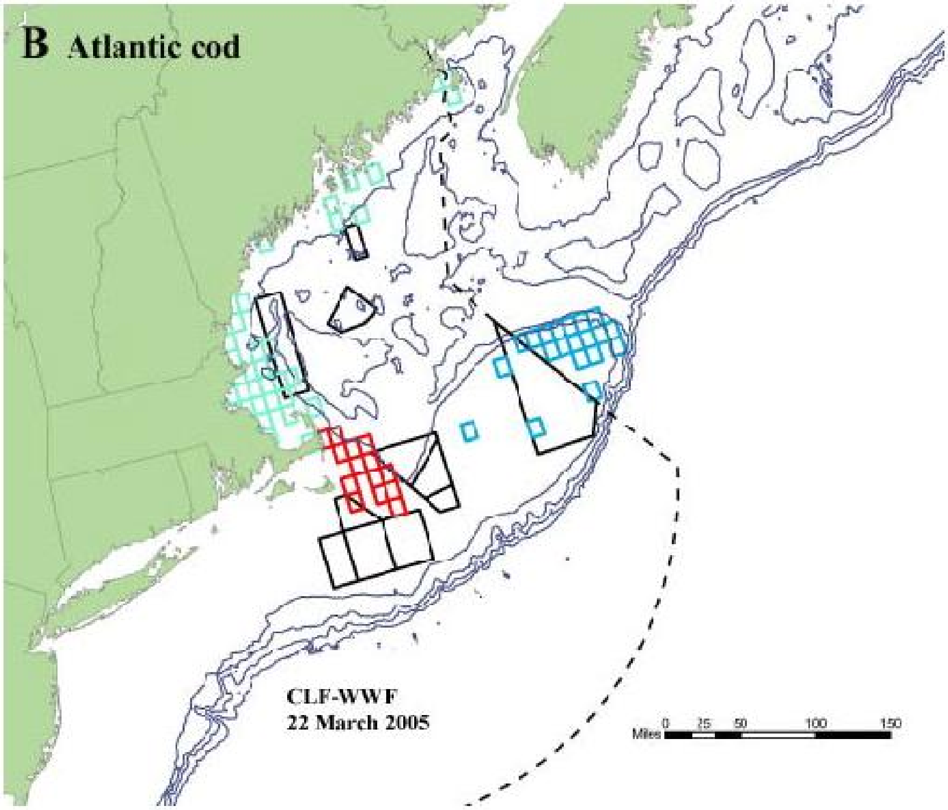


Figure 3. Juvenile cod stocks, information from the Conservation Law Foundation

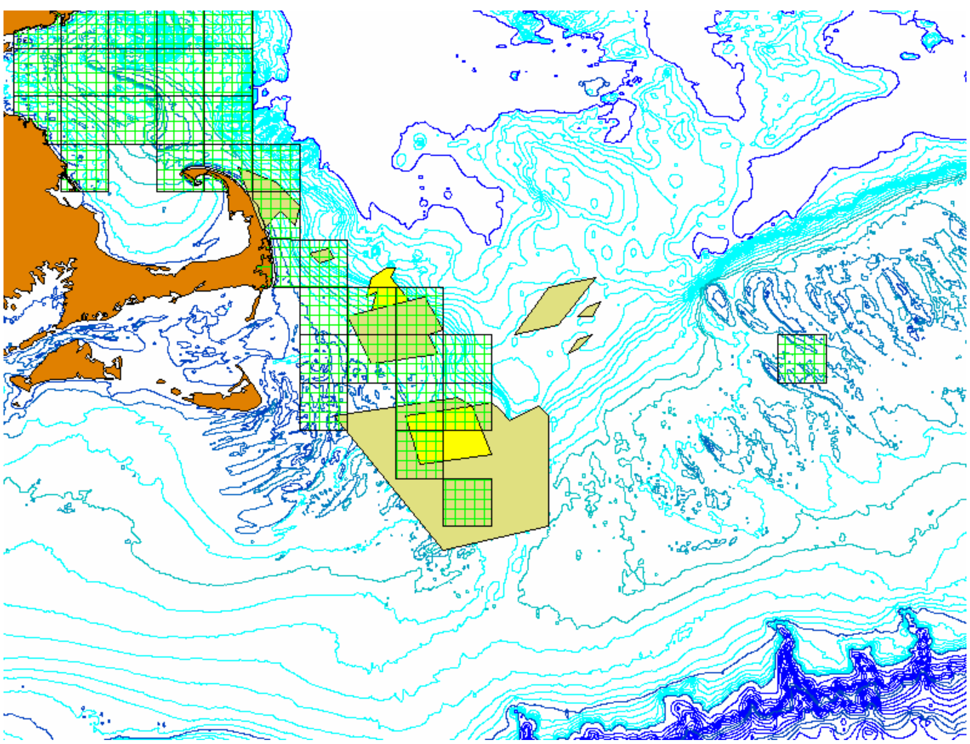


Figure 4. Map Showing Overlap Between Proposed HAPC Areas and Top 50th Percentile of Juvenile cod EFH

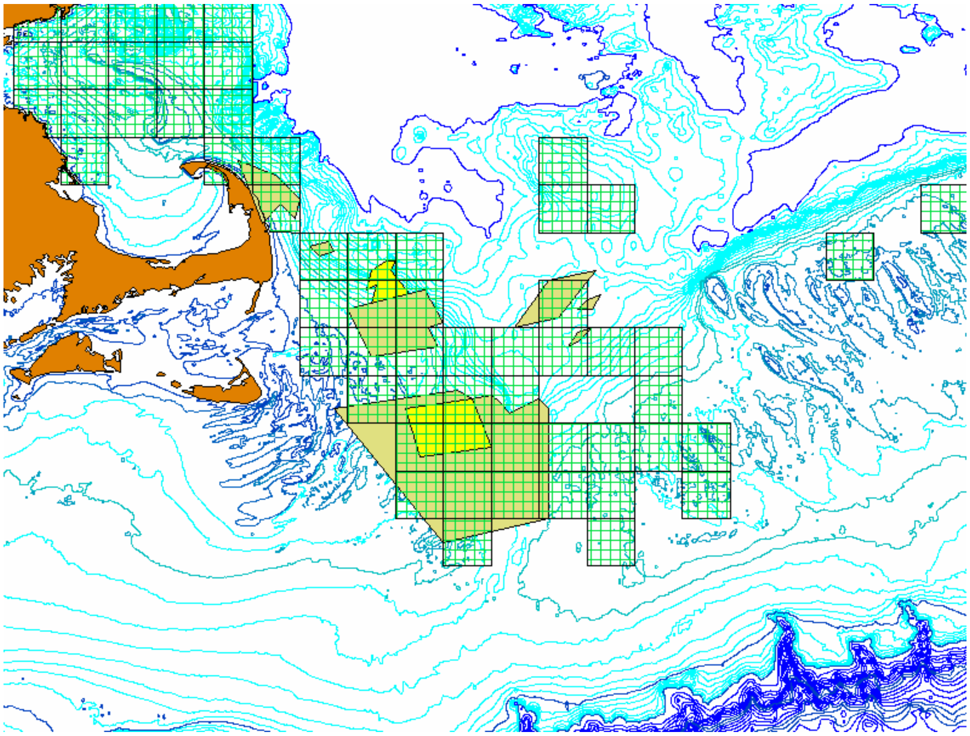


Figure 5. Map Overlaying Proposed HAPC Areas and Top 50th Percentile of Adult cod EFH

CRITERON 2 – Sensitivity to Anthropogenic Stress

Are gravel habitats sensitive to anthropogenic stress?

Yes. The areas proposed for HAPC designation contain habitat features that are particularly sensitive, both in absolute terms and relative to other habitat types, like flat sand habitats, to the adverse effects associated with bottom trawling and scallop dredging. Marine habitat scientists have conducted extensive research on juvenile cod, and have found that they depend on structurally-complex gravel and boulder habitat with emergent epifauna. If these habitats are not trawled, they support vast colonies of sea floor marine life, including benthic invertebrates that make up the major source of food for juvenile cod, and meadows of sponges, anemones, and other 'emergent epifauna' (biogenic structure-forming species like corals, sponges, sea fans, sea squirts, among many others) that provide juvenile cod shelter from predators.

