Seafood Watch
Seafood Report

MONTEREY BAY AQUARIUM®

Sea Scallop
Placopecten magellanicus

(Image © Monterey Bay Aquarium)

Northeast Region

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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 sources, whether wild-caught or farmed, which 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 (seafoodwatch.org) or obtained from the Seafood Watch® program by emailing seafoodwatch@mbayaq.org. The program's goals are to raise awareness of important ocean conservation issues and empower seafood consumers and businesses to make choices for healthy oceans.

Each sustainability recommendation on the regional pocket guides is supported by a Seafood Report. Each report synthesizes and analyzes the most current ecological, fisheries and ecosystem science on a species, then evaluates this information against the program's conservation ethic to arrive at a recommendation of "Best Choices", "Good Alternatives" or "Avoid". The detailed evaluation methodology is available upon request. In producing the Seafood Reports, Seafood Watch® seeks out research published in academic, peer-reviewed journals whenever possible. Other sources of information include government technical publications, fishery management plans and supporting documents, and other scientific reviews of ecological sustainability. Seafood Watch® Fisheries Research Analysts also communicate regularly with ecologists, fisheries and aquaculture scientists, and members of industry and conservation organizations when evaluating fisheries and aquaculture practices. Capture fisheries and aquaculture practices are highly dynamic; as the scientific information on each species changes, Seafood Watch's sustainability recommendations and the underlying Seafood Reports will be updated to reflect these changes.

Parties interested in capture fisheries, aquaculture practices and the sustainability of ocean ecosystems are welcome to use Seafood Reports in any way they find useful. For more information about Seafood Watch® and Seafood Reports, please contact the Seafood Watch® program at Monterey Bay Aquarium by calling 1-877-229-9990.

Disclaimer

Seafood Watch® strives to have all Seafood Reports reviewed for accuracy and completeness by external scientists with expertise in ecology, fisheries 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

Sea scallop is an economically-important species in the Atlantic Ocean. Productive scallop grounds occur from Cape Hatteras, North Carolina, USA to the northern shore of Quebec, Canada. Scallops are inherently resilient to fishing pressure as they are fast-growing, very fecund, and have a high intrinsic rate of population growth.

The US scallop-fishing fleet became overcapitalized during the 1970s. As a result, the US extensively reorganized its scallop fisheries in the 1980s, resulting in long-term stability and currently high biomass levels.

Finfish bycatch has been addressed by the scallop industry through the use of closed areas, gear modifications, catch limits, and other restrictions. Barndoor skate and yellowtail flounder bycatch are of concern in the northeast Atlantic. Barndoor skate populations appear to be recovering, perhaps partially due to area closures. Yellowtail flounder, whose stocks are depleted and overfished, is also caught incidentally in scallop dredges. Hard total allowable catch (TAC) limits and gear restrictions have been implemented to mitigate yellowtail flounder bycatch. Recent data and analysis by the U.S. National Marine Fisheries Service (NMFS) indicate higher numbers of loggerhead turtles, a threatened species, are injured and killed by dredges operating in the Mid-Atlantic than previously thought. However, the National Oceanic and Atmospheric Administration (NOAA) does not consider scallop dredging as jeopardizing loggerhead turtle populations. NOAA's Biological Opinion relies to a large extent on expected, but not observed, increases in sea turtle population stemming from changes in shrimp trawling gear and effort shifts in the sea-scallop fishery. Turtle excluders, or "turtle chains", on dredges have been proposed as mitigation, but NMFS has declined requiring turtle chains until they have been proven to prevent turtle injury, not just take of sea turtles. This is an ongoing issue of conservation concern.

Scallop boats primarily employ dredges, and to a much lesser extent trawls, to capture scallops. Both dredging and trawling substantially impact benthic ecosystems. These methods remove, crush, or dislodge biota, biogenic habitat, and physical habitat. Even fast-recovering habitats such as sand may be trawled more frequently than allows recovery, if located in a productive area for scallop populations. The use of closed areas and rotational fisheries will help limit habitat effects in the US limited access fishery, but open areas will continue to be trawled, with resulting habitat damage.

Overall, US management has made recent progress towards goals of sustainability in the scallop fishery, especially through the use of closed and rotational areas.

This report was updated on June 16, 2008. Please see Appendix 2 for a summary of changes made at this time.

Evaluations of Mexican Bay scallops, *Argopecten ventricosus,* and Mexican Sea scallops, *Nodipecten subnodosus,* can be found at www.montereybayaquarium.org.

Table of Sustainability Ranks

	Conservation Concern			
Sustainability Criteria	Low	Moderate	High	Critical
Inherently Vulnerability	√			
Status of Stocks	√			
Nature of Bycatch		√		
Habitat Effects			√	
Management Effectiveness		√		

About the Overall Seafood Recommendation:

- A seafood product is ranked "**Best Choice**" if three or more criteria are of Low Conservation Concern (green) and the remaining criteria are not of High or Critical Conservation Concern.
- A seafood product is ranked "**Good Alternative**" if the five criteria "average" to yellow (Moderate Conservation Concern) OR if the "Status of Stocks" and "Management Effectiveness" criteria are both of Moderate Conservation Concern.
- A seafood product is ranked "**Avoid**" if two or more criteria are of High Conservation Concern (red) OR if one or more criteria are of Critical Conservation Concern (black) in the table above.

Overall Seafood Recommendation:

Best Choice | **Good Alternative** | Avoid

Introduction

Sea scallops, *Placopecten magellanicus,* occur from Cape Hatteras, North Carolina, USA to the north shores of the Gulf of St. Lawrence and Newfoundland, Canada. They typically occur in waters 20-110 meters (m) depth, although they can range from 2-384 m depth (NEFSC 1991). Due to their sensitivity to high water temperatures, scallops become increasingly restricted to deeper waters in the southern portion of their range (Brand 1991).

The US scallop fishery is divided into a limited access fleet, which includes larger boats that make long trips, and a general category (open access) fleet of smaller boats, which make day trips. Although more than 80% of the boats in the limited access fleet are greater than 70 feet in length, smaller boats also participate. In contrast, 80% of the general category vessels were less than 70 feet in length in 2001 (NFMC 2003). Because sea scallops occur in deeper water in the US, both fleets fish the same waters. While the New England Fishery Management Council (NEFMC) manages the entire US scallop fishery, management recognizes two distinct regions within the fishery: Northeast (Maine to Connecticut, also referred to as Georges Bank or New England region); and Mid-Atlantic (New York to Virginia).

Scallops are an economically important fishery in the US; scallop landings in 2002 totaled over $US 202 million.

Scope of the analysis and the ensuing recommendation:
This report focuses on the major species of scallop fished in the US, the sea scallop, *Placopecten magellanicus,* with brief mention of the Iceland scallop, *Chlamys islandica*. While Sea scallops are fished in Canada and the US, only the US fishery is covered in this report. Wild-caught scallops imported from other countries belong to different species (e.g., the great scallop, *Pecten maximus*), and are not included in this report. Recommendations are specific to the US scallop fisheries. This report differentiates between the Northeast and Mid-Atlantic fisheries. The Northeast or Georges Bank scallop fishery includes fleets from Maine to Connecticut. The Mid-Atlantic scallop fishery includes fleets from New York to North Carolina.

Availability of Science

Much of the data required for this report were available through peer-reviewed scientific journals and government sources. The basic biology of scallops has been well researched. Because of the economic importance of the species, fisheries data for the past 20 years or more are available for sea scallop. The Northeast Fisheries Science Center (NEFSC) produces assessments of US scallop stocks as a whole every few years, with the most recent produced in 2004. Attention to the effects of dredging and trawling has increased in the past 15 years, resulting in numerous papers. However, more research is required to fully assess impacts of these extensively used gears. Some data on bycatch are in government reports, but are generally limited or not consistently released. Previous reliance on logbooks has resulted in poor historical data, but increases in observer coverage are improving data collection. US management bodies are increasing observer coverage on boats, but these data need to be made more accessible.

Market Availability

Common and market names:
Sea scallop is also known as giant scallop. When used for sushi or sashimi, sea scallop is commonly sold as *hotate* or *hotategai*.

Seasonal availability:
Scallops are available year-round.

Product forms:
Scallops are sold fresh, frozen, dried, and in brine. Scallops are most typically sold as meat out of the shell.

