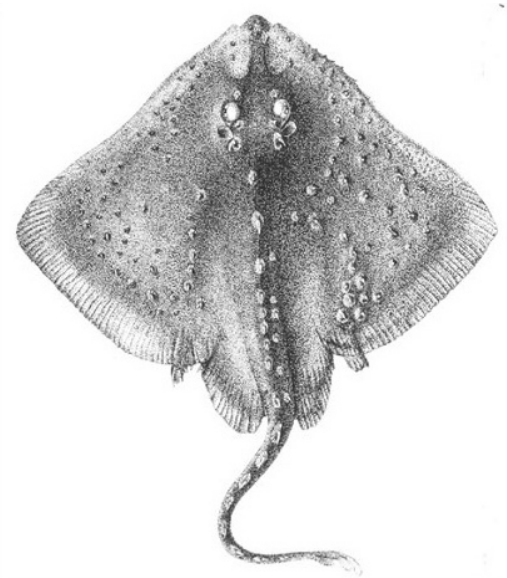
Seafood Watch

Seafood Report

MONTEREY BAY AQUARIUM®

Atlantic Skate Complex

Barndoor skate (*Dipturus laevis*)
Clearnose skate (*Raja eglanteria*)
Little skate (*Leucoraja erinacea*)
Rosette skate (*Leucoraja garmanii*)
Smooth skate (*Malacoraja senta*)
Thorny skate (*Amblyraja radiata*)
Winter skate (*Leucoraja ocellata*)



Thorny skate, *Amblyraja radiata*. (From Scott & Scott, Atlantic Fishes of Canada)
Courtesy Northwest Atlantic Fisheries Organization,www.nafo.ca/About/MANDATE/OtherFin.html

Northeast Region

Final Report
July 15, 2005

Stock Status Update August 20, 2010

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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 (831) 647-6873 or emailing seafoodwatch@mbayaq.org.

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Seafood Watch® and Seafood Reports are made possible through a grant from the David and Lucile Packard Foundation.

Executive Summary

Seven species of skate—barndoor skate (*Dipturus laevis*), clearnose skate (*Raja eglanteria*), little skate (*Leucoraja erinacea*), rosette skate (*Leucoraja garmanii*), smooth skate (*Malacoraja senta*), thorny skate (*Amblyraja radiata*), and winter skate (*Leucoraja ocellata*)—are taken in groundfish trawl fisheries off the northeastern seaboard of the United States. Formerly often discarded as "trash fish", skates have become increasingly important as traditional targets of the New England groundfish fishery (notably cod and haddock) have become depleted. Today's commercial skate fishery markets skates as food (skate wings) and as bait (used primarily in East Coast lobster fisheries).

In general, the seven Northeast skates are inherently vulnerable to fishing pressure, as they produce small batches of large eggs (a *k*-selected reproductive strategy). Most of these skates have been little studied, and commercial catch and effort data were seldom collected before 2003. Since 2003, general data on skate landings have been collected, but species-specific data are still limited because of the difficulty of distinguishing among some skate species in the field. The New England Fishery Management Council (NEFMC) is currently unable to determine fecundity, fishing mortality, or maximum sustainable yield for any skate species, and has no field data on age of maturity for five of the seven Northeast skate species. Those skate species that have been studied—winter skate and the barndoor skate—show the relatively late maturity and low fecundity typical of large elasmobranches.

Overfished and overfishing thresholds are set using a unique system based on three-year averages of skate take in annual fisheries-independent surveys. In 2005, the barndoor skate was downgraded from "threatened" to "endangered" on the IUCN Red List. This might lead Seafood Watch® to rank the status of the barndoor skate as of "critical conservation concern"; however, its latest biomass index shows a rapid and significant rebuilding trend which started about 1999 and lasted through 2006, and biomass is currently at 62% of MSY. The species is no longer considered to be overfished and overfishing is not occurring. The stock status of the barndoor skate therefore ranks as a moderate conservation concern. The latest biomass index for the winter skate shows that the stock has rebuilt to 93% of MSY. Given the recent increase in stock biomass, winter skate is not overfished and overfishing is not occuring. Seafood Watch© ranks the winter skate stock status as a moderate conservation concern. The thorny skate is currently designated a "species of special concern" by NMFS. In 2009, the NEFMC declared that the thorny skate stock is overfished but not experiencing overfishing**.** Only the smallest rebuilding trend can be discerned in its biomass index, and at its current biomass (0.42 kt/tow in 2007), it is estimated that it would take an average annual increase of 13.2% to rebuild the stock to the 4.41 kg/tow target by 2028. The stock status of the thorny skate therefore ranks as a critical conservation concern. In 2009, NEFMC estimated that while no overfishing is occurring, the smooth skate is currently overfished. Biomass has declined below the minimum threshold level as of 2007. The smooth skate's stock status is ranked as a critical conservation concern. The clearnose, little, and rosette skates are not overfished and overfishing is not occurring (2009). Rosette and clearnose skates are above MSY, while the little skate is 72% of MSY (NEFMC 2009). Therefore, Seafood Watch® considers rosette and clearnose skates to be a low conservation concern, and the little skate to be a moderate conservation concern.

Otter trawling is the fishing method used to catch the majority of skates. Trawling causes severe disturbance to seafloor habitat, and trawl nets often take a heavy bycatch of unmarketable, illegal, or undersized individuals, usually discarded dead or dying. East Coast groundfish managers have attempted to mitigate trawler habitat damage and bycatch by closing over 2800 square miles of ecologically-sensitive habitat to trawling, increasing net mesh size, and including discard estimates in fishing mortality analyses. Managers actively observe groundfish abundance patterns with three seasonal trawl surveys each year; these fisheries-independent stock data extend back to 1963. However, the near-complete lack of commercial landings data makes accurate assessments of skate stocks and their abundance trends impossible at this time. Managers are taking steps to identify and fill the holes in their data and establish a conservation regime for each skate species. The first stock assessment for Northeast skates was published in 2001, and the first Fishery Management Plan for Northeast skates was implemented in March 2003. Yearly stock-status updates are now required; the first was published in February 2005.

The critical stock status of smooth and thorny skates, and the high inherent vulnerability and severe habitat impacts for the other skates results in an overall seafood recommendation of **Avoid** for all Northeast skate species.

Table of Sustainability Ranks

	Conservation Concern			
Sustainability Criteria	**Low**	**Moderate**	**High**	**Critical**
Inherently Vulnerability			**√ All spp.**	
Status of Stocks	**√ Clearnose, Rosette**	**√ Barndoor, Little, Winter**		**√ Smooth, Thorny**
Nature of Bycatch		**√ All spp.**		
Habitat Effects			**√ All spp.**	
Management Effectiveness		**√ All spp.**		

About the Overall Seafood Recommendation:

- 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.
- 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 "**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.

Overall Seafood Recommendation:

Little, clearnose, rosette, barndoor, thorny, winter, and smooth skates:

Best Choice  Good Alternative  **Avoid** 

Introduction

Skates are elasmobranches, closely related to sharks. Their jaws and teeth are the only mineralized elements of their otherwise cartilaginous skeletons (McEachran and Dunn 1998; Love 1996). Skates are egg-layers, producing small clutches of leathery egg cases sometimes called "mermaid's purses" (NMFS/NEFSC 2000). This reproductive fact distinguishes skates from their cousins, the stingrays, which produce live young (National Shark Research Consortium 2003).

