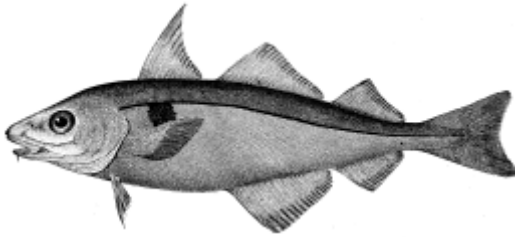
Seafood Watch
Seafood Report

MONTEREY BAY AQUARIUM®

Haddock
(*Melanogrammus aeglefinus*)



Courtesy NEFSC

U.S. Northeast Region

Final Report
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About Seafood Watch® and the Seafood Reports

Monterey Bay Aquarium's Seafood Watch® program evaluates the ecological sustainability of wild-caught and farmed seafood commonly found in the United States marketplace. Seafood Watch® defines sustainable seafood as originating from species, whether wild-caught or farmed, that can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems. Seafood Watch® makes its science-based recommendations available to the public in the form of regional pocket guides that can be downloaded from the Internet (www.montereybayaquarium.org) or obtained from the program by emailing seafoodwatch@mbayaq.org. The program's goals are to raise awareness of important ocean conservation issues and to shift the purchasing habits of consumers, restaurateurs and other seafood purveyors to support sustainable fishing and aquaculture practices.

Each sustainability recommendation on the regional pocket guides is supported by a Seafood Report. The report summarizes what is known about each species and evaluates five criteria to determine the long-term sustainability of the species. For wild-caught species, these criteria are:

- ✓ Inherent Vulnerability to Fishing Pressure
- ✓ Status of the Wild Stocks
- ✓ Nature and Extent of Discarded Bycatch
- ✓ Effect of Fishing Practices on Habitats and Ecosystems
- ✓ Effectiveness of the Management Regime

These criteria and the evaluation methodology reflect the conservation ethic of the Seafood Watch® program and Monterey Bay Aquarium. A guiding principle is associated with each criterion that reflects the program's view of sustainable fishing practices. For each criterion, Research Analysts seek out relevant scientific information from the following information sources (in order of preference): academic, peer-reviewed journals, government technical publications, fishery management plans and supporting documents, and other scientific reviews of ecological sustainability. The information is evaluated and binned into one of three color-coded categories reflecting a conservation concern of low, moderate or high. An overall seafood recommendation of "Best Choices", "Proceed with Caution" or "Avoid" is determined by combining the ranks of the individual criteria. The overall recommendation reflects the program's view of the long-term sustainability of the species and the common methods by which it is currently harvested. The body of this report synthesizes, analyses and evaluates currently available information related to each of these five sustainability criteria. The detailed evaluation methodology is available upon request.

Disclaimer
Seafood Watch® strives to have all Seafood Reports reviewed for accuracy and completeness by external scientists with expertise in ecology, fishery science and aquaculture. Scientific review, however, does not constitute an endorsement of the Seafood Watch® program or its recommendations on the part of the reviewing scientists. Seafood Watch® is solely responsible for the conclusions reached in this report.
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Executive Summary

Haddock (*Melanogrammus aeglefinus*) is a commercially important gadoid that is caught in commercial groundfish trawl fisheries in the North Atlantic Ocean. This species matures quickly and has a relatively short (~ 15 yr) lifespan. Off the U.S. coast, there are two stocks: a smaller Gulf of Maine stock, and larger Georges Bank stock (which is jointly managed with Canada). Both stocks are currently considered overfished, but overfishing has not occurred since 1995. Indices of abundance have improved since the mid 1990s and a strong year class, combined with reduced mortality (fishing and natural) will likely aid greatly in improving stock status in the future.

Trawling, the primary fishing method for this species, results in significant disturbance to the sea floor, impacting marine habitats that are important to the survival of groundfishes and other species. The severity of the impact depends upon gear components and the resiliency of the habitat type being trawled. Trawling is also indiscriminate, and along with targeted species takes unmarketable, illegal, or undersized species that are fatally discarded, adding to the overall fishing mortality of many groundfish species. Haddock caught using hook and line are a more sustainable alternative due to minimal bycatch and habitat damage with the use of this gear. Groundfish managers have attempted to mitigate both habitat effects and bycatch from trawling operations by closing over 25,000 square miles of ecologically sensitive habitat to trawling, increasing mesh size of the trawl gear, and including discard estimates in fishing mortality analyses. In addition, managers actively study stock abundance and have implemented several regulations over the years in an attempt to maintain stock productivity. The management regime, however, has not prevented significant declines of haddock stocks and until the stocks have fully recovered, can be considered only moderately effective.

Table of Sustainability Ranks

	Conservation Concern			
Sustainability Criteria	**Low**	**Moderate**	**High**	**Critical**
Inherently Vulnerability	√			
Status of Stocks			√	
Nature of Bycatch	√ **(Hook & line)**	√ **(Trawl)**		
Habitat Effects	√ **(Hook & line)**		√ **(Trawl)**	
Management Effectiveness		√		

Overall Seafood Recommendation:

- A seafood product is ranked "**Avoid**" if a total of two or more criteria are indicated as Concern: High (red) OR if one or more criteria are indicated as Concern: Critical (black) in the table above.
- A seafood product is ranked "**Caution**" if a total of three or more criteria are indicated as Concern: Moderate (yellow) OR where the "Status of Stocks" and "Management Effectiveness" criteria are both indicated as Concern: Moderate.
- A seafood product is ranked "**Best Choices**" if a total of three or more criteria are indicated as Concern: Low (green) and no remaining criteria are indicated as Concern: High or Concern: Critical.

Haddock: Best Choices **Caution (Hook & line)** **Avoid (Trawl)**

Introduction

Haddock is a demersal (bottom-living) species in the Gadidae family (subfamily Gadinae), or 'true cods'(Nelson 1994). There are 15 genera and over 30 species; many of the most important commercial groundfishes are included in this group (cod, pollock, hake, whiting). Haddock is distributed on both sides of the North Atlantic Ocean and can be found as far north as Greenland and as far south as Cape Hatteras, North Carolina (Brown 2000). Off the U.S. coast, the majority of the population is centered around Georges Bank (GB; Fig. 1), with additional stocks located in the Gulf of Maine (GOM) and Browns Bank, which is north of GB towards Nova Scotia (Brown 2000). Haddock are most commonly found in 45 to 135 meters (m) of water and in temperatures of 2° to 10° C (Brown 2000). U.S. haddock stocks are regulated under the New England Multispecies Groundfish Fishery Management Plan (FMP), which manages the catch of 15 species and 24 stocks along the U.S. Atlantic coast. Most of the Canadian catch is landed in Nova Scotia (DFO 2002). Haddock inhabiting Georges Bank are jointly managed by the U.S. and Canada.