Import and export sources and statistics:
Analysis of product sources is problematic because agencies monitoring imports and exports of scallops combine the data from various scallop species. Combining all scallop species, the US imported 23,978 metric tons (mt) of scallops worth approximately US$ 162 million in 2003, primarily from Canada, Japan, Argentina, and China. However, it is probable that only the Canadian imports, accounting for 26% of total imports, were sea scallops, *P. magellanicus*. Looking only at Canadian imports, the US imported 6,353 mt of scallops worth US$ 67 million (DFO 2004; NMFS 2004b). The US is Canada's most important sea scallop market, importing 72% of total Canadian scallop exports.

Data on scallop exports is similarly confounded by the number of scallop species combined for summary purposes; however, the bulk of the US scallop fishery is composed of *P. magellanicus*. US scallop exports totaled over 6,091 mt in 2003, valued at US$ 55 million. These data indicate a trade deficit in all species of scallop of US$ 107 million (NMFS 2004b).

Domestically, in the US, sea scallops represent over 99% of scallop landings by weight and economic value. In total, the scallop fishery landed 23,883 mt of scallops, worth US$ 202 million, in 2003. Three state are responsible for 95% of US sea scallop landings: Massachusetts (48%); Virginia (31%); and New Jersey (16%) (Fig. 1, 2002 data) (NMFS 2004b). Using the division between Northeast and Mid-Atlantic fleets, landings were fairly evenly divided in 2002, with 52% of landings from the Northeast, and 48% from the Mid-Atlantic.

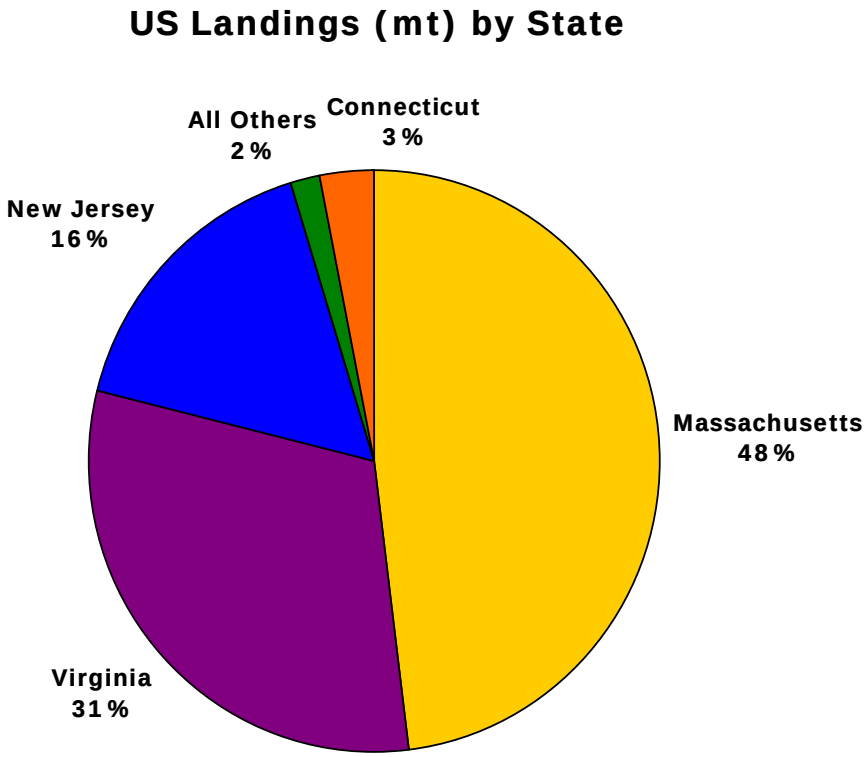


Figure 1. US Landings during 2002, in metric tons by state. "All others" includes ME, NH, NY, NJ, MD, and NC (NMFS 2004).

Analysis of Seafood Watch® Sustainability Criteria for Wild-caught Species

Criterion 1: Inherent Vulnerability to Fishing Pressure

The life history characteristics of sea scallops indicate that they are inherently resilient to fishing pressure. The sea scallop, *P. magellanicus*, forms the bulk of the scallop fishery and as such has received more scientific attention. There is less biological information available for the Iceland scallop, *C. islandica*. Since the Iceland scallop forms a far smaller portion of the scallop fishery, only the sea scallop will be considered here.

Since sea scallops are economically important, much research has been conducted assessing life history characteristics relevant to fisheries management, such as von Bertalanffy growth parameters (used to calculate biomass and F_{MSY}), reproductive potential, and recruitment. Less attention has been paid to intrinsic rates of increase or maximum age for sea scallop. Framework Adjustment 16 to the Atlantic Sea Scallop Fishery Management Plan (FMP) stated that calculations of F_{MSY} assumed the intrinsic growth rate is 0.48 (NEFMC 2004). However, actual calculations used by the Northeast Fisheries Science Center (NEFSC) to estimate fishing mortality uses a yield per recruit estimate rather than intrinsic population growth rate (NEFSC 2003).

Sea scallops have separate sexes and spawn by releasing gametes into the water to be fertilized. Other benthic invertebrates with this mode of reproduction have been shown to be vulnerable to the Allee effect, where reproduction is reduced or eliminated below a certain population density, although this has not been directly observed in sea scallops. Similarly, higher population densities would be expected to enhance recruitment, as fertilization success increases, but evidence for strong stock-recruitment relationships is equivocal. McGarvey (1993) documented an exponential increase in recruitment of sea scallops with stock size. In contrast, more recent data analyzed by NEFSC found little indication of recruitment driven by biomass (NEFSC 2003). A better understanding of stock-recruitment relationships is necessary to more precisely determine density and population size effects on recruitment at both high and low densities.

Sea scallops grow quickly, reaching maturity at age 2, even though individuals less than 5 years of age may contribute little to the population gamete pool (McGarvey et al. 1993). Von Bertalanffy growth coefficients (k) for the Mid-Atlantic and Georges Bank stocks have been estimated at 0.495 and 0.375 respectively (NEFSC 2007). Scallops continue to grow quickly during their first few years of life, increasing in length by 50-80% between 3-5 years of age. Females may release 14-66 million eggs, but only approximately 1-6% of those eggs will be fertilized, survive the planktonic larval phase, and reach 2 years of age (Barber and Blake 1991; McGarvey et al. 1992). This estimate is highly variable, and reflects the density dependent stock-recruitment relationship. Scallops are relatively long lived; estimates on life-span range from 18-29 years (Bricelj and Shumway 1991).

Intrinsic Rate of Increase (r)	Age at Maturity	Growth Rate	Max Age	Max Size	Fecundity	Species Range	Special Behaviors	Sources
0.48	2 years of age	MA=0.495 GB=0.375	18-29 years	>130mm	14-66 million eggs	Cape Hatteras, NC-Newfoundland, CA	None	Bricelj et al. 1991; McGarvey et al. 1993; NEFMC 2004 & 2007

Synthesis

Scallops exhibit characteristics of a species inherently resilient to fishing pressure, namely high intrinsic population growth rate, high individual growth rate, low age at first maturity, and high fecundity. Additionally, the species is relatively widespread across the northwest Atlantic, and while adults do not disperse, a 5-week planktonic phase allows for widespread larval dispersal. Characteristics that might undermine the species' resilience include a moderately long life span and a life history potentially vulnerable to the Alee effect, but overall sea scallops rank inherently resilient to fishing pressure.

Inherent Vulnerability Rank:

Resilient Moderately Vulnerable Highly Vulnerable

Criterion 2: Status of Wild Stocks

Currently, sea scallop biomass levels are quite high, when compared to levels from the 1980s and early 1990s (Fig. 2 & 3) (NEFSC 2004). Fisheries-independent surveys show a particularly strong recruitment class in 2000 (NEFSC 2004). Overall, biomass has increased significantly since 1995 in US fisheries (NEFSC 2004). Biomass increases in the U.S. can be at least partially attributed to closure of fished areas. Currently, biomass for fishery management is calculated across open and closed areas. In 2006 biomass was estimated at 81,047 and 85,161 mt meets in the Northeast (Georges Bank) and Mid-Atlantic respectively, with B/B_{MSY} estimated at 1.49 and 1.57. Biomass for combined stocks was estimated at 166,200 mt meats ($B/B_{MSY} = 1.53$), the highest total biomass recorded since 1982. Taken separately, biomass differs greatly between open and closed areas, with the bulk of biomass in closed areas (Fig. 4) (NMFS 2003).