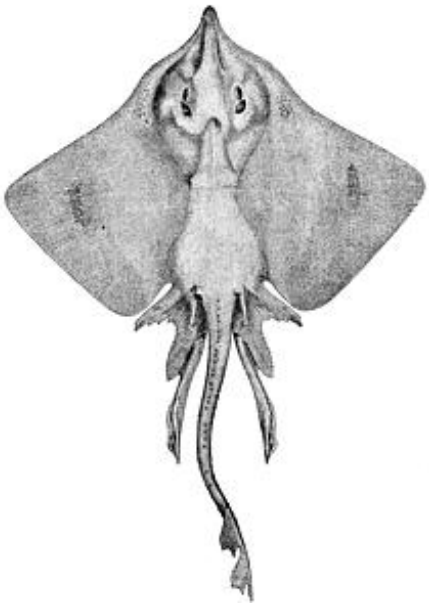


Figure 1. (Left): Adult barndoor skate. Image courtesy NOAA, from http://www.nefsc.noaa.gov/lineart/. (Right): Skate egg case, collected 2003 by NOAA expedition to Bear Seamount, off Connecticut. Photo by L. Rear, from http://oceanexplorer.noaa.gov/explorations/03mountains/logs/jul17/media/eggcase.html.

Skates are bottom-dwellers, their flat forms adapted to benthic life. They are often found resting on the seafloor or hiding partly submerged in soft sediment. They prey upon benthic fishes, worms, crustaceans, and mollusks, using flat, molar-like teeth to crush hard-shelled prey (Bigelow and Schroeder 1953). Skates swim by flapping their wing-like sides. Most species have protective spines on their backs and/or tails; the exact number and placement of spines are species diagnostics for the seven skate species of the Northeast skate complex (NMFS/NEFSC 2000). The New England Fishery Management Council (NEFMC) defines essential habitat for these seven species as bottom habitats with substrates of sand, mud, gravel, and/or broken shell, pebbles, and pteropod ooze (NEFMC 2003).

The general distribution and size at maturity of the seven species of the Northeast skate complex are given in Table 1. The seven species in the Northeast region (Maine to Virginia) are found from near the tide line to depths exceeding 700 meters (m) (NEFMC 2001). The little skate and winter skate are most abundant around Georges Bank and Southern New England (see fishery regions map, Figure 2). The barndoor skate is most common on Georges Bank, in the offshore Gulf of Maine, and in Southern New England. The thorny skate and smooth skate are most

common in the Gulf of Maine. The clearnose skate and rosette skate have a more southern distribution, and are found primarily in Southern New England and the Chesapeake Bight. Skates are not known to undertake large-scale migrations, but they do move seasonally in response to changes in water temperature, moving offshore in summer but returning inshore for the winter (NEFMC 2001).

Table 1. Skate Species Identification for Northeast Complex (Table from NEFMC 2001).

Table 1 Skate Species Identification for Northeast Complex

SPECIES COMMON NAME	SPECIES SCIENTIFIC NAME	GENERAL DISTRIBUTION	SIZE AT MATURITY	OTHER COMMON NAMES
Winter Skate	*Leucoraja ocellata*	Inshore and offshore GB and SNE with lesser amounts in GOM or MA	Large (> 100 cm)	• **Big Skate** • **Spotted Skate** • **Eyed Skate**
Barndoor Skate	*Dipturis laevis*	Offshore GOM (Canadian waters), offshore GB and SNE (very few inshore or in MA region)	Large (> 100 cm)	
Thorny Skate	*Amblyraja radiata*	Inshore and offshore GOM, along the 100 fm edge of GB (very few in SNE or MA)	Large (> 100 cm)	• **Starry Skate**
Smooth Skate	*Malacoraja senta*	Inshore and offshore GOM, along the 100 fm edge of GB (very few in SNE or MA)	Small (< 100 cm)	• **Smooth-tailed Skate** • **Prickly Skate**
Little Skate	*Leucoraja erinacea*	Inshore and offshore GB, SNE, and MA (very few in GOM)	Small (< 100 cm)	• **Common Skate** • **Summer Skate** • **Hedgehog Skate** • **Tobacco Box Skate**
Clearnose Skate	*Raja eglanteria*	Inshore and offshore MA	Small (< 100 cm)	• **Brier Skate**
Rosette Skate	*Leucoraja garmani*	Offshore MA	Small (< 100 cm)	• **Leopard Skate**

Abbreviations are for Gulf of Maine (GOM), Georges Bank (GB), southern New England (SNE), and the Mid-Atlantic (MA) regions.

Scope of the analysis and the ensuing recommendation:

This report focuses on the seven skate species managed as the New England Fishery Management Council's "Northeast Skate Complex". These are the primary species of skate landed in the northeastern United States. Although some of these species are also landed in Canada and may possibly be imported to the United States, the U.S. Department of Commerce does not track skate in its seafood import/export statistics (NMFS Foreign Trade Stats 2005). The status of Canadian stocks is only briefly mentioned here; recommendations should be considered to be specific to U.S. stocks.