Georges Bank – Northeast Peak

Heavily disturbed gravel habitat west of Area II continues to be impacted by mobile fishing gear. Note gravel is clean and sand shows between pebbles.

Recovering seafloor Community in Area II. Note some cover by epifauna, primarily sponges. Area closed 2.5 years.

Undisturbed gravel habitat on Canadian Side of Georges Bank. Note nearly full cover provided by attached fauna (Hydroids, bryozoans, calcareous worm tubes).

Figure 6. Map of Disturbed and Recovered Gravel Habitat on Georges Bank (Collie et al. 2000).

Scientists have also found that if these areas are trawled or dredged, the two ecological functions provided by this habitat are significantly reduced. First, most of the benthic life that juvenile cod rely on for food is crushed, killed and removed (Hermsen 2003; Collie et al. 2000a). Secondly, the emergent epifauna that provides shelter for juvenile cod from predators is removed. Laboratory experiments and computer modeling simulations suggest that the survival of juvenile cod is significantly reduced after gravel habitats are trawled (Lindholm et al. 1999, 2001). See Figure 6 (above).

In addition to this initial impact, these habitats are extremely sensitive to trawling and dredging as compared to other types of habitat found off the Northeast shore. While high-energy sand habitats can recover in less than a year, scientists have documented that the recovery rate for 'emergent epifauna' in gravel habitats can be more than a decade after even just one pass of a trawl or dredge[2].

[2] See NEFMC Memorandum from Chris Kellogg to Paul Howard. *Habitat and Bycatch Technical Questions*, dated Feb. 25, 2002, at 2 ("Vertically-complex habitats with biogenic structure that serve as shelter from predation for juvenile gadids are especially vulnerable [to scallop fishing]."). See also, id at 3 ("A partial reduction in fishing effort on gravel habitat with attached epifauna would not be beneficial because the gravel habitat might require 5 years (and possibly a decade or more) to recover to its undisturbed state (Collie et al. 2000)".

Leading habitat scientists in the region and nationwide are part of a growing consensus that the protection of structurally complex areas with biogenic structure is the most pressing habitat concern for commercially-managed species. See Fig. 7-8 (NRC 2002, NEFSC 2001).

Figure 7. Conceptual model of the relationship between vulnerability to fishing gear (structural complexity and recovery time) and habitat availability for the Northeast region. (NEFSC 2001).

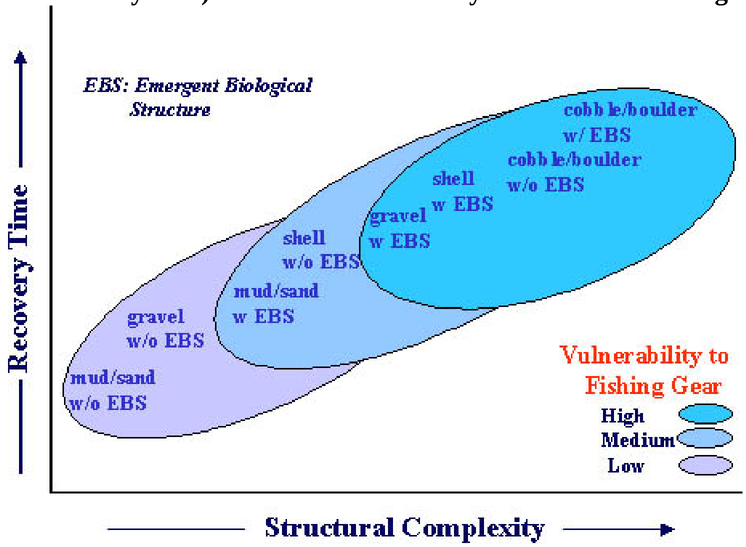
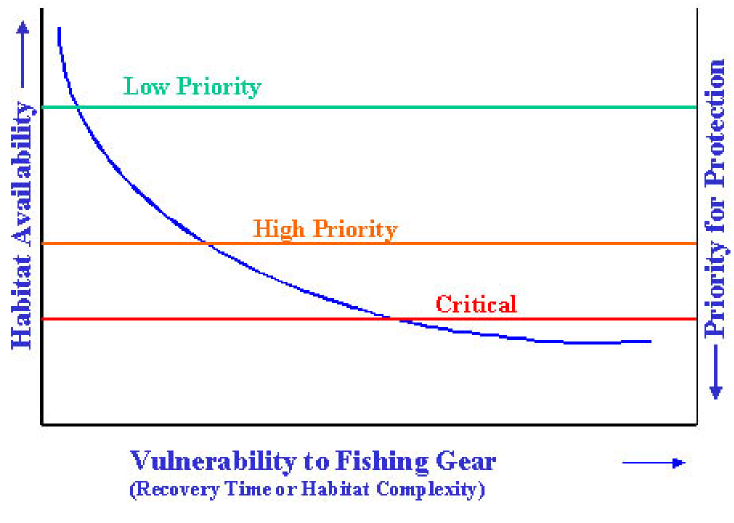