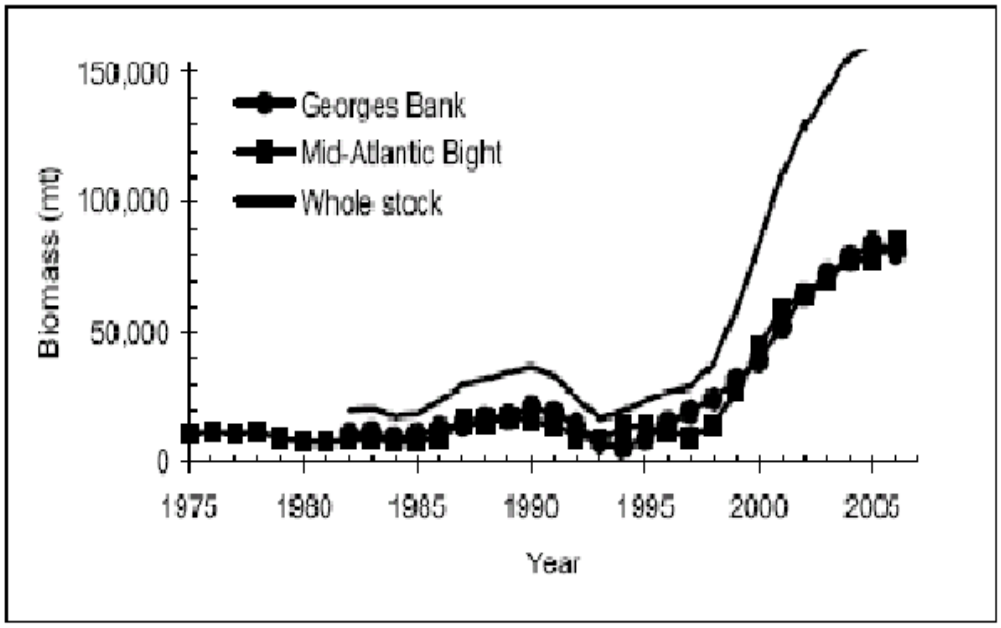


Figure 2. Scallop biomass indices versus year from 1975-2006. Data from NMFS fisheries independent surveys. B_{MSY} is set at 54.3 thousand mt meats (NEFSC 2007).

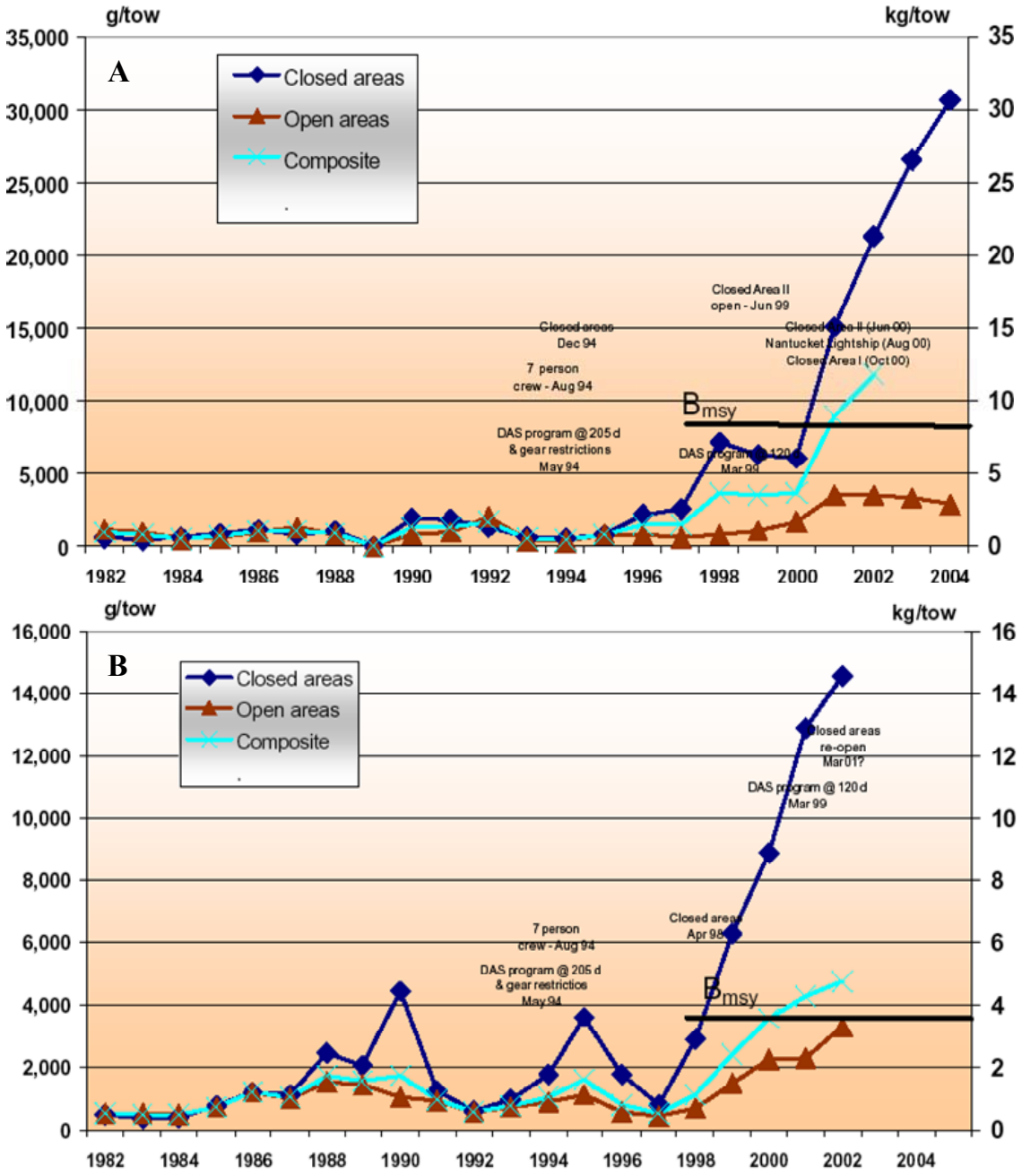
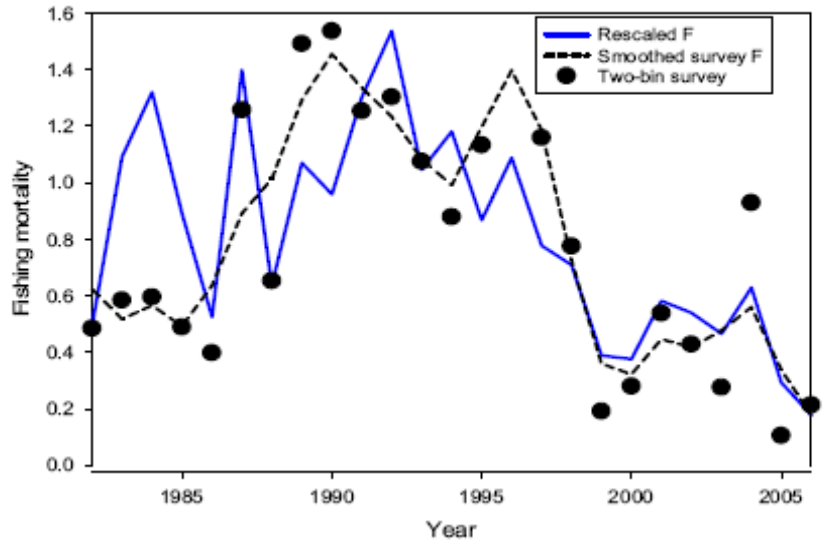


Figure 3. Biomass of scallops in open and closed scallop areas in (A) Georges Bank and (B) the Mid-Atlantic from 1982-2001. Trends from 2002-2005 in Georges Bank are projections based on status quo management in open areas. Trends from 2002-2005 in the Mid-Atlantic assume an open rotation system for the Hudson Canyon area with increasing mortality targets from 2003-2005 (NMFS 2003).

NMFS targets a fishing mortality (F_{target}) of 0.20, with an F_{MSY} of 0.29. The latest scientific stock assessment concluded that, overall, overfishing is not occurring in the US scallop fishery, with a fishing mortality of 0.23 (Fig. 5) (NEFSC 2007). Considered separately, overfishing is neither

occurring in the Northeast (Georges Bank) (F/F_{MSY}=0.83), nor the Mid-Atlantic (F/F_{MSY}=0.62) (NESC 2007). Although overall the stock is not overfished and overfishing is not occurring, some concerns still exist. As previously mentioned, the fishing mortality estimate includes biomass from within closed areas (mortality is calculated as biomass fished/total biomass). Over half of the scallop biomass is contained in the closed areas; therefore, fishing pressure in the open fishing areas must be over the fishing mortality threshold, and localized overfishing must be occurring in some areas (NEFSC 2006). This highlights the utility of protected areas in fishery management for conserving biomass, but also demonstrates how, when taken in aggregate, these data can obscure patterns of concern outside protected areas.