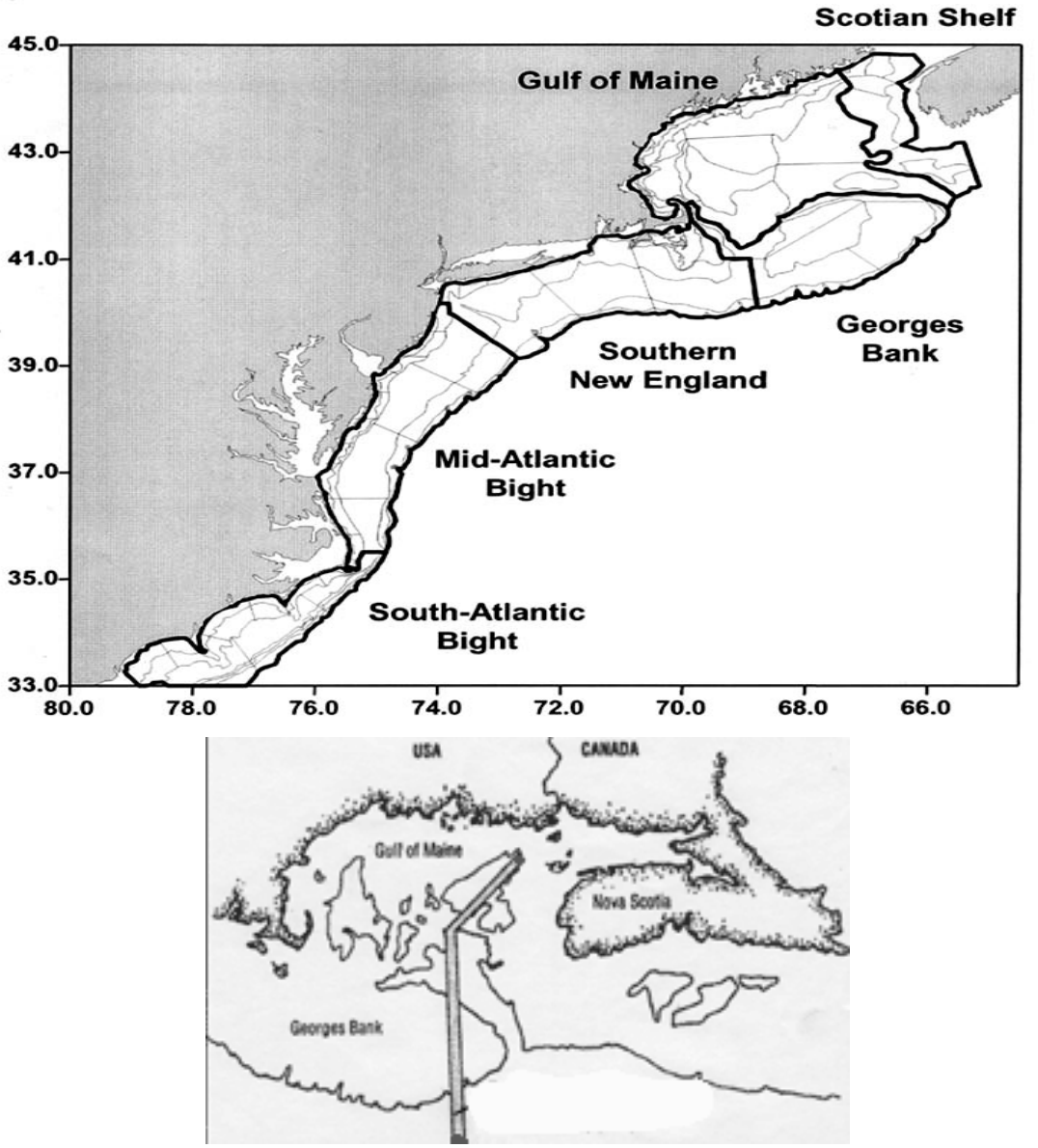


Figure 2. Top: Map of the northwest Atlantic, including the major fishery subregions (Source: NEFSC 2003). Bottom: Map showing the Hague Line border between U.S. and Canadian waters (Source: Gulf of Maine Council on the Marine Environment).

Availability of Science

Because skates were historically fished only for bait or else discarded as "trash fish" (NEFMC 2003), they have been studied less than traditional groundfish staples such as cod, haddock, and flounders. Basic biological parameters are lacking for all seven skate species treated in this report. In the 2003 Skate Fishery Management Plan (FMP), managers reported that they could not determine fecundity or age at maturity for any of the skates of the Northeast skate complex (NEFMC 2003). Biologists are currently researching population structure, fecundity, and

abundance of New England's skates, but much information is not yet published. The barndoor skate has been studied more than other species in recent years because of the legal question of whether it should be listed as a threatened or endangered species. A 2005 report offers the first well-supported determination of age at maturity and 'k' (rate of growth) for the barndoor skate in New England waters (Gedamke, DuPaul, and Musick 2005). Other new studies are shedding light on the basic biology of the winter skate (Sulikowski et al. 2003) and thorny skate (Sulikowski et al. 2005), and a 2004 review attempted to determine size at maturity of all seven skate species (Sosebee 2004).

In the absence of data, it is tempting to extrapolate maturity and fecundity parameters from a known species to its unknown relatives. However, in the case of skates, this is risky. A recent study of skates in the Bering Sea underscores that even congener species can have significantly different reproductive parameters (Ebert 2005), and skate species can vary greatly in their response to fishing pressure, depending upon life-history parameters such as size at maturity and maximum body size (Holden 1973; Brander 1981). Because of the difficulty in ageing elasmobranches, maximum age has not yet been validated for any of the species of the Northeast skate complex; however, Gedamke, DuPaul, and Musick (2005) applied a relatively new ageing method (the counting of vertebral rings) to the barndoor skate and obtained preliminary age-at-maturity values for this species (Gedamke, DuPaul, and Musick 2005).

The New England Fisheries Management Council (NEFMC) notes that the Northeast skate complex is a "data-poor" fishery (NEFMC 2003). The situation is the inverse, however, of most data-poor fisheries, in that it is fisheries-*dependent* data that are critically lacking (NEFMC 2003). Fisheries-independent data on skate abundance have been collected since 1963, as part of the thrice-annual New England Groundfish Trawl Survey (NEFMC 2001). Fisheries-dependant data, however, are generally unavailable, as skate catch, effort, and landings data—let alone skate discards—had not been systematically recorded by commercial fishermen until recently (NEFMC 2003). Basic, combined-species catch and effort data are incomplete for the time before the 2003 Skate FMP. Species-specific data are even harder to obtain; the 2003 Skate FMP notes that even trained observers have difficulty distinguishing juvenile winter skate from adult little skate. The NEFMC notes that techniques exist for estimating fishing mortality (F) and maximum sustainable yield (MSY) from landings and effort data, but that there is no established way for estimating these parameters without landings and effort data, as is the case for the Northeast skate fishery (NEFMC 2003). Therefore, the NEFMC finds it genuinely impossible to even estimate F and MSY for the Northeast skate complex (NEFMC 2003). In the past year (2003-2004), the NEFMC has begun redesigning its monitoring and reporting channels to collect species-specific catch and effort information on skates, but it will be several years before managers have the necessary data to estimate F and MSY for any skate species.

In Section 4 of the 2001 Atlantic Skate Stock Assessment and Fishery Evaluation (SAFE) Report, the New England Fishery Management Council's Scientific Advisory and Research Committee (SARC) identified the following research and data deficiencies for the Northeast skate complex:

1) The species composition and size structure of landings are unknown.
2) The true level of discards and the discard mortality rate are unknown.

3) A lack of information on the stock structure of the species in the skate complex has increased the uncertainty of conclusions about historical trends in abundance, recommendations of appropriate biological reference points, and conclusions about the status of barndoor skate relative to its candidacy for threatened or endangered listing.
4) Life history data are uncertain for winter skate and little skate and incomplete and/or totally lacking for the other five skate species.
5) Mortality estimates are based on equilibrium assumptions which are only partially met for these stocks. A preferable approach for future assessments would be an age-based method for determining mortality rates and estimates of longevity. This will require several years of future adequate length and age sampling, both from the commercial and research survey catches.
6) The proposed biomass reference points for overfished/overfishing are based on selected time periods of survey indices, but it is unknown how these relate to true estimates of B_{MSY}.

Based on the above sources of uncertainty, NEFMC generated the following "research recommendations" (NEFMC 2001):

1) The commercial fishery statistics sampling programs should be adapted to report skates landings by species.
2) Commercial fishery size composition data should be collected by species.
3) Sea sampling of directed skate landings and skate bycatch should be increased, and identification of the species composition of the skate catch improved.
4) Age and growth studies are needed for all seven species in the complex.
5) Maturity and fecundity studies are needed for all seven species in the complex. Use of life history models requires these data, and may prove useful in establishing biological reference points for the skate species.
6) Estimates of commercial and recreational fishery discard mortality rates, for different fishing gears and coastal regions and/or bottom types, for all seven species in the complex, are needed.