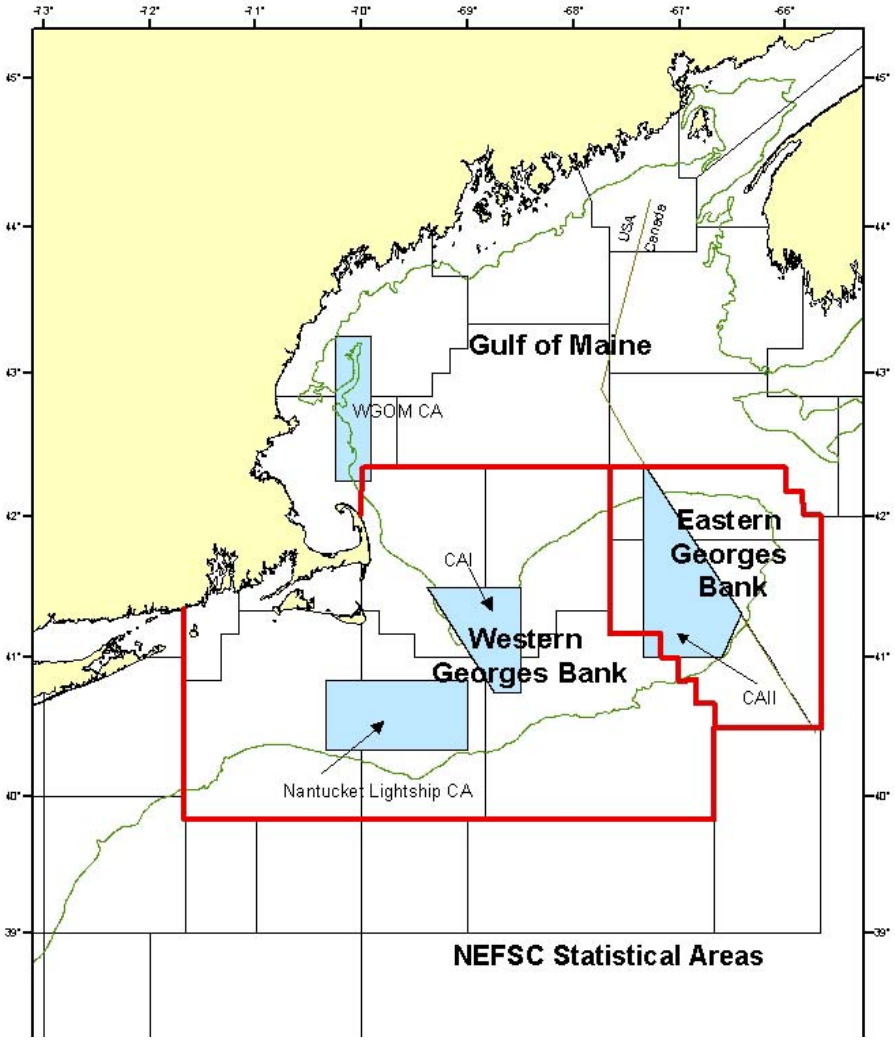


Figure 1. Map of haddock management areas in the Northeast Atlantic (courtesy: NEFSC).

The New England groundfish fishery has existed since colonial times. The first colonial fishermen used small sailing dories and caught mostly cod by hook and line, salting their product as a means of preservation (Collete and Klein-MacPhee 2002). Sailboats gave way to steamships, and the use of otter trawls (from Europe) and on-board refrigeration beginning in the early 1900s revolutionized the fishery (NRC 1998). After World War I, fishers began to target a wider variety of species, including haddock, yellowtail and winter flounders, as well as Atlantic halibut. Groundfish landings decreased during World War II, and then increased in the 1960s, particularly due to effort by distant-water factory trawlers from Russia and Spain. Prompted by concerns about overfishing, the U.S. created the first 200-mile Exclusive Economic Zone (EEZ) along its Atlantic coastline in 1977, and thereafter encouraged the growth of the U.S. fishery. Canada also created a 200-mile EEZ. Conflicts persisted over the U.S./Canada maritime boundary until the establishment of the Hague Line in 1985 (NRC 1998). Once the U.S. EEZ was established, domestic fishing grew substantially. From 1975 to 1980, the number of vessels in the U.S. groundfish fleet nearly doubled, from around 600 to over 1,100 (Brodziak and Link 2002).

Commercial landings of haddock peaked in the late 1960s with over 150,000 metric tons (mt) landed (mainly from GB), and has since declined drastically to a current low of only a few thousand metric tons each year, largely due to regulations. In 2002, 7,541 mt of haddock was landed in the U.S., primarily from Massachusetts and Maine (NMFS 2002). Excessive fishing pressure, first by international fleets, then by the domestic fleet, has led to severe overfishing of many groundfish stocks, including haddock. Lawsuits were filed in the early 1990s against the Department of Commerce (DOC, the parent agency for the National Marine Fisheries Service, which governs U.S. fish stocks), alleging the DOC failed to protect natural resources. Severe restrictions and subsequent economic hardship followed; fishing effort was limited through closed areas, reduced quotas, and government-subsidized boat buyback programs. These measures have not yet achieved the goal of reviving depleted stocks. The New England groundfish fishery has recently implemented new management options (Amendment 13, May 2004), again brought about by litigation (CLF et al. vs. NMFS et al., December 2001) aimed at drastically decreasing fishing effort to bring about recovery of several depleted groundfish stocks, including haddock.

Scope of the analysis and the ensuing recommendation:
The report focuses primarily on U.S. managed haddock stocks from Georges Bank and the Gulf of Maine. An attempt has been made to analyze those Canadian haddock stocks that may intermix with U.S. stocks, such as the Eastern Georges Bank haddock managed by the Department of Fisheries and Oceans (DFO), Canada. Imported haddock is not analyzed in this report.

Availability of Science

Because haddock is a valuable commodity in New England and Canadian economies, life history and abundance information are readily available. Further research is needed to understand the degree of mixing between stocks between the GOM, GB and Browns Bank, as separate stocks are managed under distinct management plans. Further research on migration patterns, spawning behavior (coinciding with oceanographic data), and genetics may better confirm the ranges of individual stocks. Intrinsic rate of increase, ‘r’, was not found for haddock. It does not appear that maximum age has been validated for this species.

Market Availability

Common/Market Names
Haddock is normally called by its common name. It may also be called scrod, although this term typically refers to cod.

Seasonal Availability
Haddock may be found regionally year-round in both retail and service markets.

Product Forms
Haddock may be marketed as fresh or frozen fillets, blocks, whole, or value-added (i.e., breaded).

Product Sources
Haddock is sold fresh or frozen, as fillets, smoked or canned (Froese and Pauly 2004).

Import/Export Statistics
Significantly more haddock has been imported into the U.S. over the last decade than has been landed domestically (Fig. 2). The major countries that import haddock into the U.S. are Canada, Iceland, the Russian Federation States, and Norway (Fig. 3).