Figure 8. Conceptual model of the relationship between vulnerability to fishing gear (structural complexity and recovery time), habitat availability, and priority for protection.



Scallop dredging decreases habitat complexity by razing biogenic structure and smoothing bedforms (Auster and Langton 1998; Auster et at. 1995; Collie et al. 1996, 1997; Hall 1994; Jennings and Kaiser 1998; Thrush et al. 1998). The initial impact from bottom-tending mobile fishing gear on biogenic structure is expected to be the most acute, since initial impact is expected to cause the loss of most biogenic structure.

Chronic impacts from scallop gear after biogenic structure has been lost are thought to maintain habitat values at a consistently lower level. Complete recovery of biogenic structure on gravel substrate closed to bottom fishing has been shown to take more than five years, and possibly and decade or more (NEFMC Memorandum from Chris Kellogg to Paul Howard. *Habitat and Bycatch Technical Questions*, dated Feb. 25, 2002, at 2.)

CRITERON 3 – Extent of Current or Further Development Stresses

Are the proposed areas presently experiencing anthropogenic stress?

Yes. As seen in Figures 9 - 13, the areas proposed for HAPC designation face significant threats from bottom trawling and scallop dredging, both of which occur throughout the proposed HAPC areas.

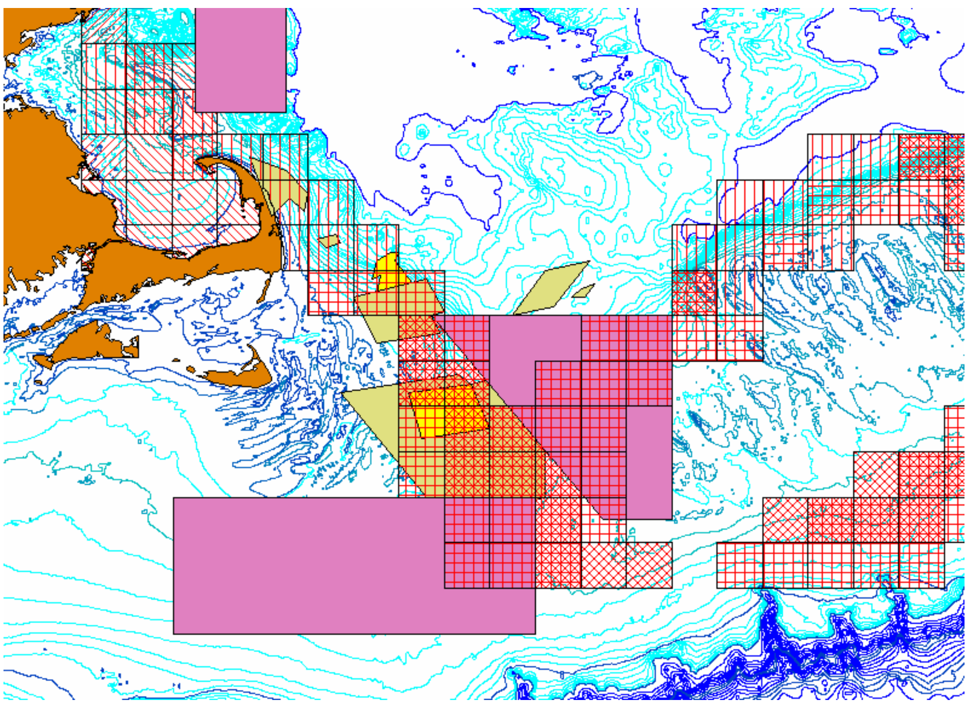


Figure 9. Map Overlaying Proposed HAPC Areas and Location of Commercial Atlantic Sea Scallop Dredging Effort, 1999 and 2000.

According to Scallop Framework 16, nearly 50% of the projected scallop effort is expected to occur in the Great South Channel vicinity as illustrated in Figure 9. As seen by the extent of scallop dredging in areas west of the Great South Channel, many of the areas proposed for HAPC designation are now experiencing high levels of scallop dredging effort. See Figures 10-11.

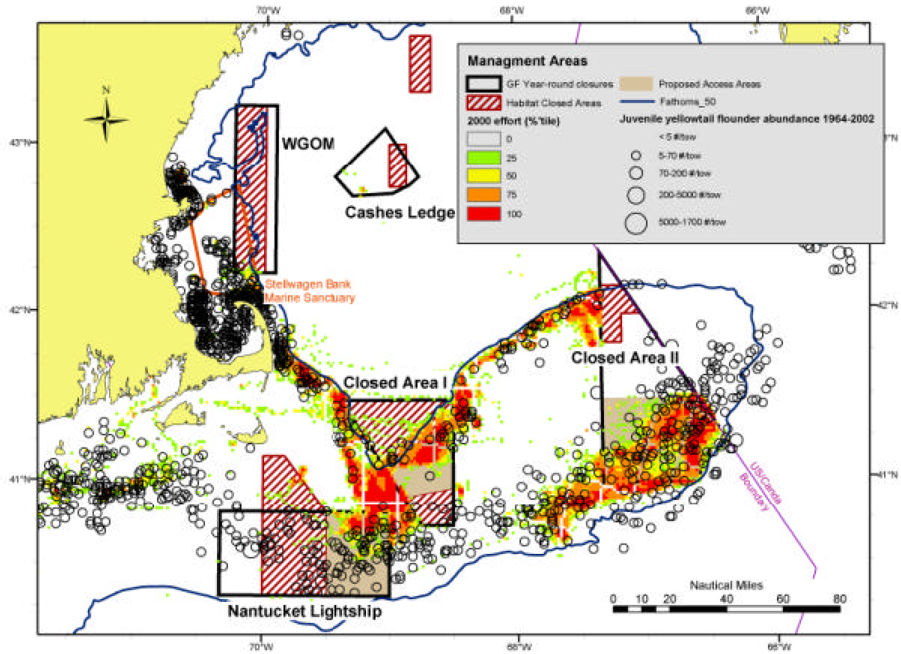
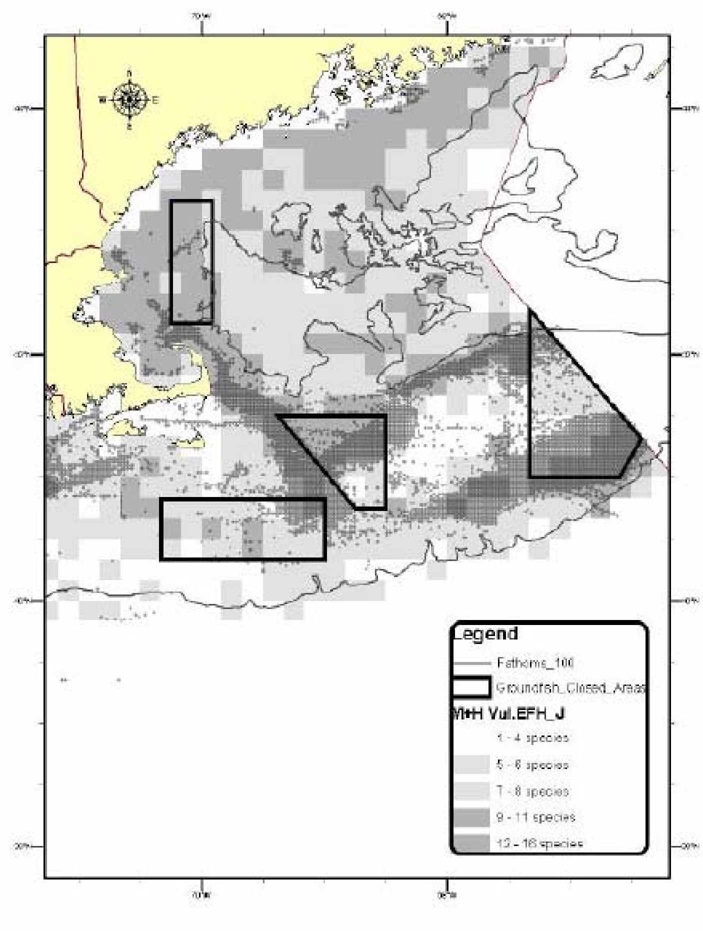