By 2005, some of these recommendations had begun to be addressed. Many are now part of law, under the 2003 Skate FMP, but the NEFMC notes a continuing need for basic research. The following are the NEFMC's biggest priorities (NEFMC 2005):

- Conduct discard mortality studies (for example, a skate tagging program) to determine the actual mortality rates (survivability) of thorny skate and other skate species released as bycatch (i.e., regulatory discards). Until this information becomes available, it remains very difficult to predict skate mortality rates from bycatch, as well as the impacts of new measures intended to reduce mortality of non-target species.
- Employ observers to collect additional skate bycatch information. In addition to the number of skates caught, the viability (or condition) of skates released as bycatch should be documented.
- Develop estimates of skate bycatch rates in other fisheries per area, season, and gear type. Use reference areas (closed areas) and gear controls to compare catch rates and minimize patchiness.

- Help develop more selective fishing gear to reduce regulatory discards of skates in other fisheries, especially with regard to juvenile skates.
- Investigate 1948-1962 NEFSC survey data (if available) to determine long-term trends in skate biomass and distribution. Also explore NEFSC survey data for stock-recruit relationships.
- Develop more techniques to help commercial vessel owners/operators correctly identify the skates they catch.
- Conduct field studies of age and growth, maturity, fecundity, and food habits for each species in the skate complex. These should be based on new samples, not reanalysis of old data.
- Conduct tagging/recruitment surveys on species distribution, stock abundance, stock delineation, and survivability.
- Investigate the influence of physical factors (including environmental changes) on shifts in range, distribution, and depth.
- Study predator/prey interactions and trophic interactions between skate species and between skates and other benthic species that share the same habitat.

Market Availability

Common and market names (Sources: NMFS/NEFSC 2000; NEFMC 2001):
Barndoor skate (*Dipturus laevis*): *no other common names*
Clearnose skate (*Raja eglanteria*): briar skate
Little skate (*Leucoraja erinacea*): common skate, summer skate, hedgehog skate, tobacco-box skate
Rosette skate (*Leucoraja garmanii*): leopard skate
Smooth skate (*Malacoraja senta*): smooth-tailed skate, prickly skate
Thorny skate (*Amblyraja radiata*): starry skate
Winter skate (*Leucoraja ocellata*): eyed skate, big skate, spotted skate

Seasonal availability:
Skates are available year-round.

Product forms:
Skates have a sweet, mild meat. Their "wings", or flat modified dorsal segments, are the part marketed for human consumption (NEFMC 2001). Skate wings may be marketed fresh or frozen, skin-on or skinless. Only skates with a wingspan of 18" or more are sold as skate wings (Avila 2002, as reported in Appendix I-A of NEFMC 2003).

Much skate is also marketed as baitfish (NEFMC 2003). Skates with a wingspan of less than 18"—called "dinner plates" by fishermen—are sold as bait, primarily to the East Coast lobster fisheries. Bait skate may be sold fresh, frozen, or salted (NEFMC 2001).

There are ongoing reports that round pieces of skate wing, stamped out with a device like a cookie cutter, are or have been offered for sale as scallops (Love 1996; Marco 2004). The sweet meat of skates might be a culinary substitute for scallops, but the extent of this practice remains unknown. New techniques for the genetic analysis of seafood may reveal the extent, if any, of this rumored practice (Marco 2004).

Domestic skate sources and statistics:
In 2003, the latest year for which U.S. Department of Commerce figures are available, approximately 29,139 metric tons (mt) of skates (all species) were landed at U.S. ports (NMFS Stats 2005); species-specific data is not yet available for U.S. skate landings (NMFS Stats 2005). The majority of U.S. skates are landed along the U.S. East Coast; of the national total of 29,139 mt of skates landed in 2003, approximately 15,003 mt, or 51%, were landed on the East Coast (Maine to North Carolina). Of the national total of 16,161 mt of skates landed in 2002, approximately 12,977 mt, or 80.3%, were landed on the East Coast (NMFS Stats 2005).

2002 landings for East Coast states were as follows: Massachusetts: 6,334.9 mt; Rhode Island: 5,029.5 mt; New Jersey: 582.3 mt; New York: 462.8 mt; Connecticut: 367.6 mt; Maine: 137.2 mt; Maryland: 52.0 mt; New Hampshire: 24.5 mt; Virginia: 12.7 mt; North Carolina: 0.2 mt. These data are graphed in Figure 3a.

2003 landings for East Coast states were as follows: Massachusetts: 8,097.9 mt; Rhode Island: 5,516.5 mt; New Jersey: 447.2 mt; New York: 353.3 mt; Connecticut: 433.7 mt; Maine: 76.4 mt; Maryland: 26.9 mt; New Hampshire: 14.9 mt; Virginia: 35.7 mt; North Carolina: 0.4 mt. These data are graphed in Figure 3b.

While Department of Commerce figures are not yet available for 2004, the NEFMC summarized NMFS dealer databases to get a preliminary total for Northeast skate landings of 5,805 metric tons (12,799,396 pounds) in 2004 (NEFMC 2005).

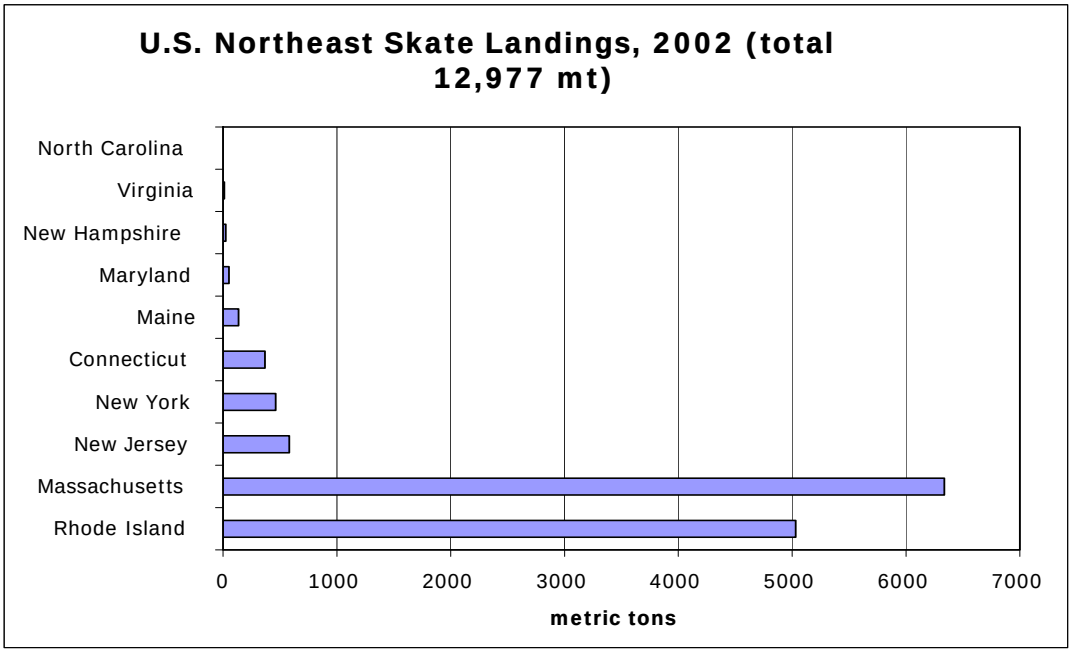


Figure 3a. 2002 U.S. landings data for Northeast skates, state-by-state, in metric tons. Source: NMFS Stats 2005.