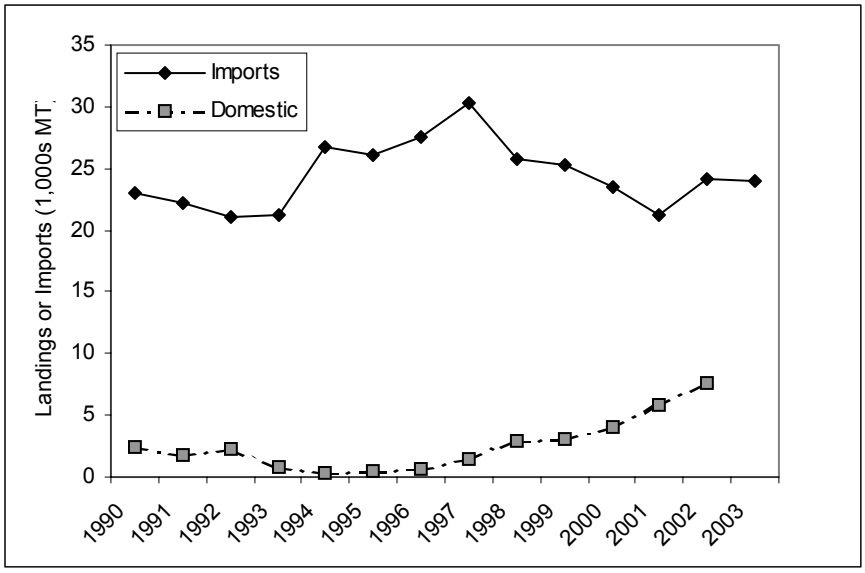


Figure 2. Haddock imports and U.S. domestic landed catch of haddock, in metric tons, 1990 – 2003 (NOAA 2004).

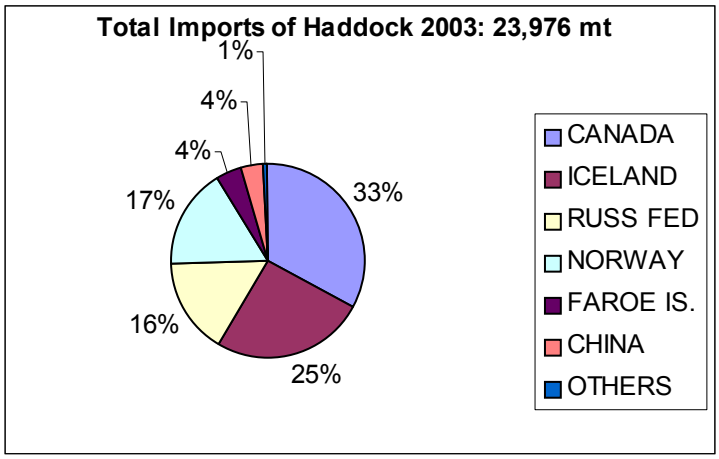


Figure 3. Composition of 2003 haddock imports by country (NOAA 2004).

Analysis of Seafood Watch® Criteria

Criterion 1: Inherent Vulnerability to Fishing Pressure

Haddock has a fairly resilient suite of life history characters (Table 1): females are 100% mature by age 3 (Cargnelli et al. 1999) and the maximum known age is 14 years (Penttila et al. 1989). According to Froese and Pauly (2004), the growth coefficient, 'k'[1], is 0.12 – 0.32. Like many teleost fishes, female haddock grow larger and older than males. In addition, individuals from Georges Bank mature at smaller size and younger age than do individuals from further north in the Gulf of Maine and Browns Bank (Cargnelli et al. 1999). There is evidence that fishing pressure has selectively reduced the size and age at maturity for this species. O'Brien et al. (1993) noted a 10 cm reduction in the median length at maturity for both males (37 to 27 cm) and females (40 to 30 cm) between 1977-1983 and 1985-1990.

Spawning habitat required by haddock consists of gravelly sand and gravel substrates (Cargnelli et al. 1999). Due to this habitat substrate being prominent on Georges Bank and Browns Banks, these areas are the principle spawning areas. Spawning is highly variable and occurs later in the year with increasing latitudes. Peak spawning in the Gulf of Maine occurs from February through May; Georges Bank peak spawning is late-March through April, while peak spawning periods in Browns Bank are late April through early May (Cargnelli et al. 1999). Fecundity is variable and largely dependent upon female size, but can be as high as 3 million eggs per spawning female (Cargnelli et al. 1999). The eggs are deposited over pebble/gravel substrate and become buoyant after fertilization. Hatching occurs 9-32 days after spawning (Cargnelli et al. 1999). Larvae range in size from 2-5 mm and are pelagic for 30-42 days (Laurence 1978), occurring at a depth of 10-50m below the surface (Cargnelli et al. 1999). Larval retention on or near the spawning grounds determines the strength of each year class and is highly dependent upon oceanographic conditions. Juveniles gradually move from the water column to the seafloor where they become demersal (thus the name groundfish) for the remainder of their lives (Collete and Klein-MacPhee 2002). At this stage there is a shift from planktonic to benthic prey, such as crustaceans, polychaetes, mollusks, echinoderms and small fish (Cargnelli et al. 1999).

[1] The value 'k' is the growth coefficient from a widely used fish growth model, the von Bertalanffy growth function, VBGF, after von Bertalanffy (1938).

Table 1. Life history parameters for haddock.

Age at Maturity	Growth Rate/Max. Size	Longevity	Fecundity	Species Range	Special Behaviors	References
Mean size at maturity (female/male, cm): Georges Bank: 29.7/26.8 Gulf of Maine: 34.5/35.0 Browns Bank: 42.5/36.5 Size at maturity positively density dependent.	'k' = 0.12 – 0.23 Average size at age: 1 - 17.5 cm, 2 - 33.8 cm, 3 - 45.5 cm, 4 - 54.0 cm, 5 - 60.1 cm, 6 - 64.5 cm, 7 - 67.6 cm, 8 - 69.9 cm, 9 - 71.5 cm, 10 - 72.7 cm, 11 - 73. 6cm, 12 - 74.2 cm, 13 - 74.6 cm, 14 - 75.0 cm, 15 - 75.2 cm. Max. size: 110cm, 16 kg, more commonly 35-60 cm Median age at maturity (female/male, years): Georges Bank: 1.5/1.3 Gulf of Maine: 1.8/2.1; evidence that median length at maturity on Georges Bank has decreased (during 1977-1983 was 40/37).	Maximum age documented at 14 years; ages 10+ uncommon.	Eggs released at intervals over a 3 week period. Fecundity ranges from 12,000 - 3,000,000 eggs; varies with size; year to year variation may be correlated with temperature	Cape Charles VA to Labrador, Canada. Occur throughout Gulf and offshore banks; greatest concentration on Georges Bank. Generally below 10 m, most in 40-150 m, few deeper than 200 m. No extreme migrations, minor inshore/offshore movements.	None reported.	(Cargnelli et al. 1999; Collete and Klein-MacPhee 2002; Froese and Pauly 2004)

Synthesis
Haddock is a quickly maturing, highly fecund gadoid that is inherently resilient to fishing pressure. There is evidence however that heavy fishing pressure has acted as a strong selective force decrease the age and size at maturity, which may adversely impact recruitment and natural mortality.

Inherent Vulnerability Rank: **Resilient** **Neutral** Vulnerable

Criterion 2: Status of Wild Stocks

There are two stocks of haddock in U.S. waters, one centered in the southwestern Gulf of Maine, and the other, larger stock located on Georges Bank. Within the GB, the stock is further divided into eastern and western management units (see Fig. 1). Off the eastern coast of Canada there are five haddock fishing areas, with the most important being the eastern Georges Bank stock. Because the International Boundary line between the U.S. and Canada runs through Georges Bank, the haddock stock is there is jointly assessed (and managed) by both countries.

Table 2. Stock status and trends for haddock. Fishing mortality (F) and Biomass (B) data are as of October 2003 (Unpublished data, NEFSC). A ratio of $F_{2002}/F_{msy} > 1$ indicates overfishing is occurring.