Figure 10. Map of 1999-2000 Scallop Effort
Reproduced from Scallop Framework Adjustment 16 at 6-15.

Figure 11. Map of Scallop Effort Overlap with Juvenile EFH Designations for Species with EFH Vulnerable to Bottom Tending Mobile Gear (Reproduced from Scallop Amendment 10, Map 64. Note: Dots represent 1 nmi2 squares with >50 hours of fishing effort per year. EFH designations are broken down into 5 categories in the legend, but for display purposes the map only has three categories (1-4 species (white), 5-8 species (light gray), and 9-16 species (dark gray)). Scallop Amendment 10 at 8-339.



Bottom-trawling is also extensive throughout juvenile cod EFH in areas west of the Great South Channel and in gravel habitats on Georges Bank. See Figure 12 for TSF/SMAST 2000-2001 Trawl Survey Project Haul Summary. VTR Maps prepared for Groundfish Amendment 13 show similar effort concentrations in these proposed HAPC areas (See Figure 13).

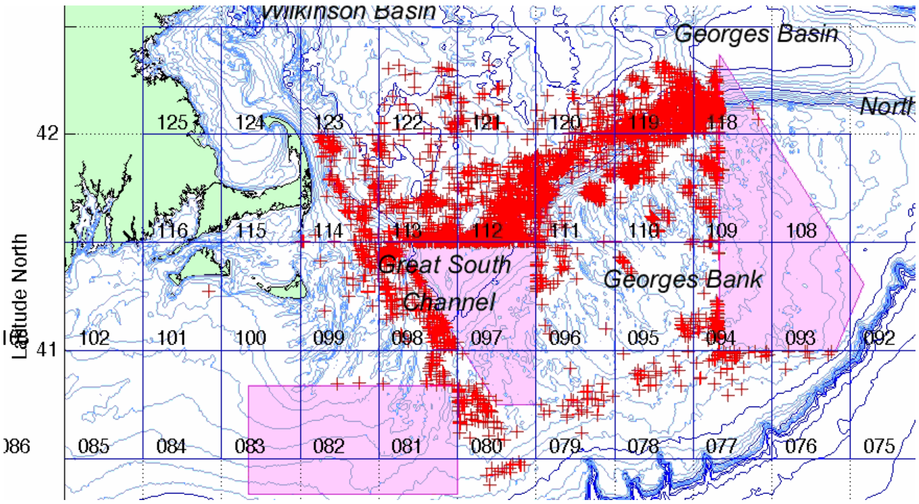


Figure 12. TSF/SMAST 2000-2001 Trawl Survey Project Haul Summary.