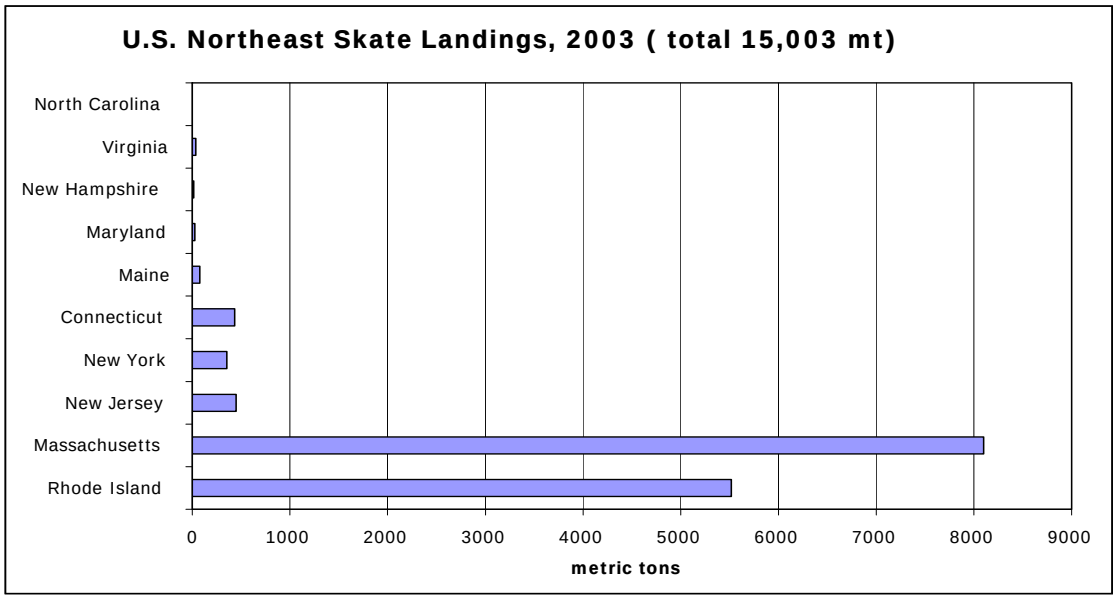


Figure 3b. 2003 U.S. landings data for Northeast skates, state-by-state, in metric tons. Source: NMFS Stats 2005.

Various amounts of the seven different skate species are caught in the Northeast skate fishery. The relative abundance of different skate species (as measured by the fishery-independent annual trawl survey) is displayed in Figure 4, below. It should be noted that as much as 40% of the skate caught commercially may never enter official landings statistics, because it is sold as bait from the catching vessels directly to lobster boats (NEFMC 2003). The NEFMC is introducing catch reporting requirements to track all segments of the skate fishery, including these small-scale fisheries in state waters (NEFMC 2003).

According to the NEFMC, the three largest skate species (barndoor, thorny, and winter skates) have been favored for skate wings because of their size. Winter skate is now the primary source of skate wings (NEFMC 2003), because landing of thorny and barndoor skates is now illegal. Perplexingly, barndoor and thorny skates are still turning up in the statistics of skate wing processors (NEFMC 2005). NEFMC is currently investigating whether this indicates illegal fishing or merely poor identification of legal skates (NEFMC 2005)—it may well be the latter, as rosette skates are being reported by processors in Massachusetts, while this species is found primarily south of Long Island (NEFMC 2005).

Bait skate can be much smaller, and the little skate is the primary species taken in the bait skate fishery (NEFMC 2003). Currently, the little skate supplies about 90% of the bait skate identified to species, and winter skate supplies the other 10% (NEFMC 2005).

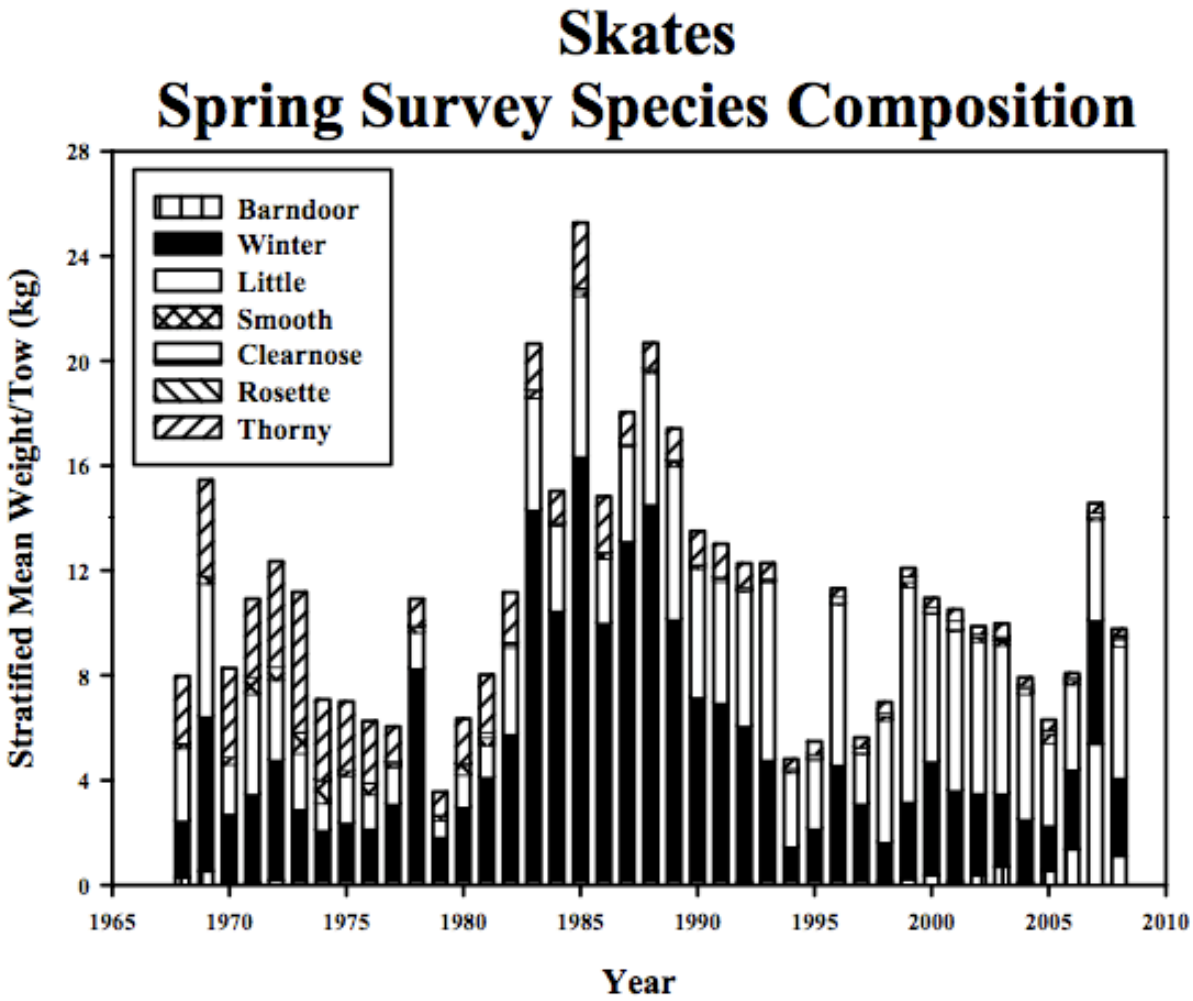


Figure 4. Skate species composition of annual fisheries-independent trawl survey (From: NEFSC 2009b).