(a)



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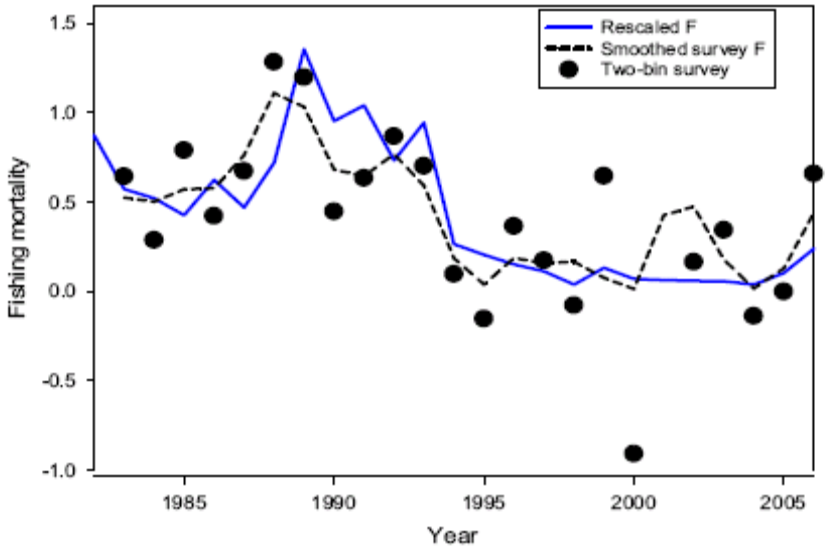

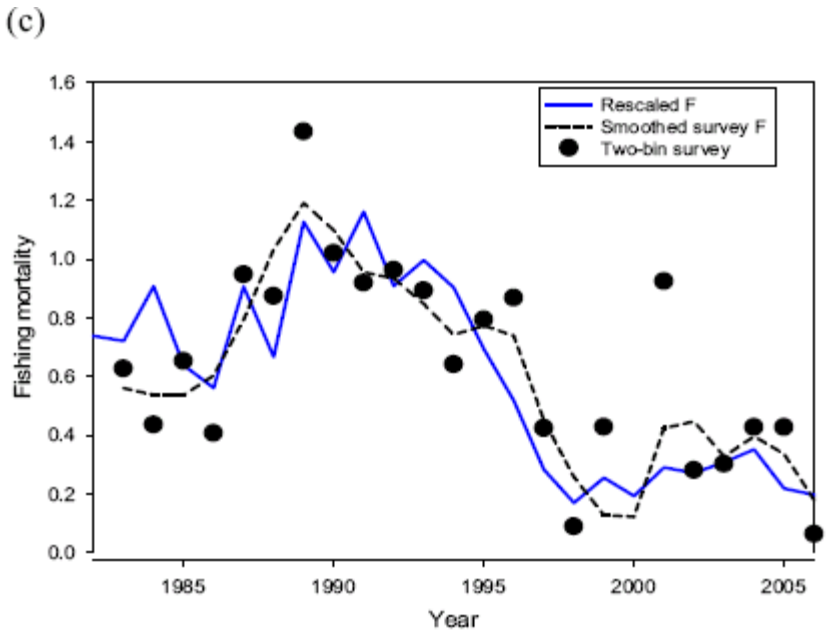

Figure 4. Sea scallop fishing mortality for Georges Bank (a), Mid-Atlantic (b), and combined (c) (NEFSC 2007).

Scallop dredging has been shown to significantly alter the size and age structure of scallop populations. Video surveys conducted by Stokesbury et al. (2004) in closed areas demonstrated that scallops in these areas were larger and older than those in open areas. However NEFSC (2007) data imply a relatively normal size distribution with increasing mean shell length for both stocks. There have also been recent increases in clapper (empty scallop shells) ratios in the Georges Bank which may be another indication of overall increased age and size of scallops in that stock (NEFSC 2007).

Table 1. Stock status and trends for US scallops. Fishing mortality (F) and biomass (B) data are for 2005. A ratio of $F/F_{msy} > 1$ indicates overfishing is occurring, while a ratio of $B/B_{MSY} > 1$ indicates the stock is not overfished (NOTE: a ratio of $B/B_{MSY} < 1$ does not necessarily indicate an overfished stock).
OFD = Overfished; OFG = Overfishing

Classification Status	B/B_{MSY}	Occurrence of Overfishing	F/F_{MSY}	Abundance Trends/CPUE	Age/Size/Sex Distribution	Degree of Uncertainty in Stock Status	Sources	SFW Rank
US Northeast (Georges Bank)	1.49	Not OFD Not OFG	0.82	Increasing since 1995	Normal Distribution	Low	McGarvey et al. 1993; Stokesbury et al. 2004; NEFSC 2007	Healthy
US Mid-Atlantic	1.57	Not OFD Not OFG	0.62	Increasing since 1997	Normal Distribution	Low	McGarvey et al. 1993; Stokesbury et al. 2004; NEFSC 2007	Healthy

Synthesis
Biomass of scallops has increased greatly since the mid 1990s in all fisheries. Dredging inevitably skews age distributions in the areas in which it is employed, as it removes all large scallops from an area. Because of high biomass and acceptable fishing mortality levels of scallops over the past seven years, US stocks are considered healthy, largely due to scallop populations in closed areas.

Status of Wild Stocks Rank:

Criterion 3: Nature and Extent 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 managed in some way.

The US scallop fishery has taken measures to reduce bycatch of finfish species. In the US, boats may retain and sell non-target finfish species such as monkfish and yellowtail flounder. US boats have made efforts to reduce bycatch by reducing days at sea (DAS), setting total allowable catch limits (TACs) for species of special concern, such as yellowtail flounder, and setting gear restrictions.

The current design of dredges in the US limited access fishery has also been modified to reduce bycatch. All dredges must have 4-inch diameter rings to allow smaller animals, including small scallops, to escape capture. Additionally, dredges are configured with a twine top with 10-inch mesh to allow bottom fish to swim out of the dredge (See Fig. 6, from Smolowitz 1998). Twine tops with 10-inch mesh reduce capture of yellowtail flounder 45% as compared to 6-inch mesh (NEFMC 2003). Regulation has stipulated increasing mesh sizes in the twine top over the past decade (NEFMC 1998; NEFMC 2004).

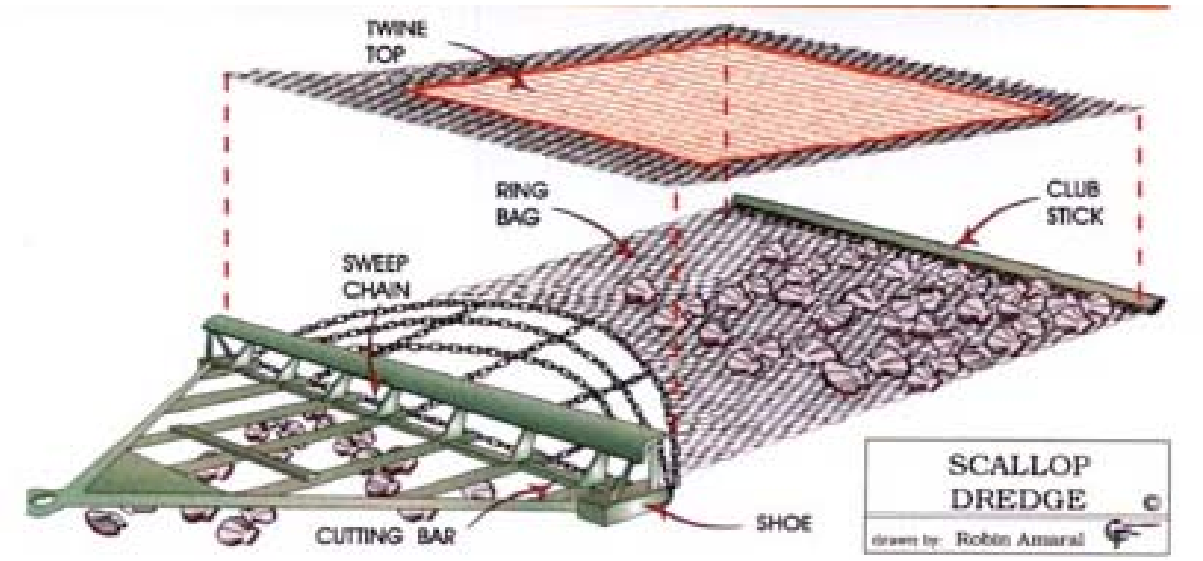

Figure 5: Scallop dredge with top removed (Smolowitz 1998).