Stock	Classification Status**	F_{2002}/F_{msy}	B_{2002}/B_{msy}	Abundance Trends	Age/Size/Sex Distributions	Degree of Uncertainty
GOM haddock	Overfished; Overfishing not occurring	0.12/0.23 =.52	46% Bmsy	Increasing since 1994	Truncated but improving	Low
GB haddock	Overfished; Overfishing not occurring	0.20/0.26 = 0.76	40% Bmsy	Increasing since 1995	Truncated but improving	Low

** From (NMFS 2004b)

Georges Bank haddock
The entire GB stock (western and eastern units) was last assessed in 2002 (NEFSC 2002). Commercial landings totaled 4,637 mt in 2001, which is a 38% increase from 2000 (Fig. 4). Canadian landings of the eastern GB stock also increased between 2000 and 2001 to 6,712 mt. Overall fishing mortality (F) increased 16% from 0.19 in 2000 to 0.22 in 2001. A Virtual Population Assessment (VPA) model indicated the total stock size increased 38% between 2000 and 2002, from 80.5 million fish to 111.4 million fish (Fig. 5). Spawning stock biomass has increased from a low of 11,400 mt in 1993 to 59,700 mt in 2000. Recruitment has improved somewhat in the late 1990s, with the 2000 year class (75.1 million) the strongest since 1978 (NEFSC 2002).

The eastern GB stock was last assessed during the seventh meeting of the Transboundary Resources Assessment Committee (TRAC) meeting in May 2003. The committee reported that "adult biomass (age 3+) has steadily increased since 1993 and was about 78,000 [mt] at beginning of 2003, which is at the lower range of the 1930 to 1950s historical level when

productivity was higher" (NEFSC 2004). The committee also examined recruitment over the last several years and noted increased recruitment and survivorship (partially due to reduced exploitation) has contributed to the increased abundance of the stock (NEFSC 2004). Apparently haddock biomass is the highest it's been in over 30 years. With respect to recruitment, the 2000 year-class is estimated to be larger than both the 1975 and 1978 year-classes, but the 2001 year-class is well below average and preliminary estimates of the 2002 year-class are low (NEFSC 2004). In a recent survey, researchers documented an extremely large 2003 year class, with the highest number per tow index (153.4 fish) ever recorded in the time series (NOAA 2004a).

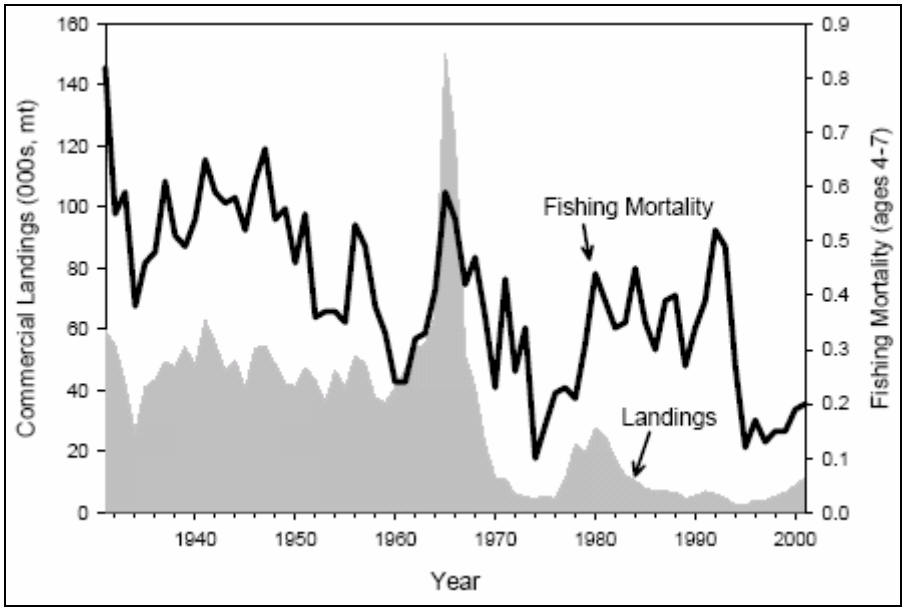


Figure 4. Trends in commercial landings (thousands of mt, live weight) and fishing mortality (unweighted mean, ages 4-7) for Georges Bank haddock from 1931-2001 (NEFSC 2002).

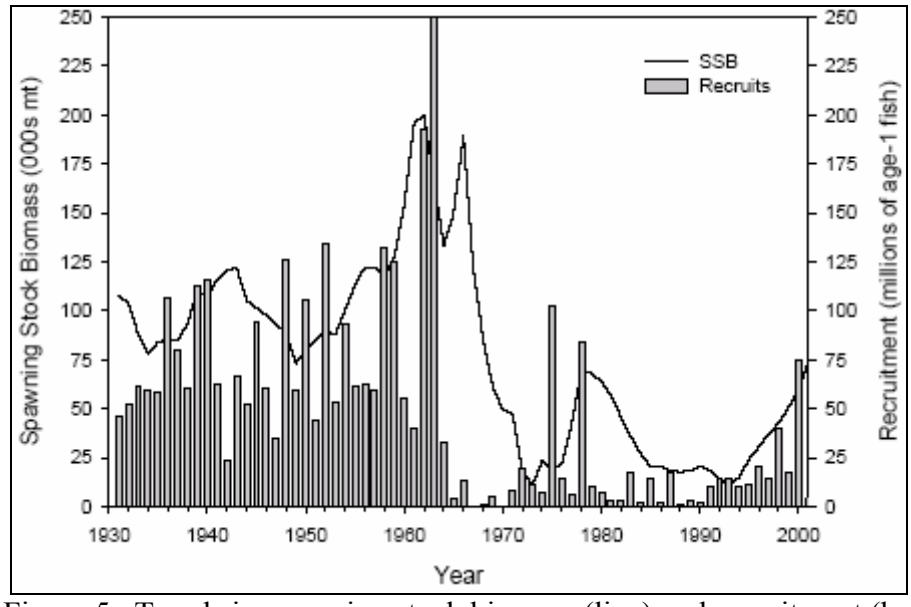


Figure 5. Trends in spawning stock biomass (line) and recruitment (bars)

for Georges Bank haddock from 1931-2001 (NEFSC 2002).

Gulf of Maine haddock

Gulf of Maine haddock was last assessed (fully) in the year 2000 (32nd SAW). At that time the stock was declared overfished (based on biomass per tow; B_{2000} = 3.41 kg/tow < B_{msy} = 4.39 kg/tow), and overfishing was occurring (NEFSC 2001). Survey estimates of abundance have begun to increase since the mid 1990s, but recruitment appears to be highly variable (Fig. 6). There has been some indication that the age structure is widening (NEFSC 2001). The most current status (as of 2003) is that the GOM stock is overfished, but overfishing is no longer occurring (Table 2) (NMFS 2004b).