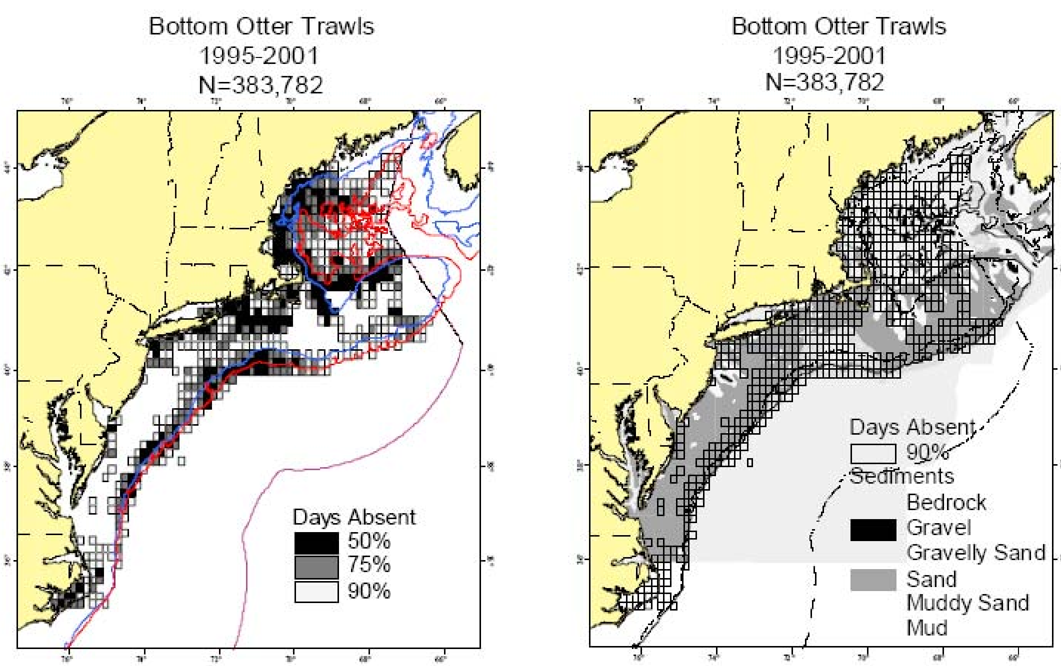


Figure 13. Reproduced from Groundfish Amendment 13 - Figure 244 - Spatial distribution of ten minute squares (TMS) that account for high (50%), medium (75%), and low (90%) levels of fishing activity by bottom otter trawls in the U.S. Northeast region and overlays of 90% TMS on sediments.

CRITERON 4 – Rarity of the Habitat Type

Are gravel habitats rare on Georges Bank?

Yes. In the Northeast region, habitat with low structural complexity and short recovery times is relatively abundant. Conversely, habitat with high structural complexity and long recovery time is comparatively less abundant (NEFSC 2001). Offshore New England marine habitat consists predominantly of sand (60%) and mud (26%). The last ice age, however, covered the Northeast with massive sheets of ice, interspersing between the sands and mud a rare habitat type that consists of boulders, cobble, and gravel (Hermsen et al. 2003). Existing sedimentary maps show that such complex habitats are rare in New England and comprise only about 1-5% of the entire US EEZ.

Proposed Management Measures for the Proposed HAPC areas

Upon designation of these proposed areas as HAPC for Georges Bank juvenile cod, Oceana recommends that these areas be designated a Level 3 Habitat Closure. A Level 3 Habitat Closure would indefinitely close the proposed HAPC areas to all bottom-tending mobile gear. This designation would protect the HAPC from the adverse impacts of these fishing practices while allowing continued fishing opportunities for groundfish.

Furthermore, scientific studies have shown that, if allowed to recover, these areas would result in a significant increase in juvenile cod survival and recruitment into the adult cod population (Lindholm et al. 2001). As seen in the case of Georges Bank haddock, improved recruitment can quickly and significantly rebuild the stock, increase sustainable catch limits, increase revenue for fishermen, and expand opportunities to fish for abundant species under Special Access Programs.

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