Dredging and trawling remove benthic biomass; however, obtaining accurate data on the amount of biomass removed by scallop dredging remains problematic, especially since logbook reports of bycatch are considered unreliable. Hopefully, increasing observer coverage and reporting will help alleviate this problem. Some summary data are available from observed fishing trips. From 1991-2000, the weight of scallops was 61% of the total weight dredged (Fig. 7) (NEFMC 2003). Data on finfish bycatch are more available than on invertebrate bycatch. For the closed areas in Georges Bank in 2000, finfish bycatch by weight was 54% of targeted landings, but may be less than 54% numerically (Hart pers. comm.; NEFMC 2003). Finfish bycatch in 2000 consisted primarily of yellowtail flounder, skates species (mostly little skate), and monkfish. The amount of finfish bycatch varied considerably among closed areas, from a low of 15% in the Nantucket Lightship Area to 188% in Closed Area II. For benthic invertebrates, summary data from 1991-2000 are available (Fig. 7). Invertebrate bycatch is largely lumped into an "other shellfish" category by observers. Starfish and "other shellfish" made up 32% of bycatch by weight from 1991-2000 (Fig. 7) (NEFMC 2003). NMFS fisheries-independent surveys also collect data on bycatch in their trawls, termed "trash bycatch," including invertebrates. Unfortunately, bycatch is reported by volume but scallop catch is reported numerically, which hampers comparison. Additionally, gear on survey boats is less selective than commercial gear, in order to catch and collect data on small size classes of scallops. Thus gear from survey boats may have higher amounts of bycatch than commercial gear. For this report we consider numerical bycatch rates to be less than 100% of targeted landings, but acknowledge than a complete picture of bycatch rates is lacking.

Bycatch of yellowtail flounder, *Limanda ferruginea*, has been an ongoing concern in the US. Yellowtail flounder stocks from southern New England/Middle Atlantic Basin are severely depleted, Cape Cod/Gulf of Maine stocks are overfished and overfishing is occurring, and the Georges Bank stock is rebuilding from being overfished (NFSC 2003). Although not a primary food source, yellowtail flounder include scallops in their diet, and have a strong association with

scallop beds (Brand 1991). Because of concern with yellowtail flounder bycatch, a TAC of 10% of the target southern New England TAC, and 10% of the US quota determined by US-Canadian agreement in Georges Bank, was set for yellowtail flounder in the controlled access areas. Depending on the area fished, an area would either close after the TAC was reached, or fishing would continue, but fish could not be retained for market (NEFMC 2004). Additionally, changes to the 10-inch mesh twine top configuration mentioned above will help reduce yellowtail flounder bycatch. Yellowtail flounder caught through the scallop fishery account for less than 5% of yellowtail landings, so trawling directed to groundfish represents the primary source of yellowtail flounder mortality, not scallop dredging. It is expected that until the New England groundfish fishery is rebuilt, yellowtail flounder bycatch will continue to be a concern, due to the close ecological connection of yellowtail flounder to sea scallop (Brand 1991).

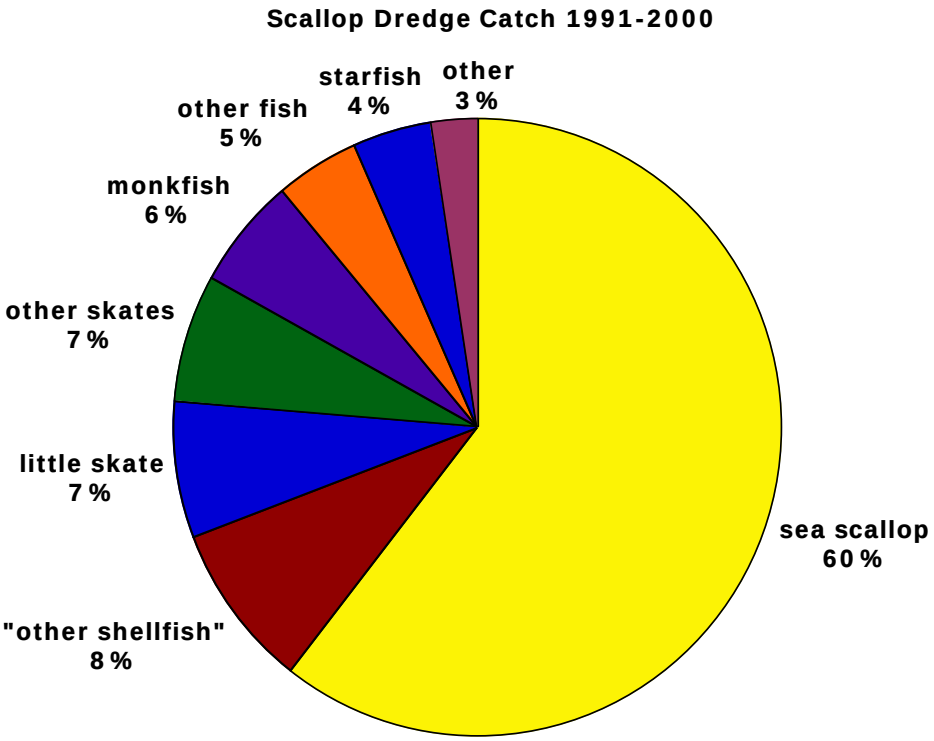

Figure 6. Catch in observed commercial sea scallop dredges, 1991-2000, as a percentage of total weight. "Other shellfish" is a category listed by observers in reporting data. Other species groupings summarized for graph (NEFMC 2003).

The barndoor skate, *Dipterus (Raja) laevis*, has declined dramatically throughout most of its range in the North Atlantic, to the point where it is considered almost completely extinct in Canadian waters (Casey and Myers 1998). In the US, barndoor skate is a species of concern and a candidate for listing under the Endangered Species Act (ESA), and is considered endangered by the World Conservation Union (IUCN 2003; NMFS 2004a). In 2002, NMFS declined to list the species under the ESA, but because of uncertainties about the species abundance and population structure, has maintained its status as a candidate species (NMFS 2002). Barndoor skates range from the northern Labrador shelf to as far south as Cape Hatteras, North Carolina. The species primarily inhabits northern waters, and prefers waters of temperatures less than 10 °C (Kulka et al. 2002).

As skates are associated with bottom habitat and brought up in trawls, trawling is suspected to have significantly impacted skate populations. Currently two skate species are in formal rebuilding programs in the US Northeast: the barndoor skate; and the thorny skate, *Raja radiata*, which is considered a species of concern. Management focuses primarily on the barndoor skate, due to its status as a candidate for listing under the ESA. Barndoor skates were caught in a high proportion of NMFS survey trawls in the early 1960s. In 1963, 76% of survey trawls caught barndoor skate, but their occurrence dropped to less than 3% from 1972-1998. Their frequency of capture in survey trawls increased after 1999, and occurred in 17% of trawls in 2003 (NEFMC

2004). A high proportion of their occurrence is within closed areas. From 1997-2003, of the 104 tows in which barndoor skate were observed, 23 (22.1%) were within closed areas. By number of individuals, 22.7% (43 of 189) of barndoor skates were caught in closed areas from 1997-2003 (NEFMC 2004). Continuation of closed areas for groundfish mortality and habitat will help continue mitigation of fishery impacts on the species. Additionally, NMFS is recommending study on mortality rates of discarded skates, an effort that increased observer coverage will assist with. Recent analysis of barndoor skate catches in Canada indicate that deep-water areas (>450 m), below those normally dredged or trawled, may contain larger numbers of barndoor skates than previously appreciated (Kulka et al. 2002). Whether deep water provides a refuge from fishing, or hosts numbers of barndoor skate sufficient to consider the stock healthy, is unknown. However, because of the coincident demise of barndoor skates in shallower areas with increases in trawling, and its recent coincident increase within closed areas, the impact of trawling on barndoor skate populations remains a concern.