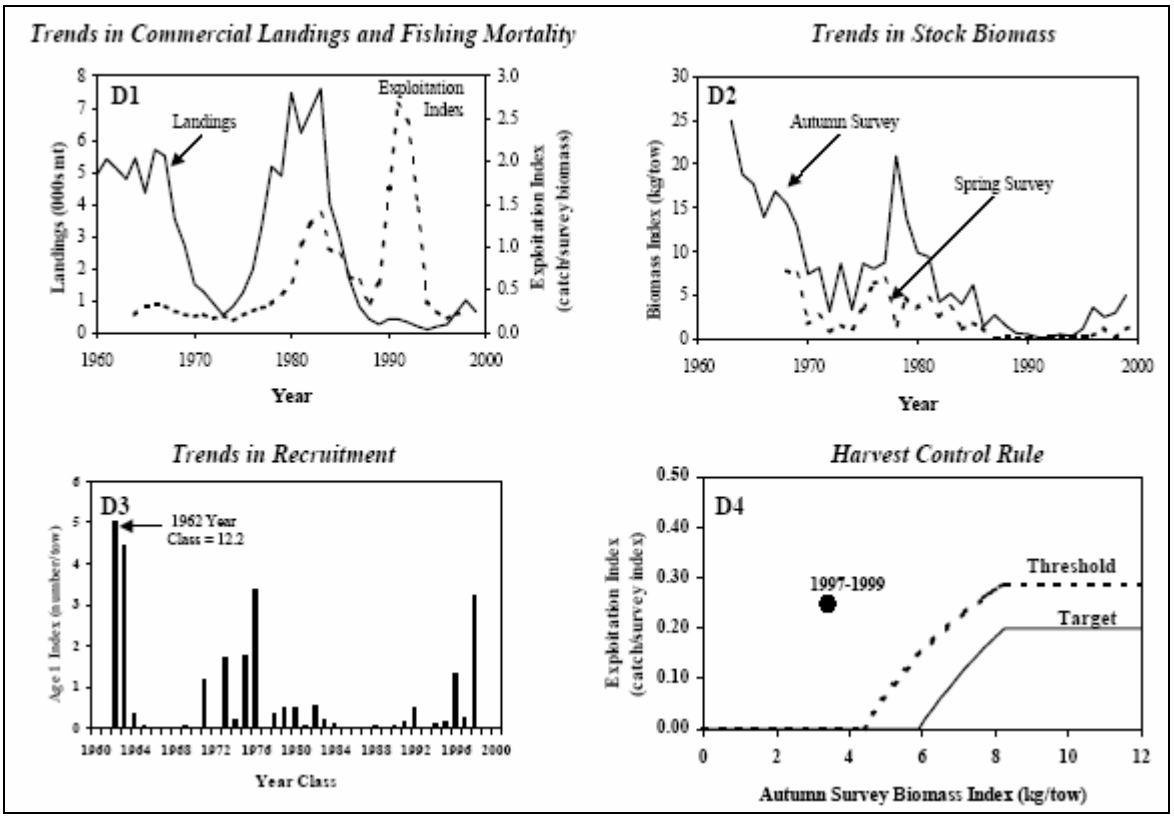


Figure 6. Landings, biomass, and recruitment trends, and Harvest control rule indices for GOM haddock (NEFSC 2001).

Synthesis

Although short-term trends in abundance and recruitment are positive for GOM and GB haddock, both stocks are still overfished. The strong 2000 (entire GB stock) and 2003 year class (eastern GB stock) has the potential to boost biomass significantly, should a large percentage of those individuals recruit to the fishery. Overfishing has not occurred since 1995, further aiding in the rebuilding of the stock. Continued biomass increase may see one or both stocks rebuilding within a reasonable period of time. However, until the stock is no longer overfished, it is considered to be of high conservation concern.

Status of Stocks Rank: Healthy Moderate **Poor** Critical

Criterion 3: Nature of Bycatch

Seafood Watch® defines sustainable wild-caught seafood as marine life captured using fishing techniques that successfully minimize the catch of unwanted and/or unmarketable species (i.e., bycatch). Bycatch is defined as species that are caught but subsequently discarded (injured or dead) for any reason. Bycatch does not include incidental catch (non-targeted catch) if it is utilized, accounted for and/or managed in some way.

Due to the mixed species nature of the Atlantic Groundfish fishery, as well as the gear type used (otter trawl), bycatch and subsequent discarding of unmarketable or otherwise illegal (e.g., undersized) species occurs frequently. In addition, trip limits, a management tool used to regulate catch, forces otherwise market-worthy fish to often be discarded. Managers have mitigated this somewhat by increasing the allowable mesh size in the trawl gear, reducing the catch of smaller-sized fishes. Accurate discard estimates are difficult to obtain without full observer coverage, but estimates of haddock discard rates in 2001 were 0-5% for primary fishing gears (NEFSC 2002). This value however does not include estimates of other finfish bycatch.

There have been a small number of observed interactions with marine mammals and sea turtles in the trawl fisheries. In 2003, Fishery Observers on 590 bottom trawling (otter, which contribute to the overall trawl discard rate) trips recorded a total of 21 interactions with marine mammals, and 4 interactions with sea turtles (NMFS 2004a). According to the Multispecies Groundfish FMP, trawlers are required to report all discards via logbooks and use bycatch reduction devices (BRDs) such as the Nordmore grate and mesh panels (NOAA 2002). Observer coverage is only about 5%, however, thus numbers of total discards may be underestimated.

A small fraction of haddock is caught with hook and line gear. Hook and line fishing is thought to have minimal bycatch impacts. Hook and line fisheries normally do not interact with endangered or protected species. Although there is no evidence to support or refute this statement, it is reasonable to conclude that catching haddock with hook and line gear involves little or no bycatch, except for undersized catch (i.e., regulatory discards).

Nature of Bycatch Rank: Low | Moderate | High | Critical

Hook & line **Trawl**

Criterion 4: Effect of Fishing Practices on Habitats and Ecosystems

Habitat Effects

In Canada, haddock is caught inshore, near-shore, and offshore by otter trawls, traps, long-lines, and gillnets (DFO 2002). In both the U.S. and Canada, most haddock are captured with various types of demersal trawl gear (mainly otter trawls, Figs. 7, 8) tailored to the habitats of target species or species assemblages. Trawling impacts sea-floor communities by scraping the ocean bottom causing 1) sediment re-suspension (turbidity) and smoothing, 2) removal and/or damage to non-target species, and 3) destruction of three-dimensional habitat (biotic and abiotic; (Auster and Langton 1999). The degree of impact is determined by many factors, most notably 1) the

type and weight of gear used; 2) the resilience of the seabed; and 3) the amount and frequency of the disturbance. Although studied to a lesser extent than otter trawls, mid-water trawls may also reduce available habitat by disturbing aggregations of gelatinous zooplankton and other floating matter, which has been shown to provide pelagic habitat for fish aggregations (Auster *et al.* 1992, Brodeur in press *in* NEFMC (1998)).

Several studies on the effects of bottom trawling have focused on the heavily trawled fishing grounds in the northwest Atlantic (Collie et al. 1997; Collie et al. 2000). Prena et al. (1999), for example, conducted an experimental trawl study on the Grand Banks off Newfoundland and reported that "otter trawling on a sandy bottom ecosystem can produce detectable changes on both benthic habitat and communities, in particular a significant reduction in the biomass of large epibenthic fauna". At a 2001 workshop to assess the effects of fishing gear on marine habitats off the northeastern U.S., experts concluded that the "greatest impacts from otter trawls occur in low and high energy gravel habitats and in hard clay outcroppings" (NOAA 2002); p 24). Based on the results of these and other studies, it is apparent that otter/bottom trawling may alter the surrounding ecosystem by reducing or altering available habitat and food resources as well as reduce survival of the target species.