Import and export sources and statistics:
The U.S. Department of Commerce does not track skate in its import/export statistics (NMFS Stats 2005). The extent of skate imports, if any, is thus unknown (NMFS Stats 2005). This fact emphasizes the status of skate as a relatively new product in U.S. fish markets. Skates are of increasing importance to local regions, but are without the historical importance of cod or haddock, and are only recently coming to the attention of management.

Some skate is known to be exported; though, again, this information is unavailable from the U.S. Department of Commerce. Export of skate is also not tracked in an organized way by the seafood industry (NEFMC 2003), although the 2003 Skate FMP did contain some information on skate exports. In 2002, nine U.S. companies reported exporting about 3.9 million pounds of processed New England skate wings (NEFMC 2003). The wings were exported primarily to France, Korea, and Greece, with a smaller amount exported to Japan (NEFMC 2003). While demand is apparently steady, profit margins for skate exports are said to be extremely low, with wholesale prices averaging just $0.81/lb (NEFMC 2003).

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

Criterion 1: Inherent Vulnerability to Fishing Pressure

The skates of the Northeast skate complex are all bottom dwellers, feeding upon small benthic fishes, crustaceans, and mollusks (Bigelow and Schroeder 1953). They are fairly sedentary, but exhibit seasonal onshore/offshore movements (NEFMC 2001).

Generally speaking, the Atlantic skates have a low reproductive potential. They are egg-layers, producing small batches of large, leathery eggs (a *k*-selected reproductive strategy). These eggs are laid in sheltered areas of the seafloor and take 6 to 12 months to hatch (Bigelow and Schroeder 1953). This protracted incubation period renders skate eggs vulnerable to factors that disturb seafloor habitat, including bottom trawlers.

In its 2003 Skate FMP, the New England Fishery Management Council noted that the Northeast skate complex species are "inherently vulnerable to overfishing" because of their slow maturity, low fecundity, and vulnerability to bottom trawl gear (NEFMC 2003). This echoes international consensus that skates and other elasmobranches are among the marine species most vulnerable to overfishing, based upon life-history patterns (IUCN 1998; IUCN 2004; IUCN 2005). Several large species of skates have suffered precipitous population declines in recent decades, coincident with the onset of intensive fishing; these include the European common skate, *Dipturus batis* (Brander 1981), the barndoor skate, *Dipturus laevis* (Casey and Myers 1998), the longnose skate, *Dipturus oxyrhyncus* (Dulvy et al. 2000), and the white skate, *Rostroraja alba* (Dulvy et al. 2000). In one of the first studies to explicitly link life history to fisheries vulnerability, Jennings, Reynolds, and Mills (1998) found that, among commercially-exploited Northeast Atlantic fishes, species that had suffered population declines were larger, slower-growing, and less fecund than their nearest relatives. While this study examined only finfishes, not elasmobranches, it might suggest that the larger species of Northeast skate—the barndoor, winter, and thorny skates—are inherently more vulnerable to exploitation than their smaller relatives. Indeed, further studies and a 2004 review found that the correlation of large maximum body size with inherent vulnerability to fishing pressure holds true across many marine families, including skates (Dulvy and Reynolds 2002; Dulvy, Sadovy, and Reynolds 2003; Dulvy et al. 2004). This is because, among related species, large maximum size is correlated with long life, slow growth, and a low annual reproductive output (Dulvy, Sadovy, and Reynolds 2003; Dulvy et al. 2004). Body size was the only accurate predictor of extinction vulnerability in a review of local extinctions of skate species worldwide (Dulvy and Reynolds 2002).

Actual values for age at maturity, fecundity, natural mortality, and other population parameters are not available for most of the skates of the Northeast skate complex, as few skates have been systematically studied (NEFMC 2003; Sulikowski et al. 2005). FishBase, an international database of fisheries information, cites a fecundity of less than 100 eggs per year and a doubling-time of 4 to 14 years for all seven of the species of the Northeast skate complex (FishBase 2005). For these numbers, they are likely extrapolating McEachren and Dunn's (1998) measured values for winter skate onto the six related species. As noted in the introduction to this report, this is a risky practice, because even closely-related skate species can vary markedly in their reproductive parameters and response to fishing pressure (Holden 1973; Brander 1981; Ebert 2005).

Research is ongoing, but some basic data are available for some of the seven skate species. For example, Sosebee (2004) used a non-lethal method (measuring clasper length in males and cloaca length in females) to find a preliminary size of first maturity for all seven Northeast skate species. She cautions that this method remains to be validated with dissection of ovaries and testes; however, if it is validated, it could be a valuable method for studying populations of skates where killing individuals should be avoided (Sosebee 2004). Her findings for the size at first maturity of the seven skate species were:

- Barndoor skate: males 100 cm, females 96-105 cm
- Winter skate: males 53-58 cm, females 66-73 cm
- Thorny skate: males 50 cm, females 43-46 cm
- Smooth skate: males 50 cm, females 33-48 cm
- Clearnose skate: males 56 cm, females 59-65 cm
- Little skate: males 39 cm, females 40-42 cm
- Rosette skate: males 33 cm, females 33-35 cm

As noted above, the winter skate has a reported fecundity of less than 100 offspring per year and a minimum population doubling time of 4.5 to 14 years (McEachren and Dunn 1998). A 2003 study used vertebral rings to determine a maximum observed age of 18 years for females and 19 years for males for winter skate (Sulikowski et al. 2003). The species in general grows extremely slowly, and females appear to grow more slowly than males (Sulikowski et al. 2003). These authors concluded that "the winter skate exhibits the characteristics that have made other elasmobranch populations highly susceptible to exploitation by commercial fisheries" (Sulikowski et al. 2003).

The thorny skate reaches over 100 cm in length in the southerly part of its range (the Gulf of Maine), but grows to less than 72 cm in length further north (off the Labrador coast) (Sulikowski et al. 2005). A 2005 study examined 224 thorny skates trawled in the Gulf of Maine (Sulikowski et al. 2005). Gulf of Maine thorny skates appear to mature at a length of about 80 cm (Sulikowski et al. 2005). Examination of vertebral rings found that this species can live at least 16 years (Sulikowski et al. 2005). Males and females appear to grow and mature at approximately the same rate; growth rate *k* was found to be 0.11 for males and 0.13 for females (Sulikowski et al. 2005). Based on the spacing of vertebral rings, growth in this species appears to slow significantly after maturity (Sulikowski et al. 2005).