South of 39^{o} latitude (mid New Jersey) the threatened loggerhead turtle, *Caretta caretta,* is also caught as bycatch in the scallop fishery. A recent analysis by NMFS extrapolated records of turtle catches by onboard observers to the Mid-Atlantic region as a whole. The analysis estimated that 630 turtles were caught as bycatch in 2003, 458 (73%) of which were injured or killed (Murray 2004a). Subsequent analysis increased these estimates to 749 turtles caught, 579 of which were injured or killed (Murray 2004b).

Because of concern over sea turtle bycatch, NOAA initiated a review of the sea scallop fishery, as required under the ESA, and concluded that continued operation of the fishery was not likely to result in further declines in loggerhead turtles (NOAA Fisheries 2004). The opinion rests primarily on two assumptions. (1) Recently mandated modification in turtle excluder devices (TEDs) on shrimp trawling gear will cause an increase in the loggerhead turtle population by reducing annual turtle mortality in the shrimp fishery from 62,694 to 3,947. This mortality reduction and population increase, however, has only been modeled, not observed. (2) The implementation of Amendment 10 to the Atlantic Sea Scallop FMP will reduce sea turtle capture by shifting effort to northern waters. Additionally, NEFSC projects that new management practices will result in higher biomass in the Mid-Atlantic. As a result, catch per unit effort will increase and the area towed will decrease, further reducing turtle-dredge encounters. NMFS expects a 57-67% decrease in the area dredged in the Mid-Atlantic after 2004; as with the TED modeling, however, this decrease in turtle mortality and injury is projected, not observed. In addition to TED modifications and potential changes in fishing effort, new management practices in longline fisheries are expected to reduce longline turtle mortality to 339 averaged over three years, after 2006, as compared to an annual mortality of 381 in 2001 (NOAA Fisheries 2004).

To further alleviate turtle bycatch in the scallop fishery, fishers and scientists have also designed “turtle chains”, which prevent turtles from entering scallop dredges. NMFS recently declined to require turtle chains on dredges, however, because the technology has not been thoroughly tested. In particular, while chains may prevent entry of turtles into dredges, they would not prevent turtles from being struck by dredges, which can result in injury or death (NOAA Fisheries 2004). NOAA has recommended that video observations of sea turtle interaction with dredges be conducted (NOAA Fisheries 2004).

While the changes to management practices and gear are promising for sea turtles, a precautionary approach should still be used. While NOAA does not consider sea scallop dredging to jeopardize loggerhead turtles, their dependence on the projected effects of management changes, rather than observed effects, is of concern. Additionally, the nesting areas used by loggerhead in the western Atlantic (North Carolina to Florida) were struck by a number of hurricanes in 2004. The damage to nesting sites and hatchling survival is still being assessed (NOAA Fisheries 2004). If hurricane damage adversely effects loggerhead populations, NMFS must be prepared to modify management as new data arrives. Basing effects of a particular fishery on projected rather than observed mortality rates in another fishery goes against a precautionary approach, especially when the agency is mandated by the US Congress to give "the benefit of the doubt" to the species. At best it can be said that impacts of management changes across several fisheries and hurricane damage have yet to be fully assessed, and sea turtle bycatch in the Mid-Atlantic remains a serious concern. As with the barndoor skate, increased observer coverage will help provide a more accurate picture of turtle bycatch rates and effects. At present, fewer than 5% of boats in the US carry observers. Observer coverage has been particularly low in the Mid-Atlantic, where it was only 2.7% for the period considered by Murray (2004a; 2004b).

Synthesis

Overall, both northern and southern sea scallop fisheries have bycatch concerns. In the US Northeast, yellowtail flounder and barndoor skate are caught as bycatch. Changes in gear design, such as twine top reconfigurations, will help mitigate bycatch of finfish such as yellowtail flounder. Areas closures in Georges Bank for groundfish mortality and fish habitat will also help recovery of yellowtail flounder and barndoor skate population in those areas, but will not decrease mortality in open areas. Recent increases in barndoor skate numbers is encouraging, but requires continued monitoring and research. The US Northeast is rated as having moderate bycatch.

Loggerhead turtle catches in the Mid-Atlantic fishery represent a bycatch problem for that fishery, as the loggerhead turtle is listed as threatened under the ESA. However, new regulations to decrease turtle mortality in the longline and shrimp trawling fisheries, as well as a projected reduction in dredge area swept in the Mid-Atlantic, have led NOAA to conclude that sea scallop dredging will not significantly impact loggerhead populations. Because NOAA's assessment is largely based on projected numbers rather than observed data, loggerhead turtle bycatch remains a concern until the data picture becomes more complete. Because of the loggerhead turtle's threatened status, uncertainty connected to changes in management practices, and potential damage to nesting areas by hurricanes in 2004, the US Mid-Atlantic fishery is rated as having moderate bycatch. The nature of bycatch is ranked as moderate across the US sea scallop fisheries.

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

Criterion 4: Effect of Fishing Practices on Habitats and Ecosystems

The scallop fishery operates almost completely through dredging of bottom habitats, which has severe impacts on benthic communities. In 2002, scallop dredges accounted for 93% of US landings, and otter trawls accounted for an additional 6% of landings (Fig. 8).

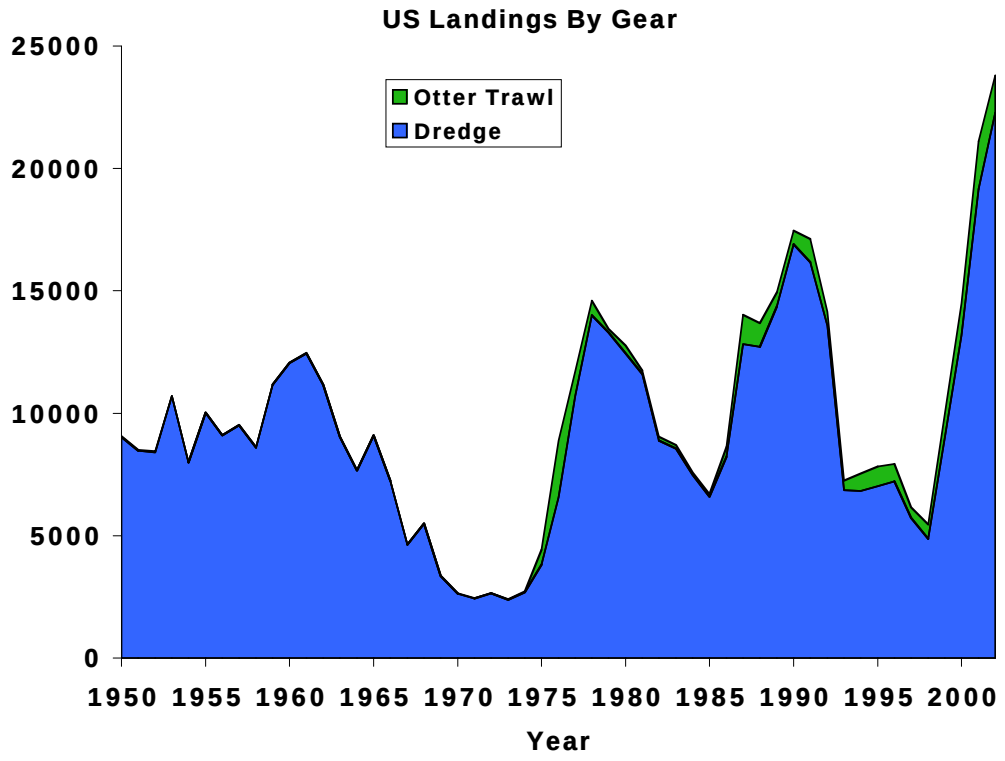

Figure 7. US landings by gear, 1950-2002 (NMFS 2004).

Concern over the effects of dredging and trawling on benthic ecosystems grew during the 1990s, and a host of scientific papers have since documented the damage to benthic communities resulting from these fishing methods (For reviews, see Watling and Norse 1998, and Thrush and Dayton 2002). Scallop dredges (Fig. 6) not only remove extensive amount of biomass, they destroy biogenic habitat structures such as sponges and tubes (Schwinghamer et al. 1988; Watling and Norse 1998; Thrush and Dayton 2002; Dinmore et al. 2003). These impacts led to the comparison of dredging with forest clearcutting (Watling and Norse 1998; Zeller and Russ 2004). As with forest clearing, benthic ecosystems can be slow to recover, and recovery times will vary with the exact species, habitat, and depth considered (Watling and Norse 1998; Dinmore et al. 2003).