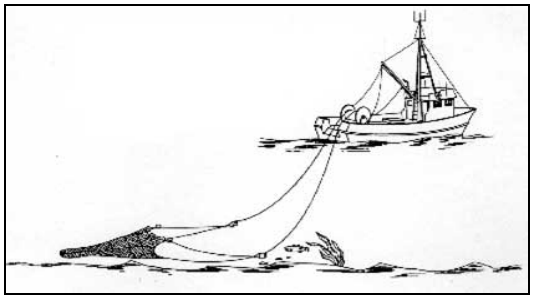


Figure 7. Diagram of an otter trawl, courtesy Matt Squillante, Monterey Bay Aquarium.

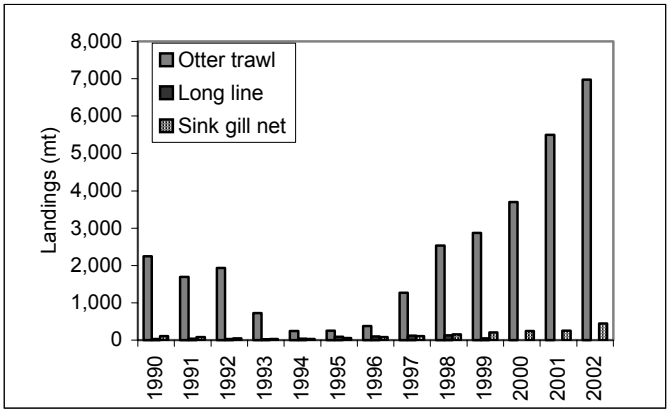


Figure 8. U.S. Haddock landings (mt) by major gear type (NMFS 2002).

Bottom trawl disturbance of the seabed is mainly a function of bottom type (rock, sand, mud, etc.) and gear type (dredge, beam, otter trawl, etc.). Some types of trawling gear cause less damage (i.e., otter trawls vs. scallop dredge) and some sediment types (and their associated ecosystems) are more resilient to disturbances caused by trawling. In a review of fishing effects, Collie et al. (2000) found that fauna associated with sandy (coarser) sediments were less affected by disturbance than those in soft, muddy (biogenic) sediments. Recovery rate appears to be slower in muddy and structurally complex habitats, while mobile sandy sediment communities can withstand 2-3 trawl passes per year without significant (adverse) change (Collie et al. 2000). The bathymetry of the Atlantic continental shelf, and habitat preferences of haddock (pebble/gravel), is such that groundfish trawlers targeting groundfish off the U.S. East Coast encounter both types of substrate (see Appendix I). Otter trawling is thought to cause less disturbance to the sea floor than other types of trawling (such as inter-tidal and scallop dredging, Collie et al. 2000; NOAA 2002), but it is likely that repetitive trawling in these areas causes substantial, and likely adverse impacts to seabed ecosystems along the U.S. East Coast.

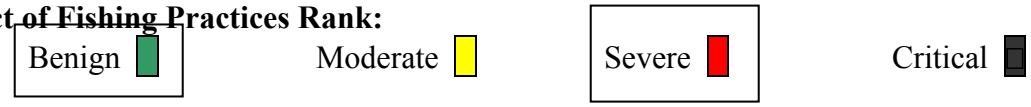
Ecosystem Effects

The fishing grounds of the Gulf of Maine, Georges Bank, and the continental shelf off New England represent one of the most productive oceanic ecosystems in the world. Tidal cycles and strong current flows lead to an extremely productive clockwise gyre in which a diverse array of life flourishes. Analyses of food web structure show that this area is rich in species diversity and abundance, and has a high degree of complexity and connectivity (Brodziak and Link 2002). Consequently, heavy fishing pressure over the last few centuries has resulted in a notable shift from a largely benthic fish community towards a largely pelagic fish community (Fogarty and Murawski 1998; Brodziak and Link 2002). It is extremely difficult to quantify the effects of this shift, but certain outcomes have been postulated, such as changes in predator-prey interactions and species survival rates, and decreases in overall productivity and perturbation of food web dynamics (Brodziak and Link 2002). One example is the increased predation on groundfish larvae by small pelagic species such as mackerel and herring, and a shift, during the 1980s, in the dominant fish predator from cod to spiny dogfish (Brodziak and Link 2002). In addition to fishing impacts, natural and anthropogenic environmental impacts (i.e., temperature shifts) may also be resulting in changes to the ecosystem. Separating the effects of fishing from the effects of environmental changes may be close to impossible.

Synthesis

Based on the published literature noting the adverse effects of trawling on the various habitat types where haddocks are found, as well as the substantial amount of fishing effort along the continental shelf over the last 50 years, it is concluded that trawling for groundfish (including haddock) has significantly altered or damaged a large portion of the seabed and the ecosystem. The degree of recovery from these actions is largely unknown. The effects of these fishing practices on habitats and ecosystems is therefore considered a high conservation concern. A notable exception is haddock caught by hook and line, a gear type which does not impact habitat.

Effect of Fishing Practices Rank:



Hook & Line **Trawl**

Criterion 5: Effectiveness of the Management Regime

The U.S. Atlantic Groundfish fishery was largely unregulated until the 1950s, when the newly (1949) formed International Commission for Northwest Atlantic Fisheries (ICNAF) began to set certain restrictions in response to concerns about wasteful bycatch and declines in groundfish abundance (Fogarty and Murawski 1998). ICNAF managers used a harvest strategy involving trip limits or total allowable catch (TAC) and annual quotas, but these regulations were largely disregarded by fishermen and landings were consistently higher than target levels. Fishery-independent surveys were implemented in 1963, and the first formal stock assessments of cod, haddock, and yellowtail flounder were conducted in 1971 (NRC 1998). In 1977, the New England Fishery Management Council (NEFMC) gained control over the fishery (as mandated by the MFCM Act, passed in 1976). In 1982 the NEFMC implemented the Multispecies Groundfish FMP, which contained a suite of indirect effort control measures such as minimum mesh size and fish size restrictions, and seasonal area closures (NRC 1998). Despite these attempts at regulating the fishery, exploitation rates could not be sustained, and populations declined severely in the late 1980s and early 1990s. In response to stock collapse, more restrictive measures were put into place, severely affecting coastal fishing communities. In 1994, a moratorium on groundfish fishing (all mobile gears) was implemented for a large area of Georges Bank and southern New England (Fogarty and Murawski 1998).

In May 2000, the Conservation Law Foundation (CLF) filed a lawsuit against NMFS charging that approved groundfish catch levels were too high and thus violated federal law by risking further depletion of New England groundfish populations. In December 2001, a federal district court judge upheld CLF's allegations that NMFS did not act to prevent overfishing and decrease bycatch in the New England groundfish fishery. The court found that NMFS was violating the federal Sustainable Fisheries Act of 1996 by failing to obey its own regulation that mandates rebuilding fish populations and prohibits the continued overfishing of cod and other groundfish off the coast of New England[2].