The barndoor skate has been reported to grow slowly, reach maturity in 11 years, and produce a maximum of 47 offspring per year (Casey and Myers 1998); however, these values actually belong to the European common skate, *Dipturus batis*, and were used by Casey and Myers as a "best guess" for barndoor skate—in 1998, there were no quality data available specific to the barndoor skate (Gedamke, DuPaul, and Musick 2005). Two recent Canadian studies found that in Canadian Atlantic waters the barndoor skate has a length at first maturity of 105 cm and at 50% maturity of 110 cm. The Canadian workers found that these parameters applied to both male and female barndoor skate (Simon, Frank, and Kulka 2002). In an effort to further elucidate the life history of this species, Gedamke, DuPaul, and Musick (2005) examined 2,310 barndoor skates taken as bycatch in commercial scallop dredges on the southern Georges Bank.

The skates were visually examined for evidence of sexual maturity, and age was assessed by examination of vertebral rings (Gedamke, DuPaul, and Musick 2005). The authors found sexual dimorphism in length at 50% maturity, with 50% of females mature at 116.3 cm and 50% of males mature at 107.9 cm (Gedamke, DuPaul, and Musick 2005). Preliminary analysis of 118 vertebral samples indicates that females mature at between 6.5 and 7.2 years of age and males at between 5.3 and 6.3 years (Gedamke, DuPaul, and Musick 2005). This is considerably younger than the oft-cited value of 11 years (which, as noted above, actually belongs to the European common skate, not the barndoor skate). Likewise, analysis of the European common skate data gives a *k* value of 0.05, while Gedamke, DuPaul, and Musick (2005) found the barndoor skate's *k* value to lie between 0.14 and 0.18. This new information has important conservation implications, suggesting as it does that barndoor skate populations may be capable of quicker recovery than previously thought (Gedamke, DuPaul, and Musick 2005). However, the authors caution that their samples were taken in a small, southerly, shallow-water portion of the range of the barndoor skate. Therefore, the growth parameters they found may not apply across the barndoor skate's entire range (Gedamke, DuPaul, and Musick 2005). Gedamke, DuPaul, and Musick (2005) do not suggest that the barndoor skate is robustly resilient to fishing pressure, merely that its resilience may be more than previously believed. While their new data suggest that the barndoor skate is not in imminent danger of extinction on the eastern Georges Bank, the authors conclude their article with the caution that "the life history of this elasmobranch still renders it much more vulnerable to overharvest than the vast majority of bony fishes" (Gedamke, DuPaul, and Musick 2005).

With the few exceptions noted above, most of the biological data necessary for a robust assessment of skate vulnerability do not yet exist (Sulikowski et al. 2005). The NEFMC cited the following data needs in its 2001 Skate SAFE Report:

- The species composition and size structure of landings are unknown.
- The true level of discards and the discard mortality rate are unknown.
- A lack of information on the stock structure of the species in the skate complex has increased the uncertainty of conclusions about historical trends in abundance, recommendations of appropriate biological reference points, and conclusions about the status of barndoor skate relative to its candidacy for threatened or endangered listing.
- Life history data are uncertain for winter skate and little skate and incomplete or totally lacking for the other five skate species.
- Mortality estimates are based on equilibrium assumptions which are only partially met for these stocks. A preferable approach for future assessments would be an age-based method for determining mortality rates and estimates of longevity. This will require several years of future adequate length and age sampling, both from the commercial and research survey catches.
- The proposed biomass reference points for overfished/overfishing are based on selected time periods of survey indices, but it is unknown how these relate to true estimates of B_{MSY}.
- The commercial fishery statistics sampling programs should be adapted to report skate landings by species.
- Commercial fishery size composition data should be collected by species.

- Sea sampling of directed skate landings and skate bycatch should be increased, and the identification of the species composition of the skate catch improved.
- Age and growth studies are needed for all seven species in the skate complex.
- Maturity and fecundity studies are needed for all seven species in the skate complex. Use of life history models requires these data and may prove useful in establishing biological reference points for the skate species.
- Estimates of commercial and recreational fishery discard mortality rates, for different fishing gears and coastal regions and/or bottom types, are needed for all seven skate species in the Northeast skate complex.

While managers and researchers are working hard to fill in these gaps, much uncertainty still remains. Much of the data required to fill these gaps is still being collected (Sulikowski et al. 2005).

Synthesis

Basic biological parameters—including fecundity, age at maturity, age/growth curves, and natural mortality—are unknown or uncertain for the seven species of the Northeast skate complex. The few studies that have been published (on winter skate and barndoor skate) show the animals have very low fecundity and slow maturity compared to bony fishes. Sharks, rays, and other elasmobranch relatives of the skates have proven inherently vulnerable to overfishing, and peer-reviewed literature links the decline of several large-bodied skate species to the onset of intensive fishing. In its 2003 Skate FMP, the New England Fishery Management Council stated that the Northeast skate complex species are "inherently vulnerable to overfishing" because of their slow maturity, low fecundity, and vulnerability to bottom trawls (NEFMC 2003). This assessment by the management agency responsible for the Northeast skate fishery adds weight to the Seafood Watch® ranking of these species as "inherently vulnerable" to fishing pressure.

Inherent Vulnerability Rank:

Resilient | Moderately Vulnerable | **Highly Vulnerable**

Criterion 2: Status of Wild Stocks

In 2000, when the first preliminary stock assessment of skates was published, a severe lack of basic biological and fishing data hampered managers' attempts to assess the status of skate stocks (NEFMC 2003). As of that 2000 publication, four of the seven species of the Northeast skate complex—the barndoor, smooth, thorny, and winter skates—were "thought to be in an overfished condition" by NMFS (NEFMC 2001) because their stock biomass, estimated from the fisheries-independent trawl survey, was lower than their threshold biomass (managers' best estimate of the minimum stock size that could support a sustainable yield).

The 2003 Skate FMP requires annual stock status reviews of Northeast skates. The first such review was published in February 2005 (NEFMC 2005). The most recent assessments, the 2008 Stock Assessment and Fishery Evaluation Report (SAFE) and the NEFMC Amendment 3 to the

Skate FMP, were published in September 2008 and November 2009, respectively. According to the 2009 report, the NEFMC no longer considers any of the skates except thorny skate and the smooth skate to be overfished (Figure 5).

Skate Management Reference Points

After the 30th Northeast Regional Stock Assessment Workshop (SAW 30) analysis in 2000, the NEFMC's Scientific and Statistical Committee (SSC) reviewed the proposed management reference points for skates. "The SSC concluded that fishing mortality-based reference points currently could not be adequately estimated in a way that can inform management, because although it might be possible to calculate F_{MAX}, there is not a reliable time-series of fishing mortality estimates to compare with F_{MAX}" (NEFMC 2003). Reliable estimates of MSY and overfishing await development of a reliable estimate of fishing mortality (F), which will require several seasons of fisheries-dependent data collection. Nonetheless, the 2009 Skate FMP proposed to initiate "rebuilding of smooth skate (which recently became overfished), promoting rebuilding of thorny skate (which has been overfished since plan implementation), stopping overfishing of thorny skate, preventing overfishing, and preventing other skate stocks (namely smooth and winter skate) from becoming overfished" (NEFMC 2009a).