In addition to removal of biomass and biogenic structures, mobile fishing gear (i.e., dredges and trawls) alter physical habitat. Even in sandy areas, where trawl impacts are expected to be minimal, experimental trawling has revealed significant changes to the physical habitat, such as the loss of topographic relief (Schwinghamer et al. 1988). In deep water, where storm

disturbance is minimal, trawl tracks have still been visible after 1 year. Even so, sandy bottoms, where most dredging occurs, are considered to be much more resilient to dredge and trawl damage than rocky areas. Currently, trawls are not restricted to sandy areas, and may trawl more frequently than those areas can recover.

Fishery management is beginning to recognize the effects of mobile fishing gear on habitat. Amendment 10 to the Atlantic Sea Scallop FMP specifies a closure in the Nantucket Lightship Area to protect essential fish habitat for groundfish, acknowledging that trawling and dredging negatively effects benthic ecosystems and the fisheries they support (NEFMC 1998).

Synthesis
A large and growing body of evidence documents the severe impacts that dredging and trawling have on benthic habitats. Because the scallop fishery stretches from Newfoundland to North Carolina, the spatial scale of these impacts is large and has altered a significant amount of the benthic ecosystems of the Atlantic coastal shelf. As a result, the effect of fishing practices is ranked as severe.

Effect of Fishing Practices Rank:

Benign | Moderate | **Severe** | Critical

Criterion 5: Effectiveness of the Management Regime

As mentioned in the Introduction, the US has substantial scallop fisheries (Fig. 9). The bulk of landings come from large boats in the limited access fleet making multi-day trips. Smaller boats, also called day-boats, outnumber large boats by over 7 to 1 in the US, but account for less than 1/30 of scallop landings (Howard 2002). The US has altered management practices since the 1970s when overcapitalization of fleets became an evident problem.

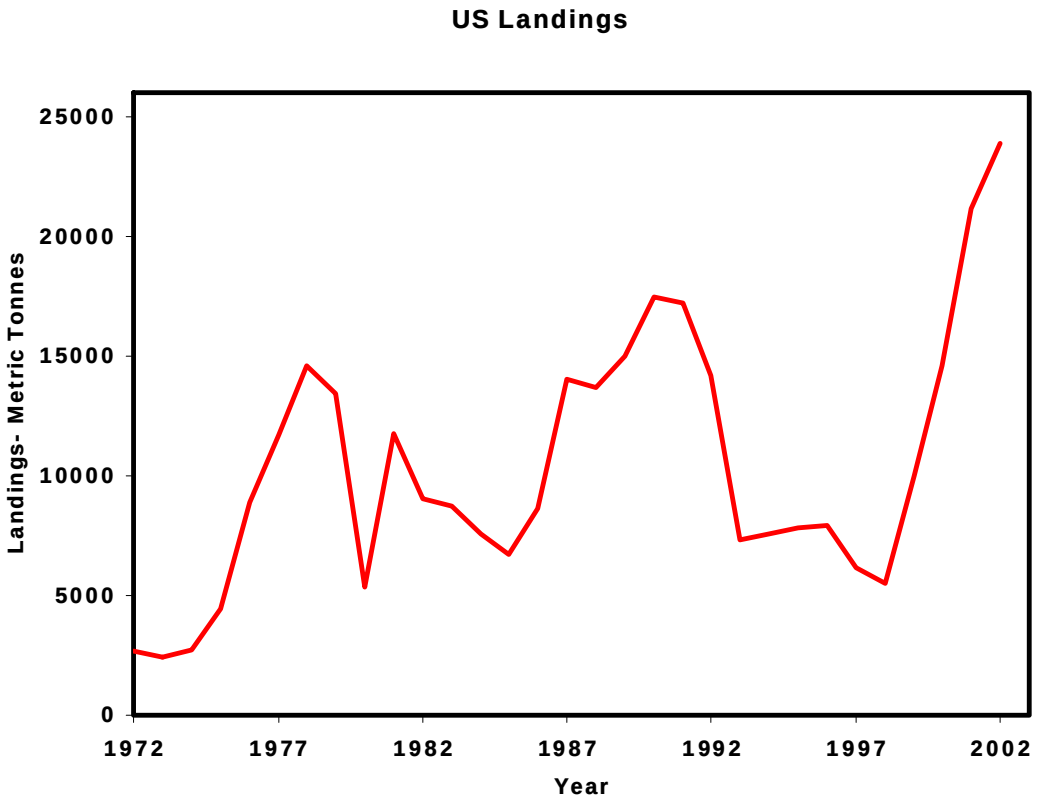

Figure 8. US landings (mt), from 1970-2002 (NMFS 2004).

The US scallop fishery, including the Mid-Atlantic fishery, has been managed by the New England Fishery Management Council (NEFMC) since 1982. The original management scheme of open access permits, industry agreements on trip lengths, and minimum scallop size (as determined by meat counts/pound), failed to adequately manage the fishery. Fishing mortality remained high and biomass low until the late 1990s (Fig. 2, 4, & 5).

The primary management tool during the 1980s and 1990s was the use of average meat counts per pound. This failed to protect large year classes of small scallops produced by a good recruitment episode. Fishers complied with the letter but not the sprit of the regulations by fishing large amounts of small, abundant scallops, followed by selectively targeting enough very large scallops to bring the meat counts per pound up to the regulatory average (NEFMC 2003).

As stated above, management practices did not prevent low stock biomass or high fishing mortality through the 1980s into the 1990s (Fig. 2, 4, & 5). In 1994, Amendment 4 to the Atlantic Sea Scallop FMP was adopted to address excessive fishing mortality, overfishing, and overcapitalization of the fleet (NEFMC 2003). Measures included reduced days at sea (DAS), changes in gear to improve size selection and reduce bycatch, limited access to the fishery, and monitoring of boats to track effort (NEFMC 2003). Overfishing was officially defined, and a seven-year plan to eliminate overfishing was outlined. Management was also restructured to promote responsiveness.

The scallop fishery was inadvertently aided by the concurrent collapse of the New England groundfish industry and subsequent emergency management measures. In 1994, three areas off of New England were closed to almost all fishing to control groundfish mortality. Scallop biomass within the closed areas skyrocketed, reaching record levels (Fig. 4). Limited reopening of closed areas on Georges Bank to scallop dredging began in 1999. After observing the potential utility of closed areas for increasing scallop biomass, and thereby enhancing fishery catch, temporary closure of scallop fishing grounds has been incorporated into subsequent management plans. In 1998, two additional areas in the Mid-Atlantic, Hudson Canyon and Virginia Beach controlled access areas, were closed specifically to enhance scallop production (Hart 2003).

From 2004-2007, the Elephant Trunk area in the Mid-Atlantic was closed to scallop fishing, as part of a rotational scallop fishing plan (NEFSC 2007). Under the rotational plan, the Hudson Canyon Area, which was closed from 1998-2001 and has been on a special access program since that time, will fully reopen in the 2008-2009 season. Virginia Beach also underwent area closures from 1998-2001, although these closures have been considered unsuccessful (NEFSC 2007).