In response to a 2002 court order, the New England Fishery Management Council updated its groundfish management plan, which was then implemented in May 2004. This new amendment (Amendment 13) further restricts fishing effort through days-at-sea 'DAS' allocations, gear modifications, and adjusted biological reference points[3]. A further management measure, Framework 40A, is an attempt to provide additional fishing opportunities to target healthier stocks with minimal impact to other depleted species or their habitat (NEFMC 2004). One such fishery is for longline-caught haddock in an area previously closed to protect depleted cod stocks (see Appendix II). An experimental hook fishery operating in the fall of 2003 and winter 2004 (using alternative bait such as herring or fabricated bait) was shown to have minimal bycatch of cod[4].

Managers assess stock abundance of groundfish species at regular intervals, analyzing both fishery-dependent (catch records, effort, etc.) and fishery-independent (NMFS trawl surveys,

[2] Taken from: http://www.clf.org/advocacy/fisheries_lawsuit.htm
[3] For more information, go to http://www.nero.noaa.gov/amend13/ .
[4] Paul Parker. 2004. Personal commun. Executive Director. Cape Cod Commercial Hook Fishermen's Association. 210 Orleans Road, North Chatham, MA 02650.

tagging studies, etc.) data. Age-based data are available for the most commercially important species, and is used to model stock structure, recruitment capability, and overall biomass.

Table 3: Summary of management regulations for the haddock.

Jurisdiction and Agencies	**TAC**	**Size Limits***	**Trip Limits****	**Gear Restrictions***	**Closed Seasons/Areas**
NMFS NEFSC NERO	Yes (in-season adjustable)	19 inches (48.3 cm)	Yes, 5/1-9/30 3,000lbs per DAS; 10/1-4/30 5,000lbs DAS	Yes, 6-inch (15.2-cm) diamond mesh or 6.5-inch (16.5-cm) square mesh	Yes, see Fig. 9 and *

* 50 CFR Part 648 as of May 7, 2004 (http://www.nero.noaa.gov/nero/regs/index.html)
** 65 FR 21658, April 24, 2000

By law (MSFCMA/SFA 1996), the Fisheries Councils are required to prevent, mitigate, or minimize any adverse effect from fishing, to the extent practicable, if there is evidence that a fishing practice is having an identifiable adverse effect on Essential Fish Habitat (EFH) (NEFMC 1998). To conform with this requirement, the NEFMC has closed certain areas entirely to fishing (Fig. 7) and limited fishing effort to a certain number of DAS per year for each groundfish permit holder. The system of closed areas on Georges Bank protects approximately 6,500 square nautical miles year-round by completely closing this area to fishing. In the Gulf of Maine, approximately 13,000 square nautical miles of habitat are protected during temporary closures, with an additional 1,200 square nautical miles closed year-round (NEFMC 1998). In addition to these measures, the council, through Amendment 9 to the Groundfish FMP, prohibited "street-sweeper" trawl gear, (whose entire footrope length is in contact with the bottom) which is thought to be so efficient as to nullify DAS protections (NEFMC 1998). Amendment 13 has also implemented a trawl rope diameter (including rockhopper gear) of no more than 12 inches.

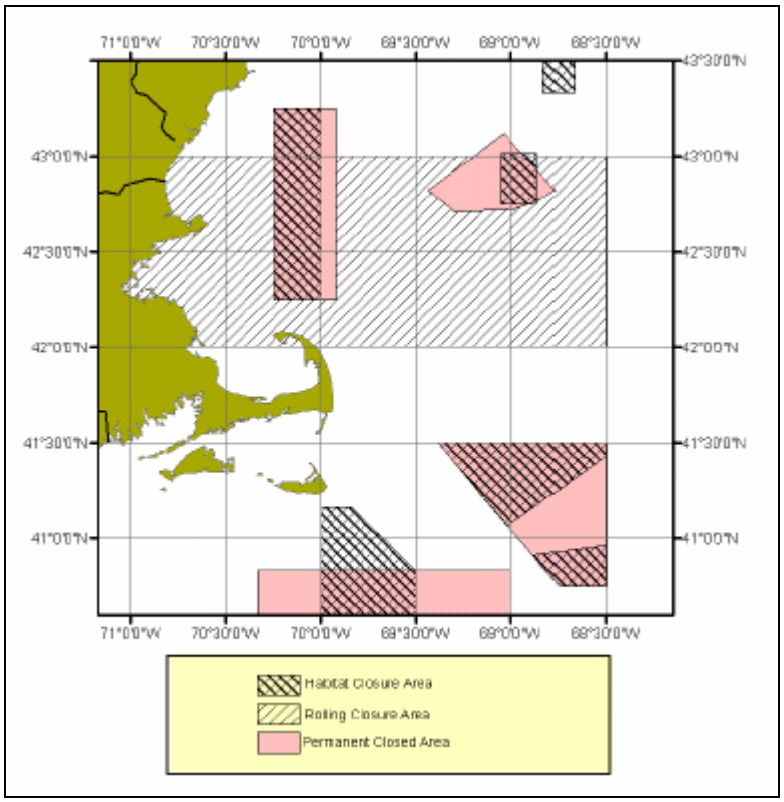


Figure 9. Rolling and permanent closed areas for the Northeast Multispecies fishery (NOAA 2004b).

Synthesis

Managers of Northeastern Groundfish resources assess stocks on a timely basis (annually or semi-annually) and use both fishery dependent and independent data to determine stock status and fishing mortality, which they evaluate against biological reference points. Managers require specific mesh sizes and gear types to reduce wasteful discard, as well as implement seasonal and permanent closure areas to reduce trawling impacts. Management has not, however, prevented the extreme decline of haddock stocks, and until stocks have fully recovered can be considered only moderately effective.

Effectiveness of Management Rank:

Highly Effective | **Moderately Effective** | Ineffective | Critical

Overall Evaluation and Seafood Recommendation

Haddock is a quickly maturing species with a relatively short (~ 15 yr) lifespan. Both the Gulf of Maine and Georges Bank stocks are considered overfished, but overfishing has not occurred since 1995. Indices of abundance have improved since the mid 1990s and a strong year class, combined with reduced mortality (fishing and natural) could aid greatly in improving stock status in the future. The primary fishing method for this species, trawling, results in significant disturbance to the sea floor, impacting marine habitats that are important to the survival of groundfishes and other species. Trawling is also indiscriminate, and along with targeted species takes unmarketable, illegal, or undersized species that are fatally discarded, adding to the overall fishing mortality of many groundfish species. Hook and line caught haddock is somewhat a more sustainable alternative because the gear has little habitat affects and very low bycatch. Groundfish managers have attempted to mitigate both habitat effects and bycatch from trawling operations by closing over 25,000 square miles of ecologically sensitive habitat to trawling, increasing mesh size of the trawl gear, and including discard estimates in fishing mortality analyses. In addition, managers actively study stock abundance and have implemented several regulations over the years in an attempt to maintain stock productivity. The management regime, however, has not prevented significant declines of haddock stocks and is only now showing signs of success. The high conservation concern over the stock status and trawl gear results in a recommendation of "Avoid" trawl caught haddock. Hook and line gear with much resuced concern over habitat and bycatch results in an overall recommendation of "Proceed with Caution."