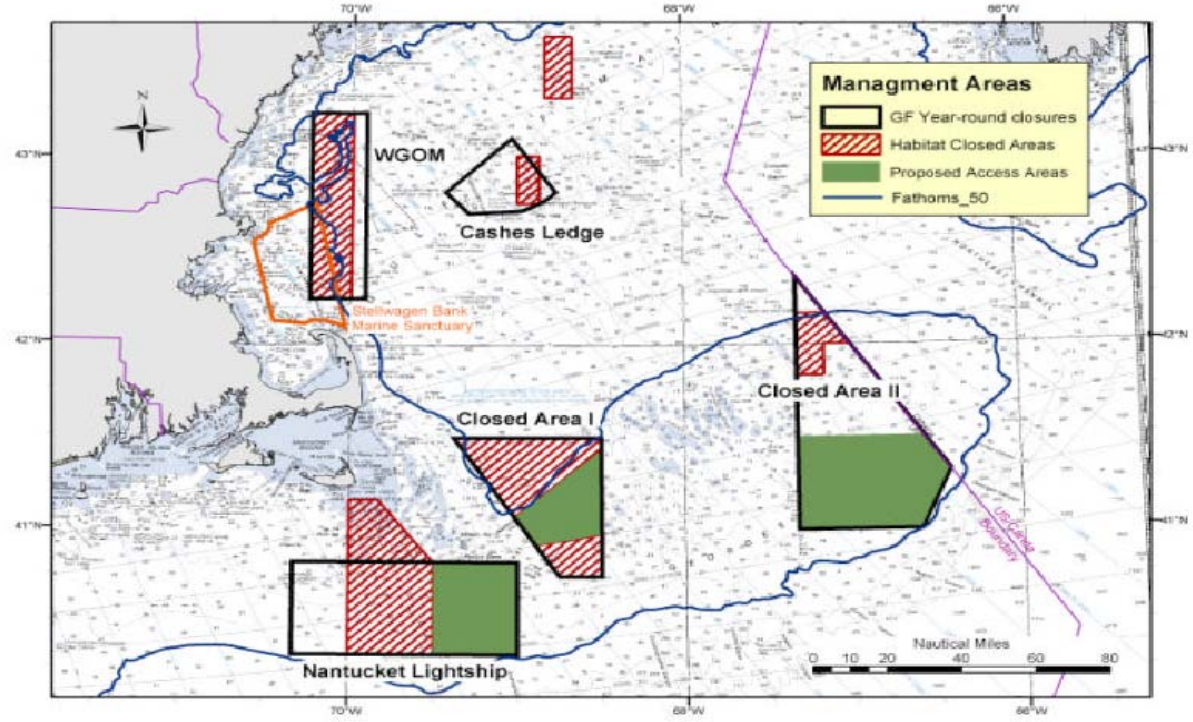

Figure 9. Map showing proposed closed areas under Amendment 10 and Framework Adjustment 16/39 to the Atlantic Sea Scallop FMP (NEFMC 2004).

In Georges Bank, limited access to closed areas was permitted beginning in 2004. Some portions of closed areas will remain inaccessible under both scallop and multispecies fishery management plans and groundfish mortality closures (Fig. 10) (NEFMC 2004).

Besides closed areas, management has implemented other restrictions on the US scallop fishery. In 1998, Amendment 7 to the Atlantic Sea Scallop FMP was implemented to comply with the Sustainable Fisheries Act. As part of the amendment, the NEFMC developed a 10-year plan for stock rebuilding. The amendment redefined overfishing and further reduced allowable DAS. It

also closed 2 areas in the Mid-Atlantic (see above) to scallop fishing, for 5 years until 2001. Fishing mortality remained high in the open areas, above F_{MAX}, but overall fishing mortality was lowered due to the closed areas (Fig. 4) (NEFSC 2004). As a result, DAS allocations were increased in 1999 to 120 DAS for the limited access fishery (NEFMC 2003). Management must, however, address the problem of decreased biomass outside of closed areas, especially as the use of closed areas displaces effort. In New England, for example, scallop biomass outside of closed areas has been historically low relative to biomass inside closed areas (NEFSC 2007).

US management units use independent scientific stock assessments. The NOAA ship *RV Albatross* makes yearly dredge surveys in the Mid-Atlantic and Georges Bank areas to monitor scallop populations for the US (Northeast Fisheries Science Center 2004). The Northeast Fisheries Science Center (NEFSC) produces stock assessment reports for management (e.g., NEFSC 2004).

The effect of dredging on habitat is just beginning to be seriously addressed. This is partly driven by concerns over protecting essential fish habitat (EFH) for groundfish (NEFMC 2004). The most productive scallop areas occur over sandy beds, which are more resilient to trawl impacts than are rocky areas; however, very productive areas, when not protected through closures or other restrictions, may receive a disproportional amount of effort, high enough to prevent recovery (Kaiser et al. 2001). Howard (2002) estimated that 12,000 square nautical miles (nm^2) are dredged each year by the US fleet, but 3000 nm^2 of that area received 75% of the fishing effort in 1999. NMFS disputes that estimate of trawling extent and estimates that 5000 nm^2/year are trawled (NMFS 2004).

US management has taken steps to reduce bycatch and protect habitat. Measures include gear restrictions, TAC limits, and area closures. The bycatch of loggerhead turtles in the Mid-Atlantic fishery remains a great concern that has not been adequately addressed. Observer programs are being developed to better monitor bycatch, but coverage remains low, below 5%.

Synthesis

The US fishery utilizes scientific stock assessments and independent stock assessments. Regulations are in place to reduce bycatch and observer programs are developing. Despite regularly seeking scientific advice, US management has historically failed to prevent overfishing, although overfishing is no longer occurring on either stock. Protection of Georges Bank scallop grounds only occurred in response to groundfish declines, with unexpected benefits for scallops. US management is ranked as moderately effective.

Effectiveness of Management Rank:

Overall Evaluation and Seafood Recommendation

Sea scallops are fecund and fast-growing, and thus inherently resilient to overfishing. Sea scallop stocks in the US Northeast are currently healthy, reflecting a dramatic increase in biomass over the past 5 years, in part due to closures in the Mid-Atlantic and US Georges Bank. Because of biomass increases, sea scallops are not considered overfished in the US, and overfishing is not occurring.

Sea scallops are primarily caught through dredging, which disturbs both biogenic and physical habitat. The effects on habitat are severe and demonstrable. Bycatch data are hard to come by, and often not collected in an analytically-tractable fashion. Bycatch species of concern include yellowtail flounder, which has depleted, overfished, and rebuilding stocks; barndoor skate, which is being considered for listing under the US endangered species act (ESA); and loggerhead turtle, which is listed as a threatened species under the US ESA. Yellowtail flounder and barndoor skate occur in northern waters, while loggerhead turtle occurs in Mid-Atlantic waters. Recent analysis by NMFS indicates that loggerhead turtle bycatch and mortality may be much higher than previously realized.

Management agencies in the US have taken measures to address bycatch and overfishing concerns, however, management failed to prevent depletion of scallop stocks. The area closures in the US fishery that have allowed scallop stocks to rebuild were in response to a different fishery crisis, the collapse of New England groundfish stocks. Recent steps by US management to increase the use of closed and rotational areas, increase gear restrictions, decrease TACs and DAS, and increase observer coverage, are positive.

The criteria analyzed in this report result in an overall recommendation of Good Alternative for sea scallops from the US.

Table of Sustainability Ranks

	Conservation Concern			
Sustainability Criteria	Low	Moderate	High	Critical
Inherently Vulnerability	√			
Status of Stocks	√			
Nature of Bycatch		√		
Habitat Effects			√	
Management Effectiveness		√		

Overall Seafood Recommendation:

Best Choice | **Good Alternative** | Avoid

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Scientific review does not constitute an endorsement of Seafood Watch® on the part of the reviewing scientists. The Seafood Watch® staff is solely responsible for the conclusions reached in this report.

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Appendix 1

Prior to the release of the 2006 Status of U.S. Fisheries Report (NMFS 2007), NMFS had deemed the overall U.S. sea scallop stock to be experiencing overfishing. However, NMFS (2007) has deemed that the overall U.S. sea scallop is no longer experiencing overfishing due to the overall decrease in fishing mortality over the past two years. This change in the overfishing designation does not lead to a change in the stock status ranking. The stock status of U.S. sea scallops is determined by region (Northeast and Mid-Atlantic). Overfishing is still occurring in the Mid-Atlantic, thus this stock still receives a "poor" ranking. As such, there is no change in the overall recommendation of U.S. Northeast and U.S. Mid-Atlantic sea scallops, which remain "Good Alternative" and "Avoid", respectively.

Appendix 2

Prior to the NEFSC's release of the 2007 Stock Assessment Workshop Report, the Northeast (Georges Bank) scallop fishery was considered to be neither overfished nor undergoing overfishing, while the Mid-Atlantic fishery was not considered overfished, but was considered to be undergoing overfishing (NEFSC 2006). According to the most recent stock assessment conducted in 2007, Mid-Atlantic scallops are no longer subject to overfishing (NEFSC 2007). This new designation constitutes a change in the stock status of the Mid-Atlantic stock from "poor" to "healthy" and an overall Seafood Watch® recommendation change from "Avoid" to "Good Alternative."

Additionally, new biological reference points and biomass calculations were used in the stock status criterion. Instead of using NEFSC survey data (kg/tow), reference points were calculated as total stock biomass (mt). The proposed target biomass was set at 108.6 thousand mt meats, with critical biomass set at 54.3 thousand mt meats. Stock biomass for the Northeast US and the Mid-Atlantic were estimated at 81,047 and 85,161 mt respectively. B/B_{MSY} values are 1.49 for the Northeast and 1.57 for the Mid-Atlantic. F_{MSY} was set at 0.29, and F/F_{MSY} values were calculated at 0.87 (Northeast) and 0.62 (Mid-Atlantic).