Table of Sustainability Ranks

	Conservation Concern			
Sustainability Criteria	**Low**	**Moderate**	**High**	**Critical**
Inherently Vulnerability	√			
Status of Stocks			√	
Nature of Bycatch	√ **(Hook & line)**	√ **(Trawl)**		
Habitat Effects	√ **(Hook & line)**		√ **(Trawl)**	
Management Effectiveness		√		

Overall Seafood Recommendation:

GOM/GB haddock: Best Choices  **Caution (Hook & line)**  **Avoid (Trawl)** 

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Seafood Watch gratefully acknowledges Dr. Jon Brodziak, Dr. Russell Brown, of NOAA's Northeast Fisheries Science Center (NEFSC) Population Dynamics Branch, and one other reviewer who wishes to remain anonymous, who graciously reviewed this report for scientific accuracy and clarity.

Scientific review does not constitute an endorsement of the Seafood Watch® program on the part of the reviewing scientists or its seafood recommendations. Seafood Watch® is solely responsible for the conclusions reached in this report and the ensuing seafood recommendations.

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Appendix I. Geomorphology of the New England fishing grounds, from NEFSC (1998).

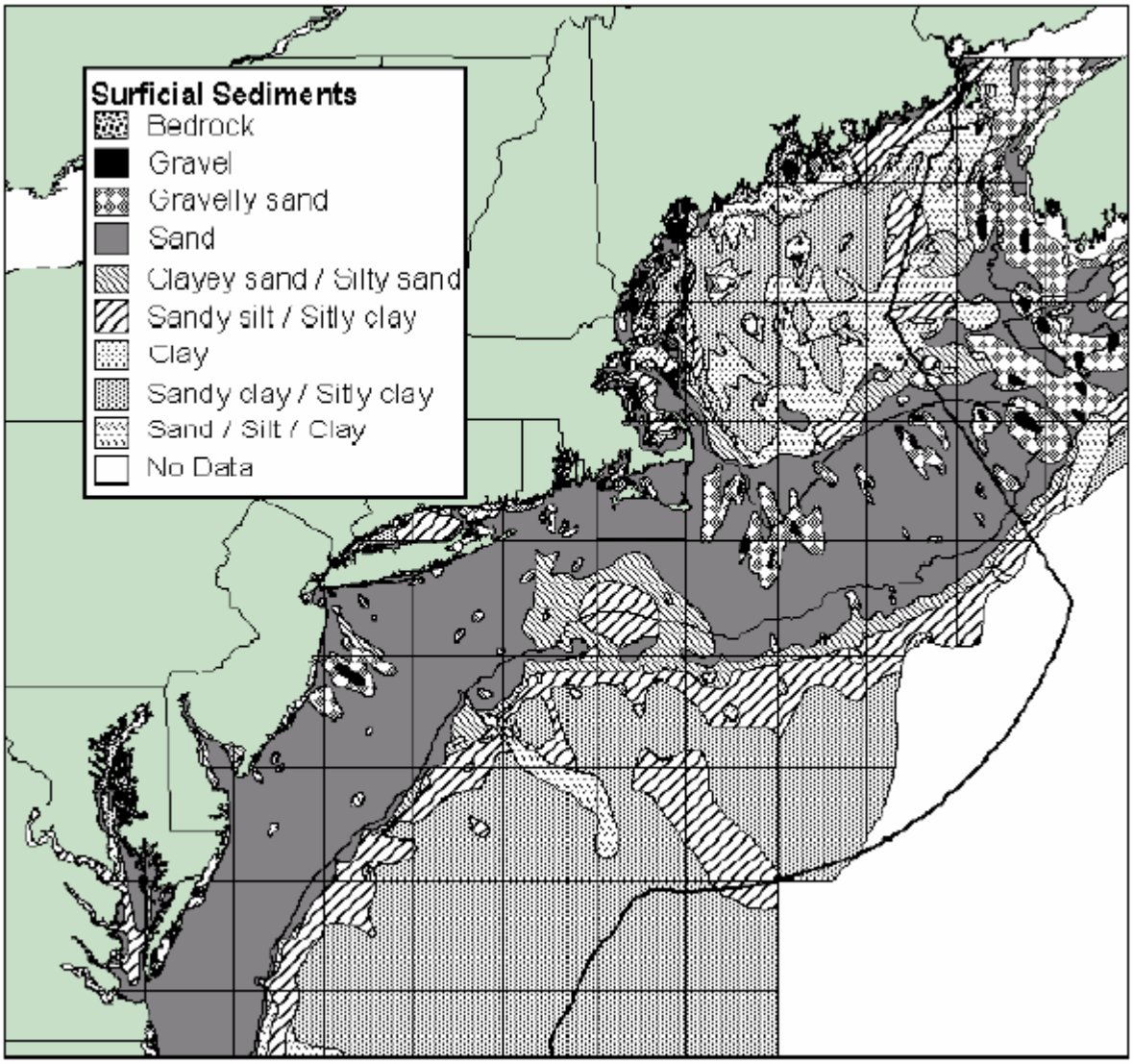
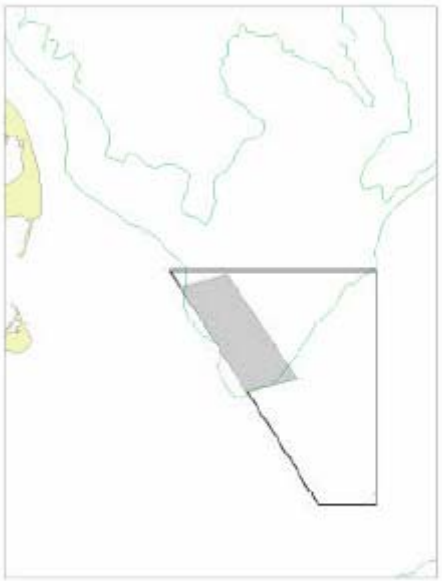


Figure A1. Map showing the distribution of sediments in the Gulf of Maine, Georges Bank, and southern New England. Southern New England sediment distributions are similar to those observed in the Mid-Atlantic Basin.

Appendix II. Special Access Program (SAP) for haddock in Closed Area I (Excerpted from (NEFMC 2004).

Closed Area I (CAI) Hook Gear Haddock SAP: This SAP allows vessels using longline or tub trawl gear to harvest 1,000 metric tons of haddock while fishing in a small area located in the northwest corner of CAI. Fishing in the SAP is only allowed from October 1 through December 31. All vessels participating in the SAP must use a VMS and are subject to specific reporting requirements so that catches are monitored daily. The requirements for vessels in the GB Hook Sector differ from those for vessels that are not in the sector. Vessels in the hook sector cannot discard legal size cod and do not have a landing limit for cod, but all cod catches apply against the sector's GB cod allocation. Vessels that are not in the hook sector are limited to 500 lbs./DAS of cod, with a maximum of 4,000 lbs./trip. Cod catches by non-sector vessels fishing on a Category B (regular or reserve) DAS are counted against the GB cod incidental catch TAC for this SAP. Vessels not in the hook sector can use any type of DAS to fish in the SAP. If fishing on a Category A DAS, they can fish inside and outside the SAP area on the same trip but must comply with the most restrictive regulations in effect for the area fished and must report catches when leaving the SAP area. The program is ended for all vessels if the haddock TAC is caught, and non-sector vessels cannot participate in the program while using Category B DAS if the cod incidental catch TAC is caught.



CAI hook gear haddock SAP area (shaded)