The NEFMC notes that development of a reliable value for F for each skate species depends on two factors: collection of species-specific catch data; and expansion of reporting to cover all segments of the fishery. In 2003, at the time of the implementation of the Skate FMP, managers estimated that as much as 40% of skate landings might go unreported (NEFMC 2003). At present, the majority of reported skate landings come from vessels fishing federal waters and taking skates as incidental catch in the groundfish trawl fishery or the monkfish gillnet fishery (NEFMC 2003). As skates are not a primary target of these vessels, managers consider it likely that these data are incomplete, especially in their regard to discards of skates (NEFMC 2003). Skate fishing within state waters is completely untracked; the extent of offshore sales between small skate vessels and lobster boats is unknown (NEFMC 2003). It is unknown to managers whether there is any directed fishing for skates, but input from fishermen suggests that there might be small boats based in state waters that make skates their primary target. Without complete knowledge of the fishery, managers can do little to protect the resource. The NEFMC states that one of the most important objectives of the 2003 Skate FMP was to set up channels for collecting complete and reliable data on skate landings and discards in all segments of the fishery (NEFMC 2003).

It is important to note that stock status for the skates of the Northeast skate complex cannot be accurately determined using conventional methods, due to a lack of species-specific catch and effort data (NEFSC 2003). Fishing mortality remains undefined for most skate species; MSY cannot be calculated; and MSY proxies "unfortunately…cannot be used for skates at this time because the basic information needed to develop them is not currently available" (NEFSC 2003). The "precautionary measures" offered by managers—best guesses for overfished/overfishing thresholds—are based on the fisheries-independent groundfish trawl survey, which began in 1963 and managers now conduct three times a year (NEFMC 2003).

Management estimates the status of each skate species using the wealth of groundfish trawl survey data. For each species, indices of relative abundance have been developed. In the absence of fishing-effort data, there is no way to relate changes in abundance to changes in fishing effort (NEFSC 2003). However, managers developed a way for estimating B_{MSY} from the data they had.

Managers have noted that the highest abundance of skates recorded in their trawl surveys might possibly represent the abundance of a stock essentially untouched by fishing effort—a proxy for each stock's unexploited biomass, also known as its ecological carrying capacity, K. In management models, B_{MSY} is set as one-half of K. Therefore, B_{MSY} might be estimated as 50% of the highest recorded abundance (NEFSC 2003). On the other hand, the highest recorded abundance of skates might represent equilibrium between fishing effort and stock productivity—in other words, the highest recorded abundance might be B_{MSY}, or, put another way, B_{MSY} might be estimated as 100% of the highest recorded abundance (NEFSC 2003). Without fisheries-dependent data, managers had no way of knowing which of these scenarios was closer to the truth. Therefore, they decided to split the difference. They assumed that B_{MSY} was 75% of the highest recorded abundance. They then set the overfished threshold—the abundance below which the stock must be considered overfished—at one-half of that B_{MSY} value (NEFSC 2003).

When the Skate FMP was developed, the target biomass reference points (B_{MSY} proxy) for all skate species except the barndoor skate and little skate were the 75th percentile of the biomass index calculated in the NEFMC autumn survey data through 1997. For the little skate, the target biomass reference point was the 75th percentile of the biomass index calculated in the NEFMC spring survey data through 1998. For the barndoor skate, the target biomass reference point was the mean value of the autumn biomass index from 1963-1966. In each case, the overfished threshold was one-half of the B_{MSY} proxy (NEFSC 2003). The NEFMC may periodically change either the selected reference time series, the survey used for the determination, or the selected strata, following review and approval of the Council's Scientific and Statistical Committee (SSC). Recently, the Data Poor Assessment Workshop considered the issue of updating the skate reference points because a considerable amount new data had accumulated since the development of the Skate FMP. They had no reason to believe that the most recent decade of survey data shouldn't be part of that time series. The SSC reviewed the workshop's recommendations and agreed that there was no reason to exclude the new data from the selected reference time series at this time. Therefore, the skate reference points have been updated (NEFMC 2009a). The barndoor skate's target biomass reference point has not changed, but for all other species except the little skate, the target biomass reference points are now the 75th percentile of the biomass index calculated in the NEFMC autumn survey data through 2007. For the little skate, the target biomass reference point is the 75th percentile of the biomass index calculated in the NEFMC spring survey through 2008. In each case, the overfished threshold is one-half of the B_{MSY} proxy (NEFSC 2009). The updated reference points are listed in Table 2 below. As a result of this update, the biomass targets and thresholds increased for 3 species, declined for 3 species, and remained the same for the barndoor skate (NEFMC 2009a).

In order to determine whether overfishing is occurring, the [2003 Skate] FMP implemented specific criteria for each species. The most recent three-year moving average is compared to the three-year moving average from the year before, and each species has a specific percent change

value assigned to it. The 2002-2004 three-year moving average is compared to the 2001-2003 average, and if the difference is greater than the percent change identified for a specific species, then overfishing is occurring for that stock. For example, if the 2002-2004 average is 30% less than the 2001-2003 average for barndoor skate, then overfishing is occurring for that species (NEFMC 2005). The value ranges from a 20% decline in the three year moving average of biomass for little, thorny, and winter skates to a 60% decline in the three year moving average of biomass for rosette skate (Table 2) (NEFMC 2009a).

Table 2. Updated biomass and fishing mortality reference points for skates in the management unit (Table from NEFMC 2009).

SKATE SPECIES	TARGET BIOMASS B_{target} (kg/tow)	THRESHOLD BIOMASS $B_{threshold}$ (kg/tow)	TARGET FISHING MORTALITY F_{target}	THRESHOLD FISHING MORTALITY $F_{threshold}$
Winter	5.60	2.80	N/S	A decline of **20% or more** in the three-year moving average of the autumn trawl survey, or a decline in the autumn survey mean weight per tow for three consecutive years
Little	7.03	3.51	N/S	A decline of **20% or more** in the three-year moving average of the spring trawl survey, or a decline in the spring survey mean weight per tow for three consecutive years
Barndoor14	1.62	0.81	N/S	A decline of **30% or more** in the three-year moving average of the autumn trawl survey, or a decline in the autumn survey mean weight per tow for three consecutive years
Thorny	4.12	2.06	N/S	A decline of **20% or more** in the three-year moving average of the autumn trawl survey, or a decline in the autumn survey mean weight per tow for three consecutive years
Smooth	0.29	0.14	N/S	A decline of **30% or more** in the three-year moving average of the autumn trawl survey, or a decline in the autumn survey mean weight per tow for three consecutive years
Clearnose	0.77	0.38	N/S	A decline of **30% or more** in the three-year moving average of the autumn trawl survey, or a decline in the autumn survey mean weight per tow for three consecutive years
Rosette	0.048	0.024	N/S	A decline of **60% or more** in the three-year moving average of the autumn trawl survey, or a decline in the autumn survey mean weight per tow for three consecutive years

The 2008 survey biomass relative to previous years and the current overfished and overfishing designations for barndoor, clearnose, little, rosette, smooth, thorny and winter skates are shown in Figure 5. The 2008 survey biomass for barndoor and thorny skates was close to the same as it was in 2007. Barndoor skate is still rebuilding to the MSY target and thorny skate is still overfished. The 2008 biomass for smooth skate has declined by 7.6%, below the minimum biomass threshold and is once again considered overfished. Rosette skate biomass declined by 18.9%, but is above the biomass target and therefore is not considered overfished. Little, clearnose, and winter skate biomass increased and none of these species are considered overfished (NEFMC 2009a).

	BARNDOOR	CLEARNOSE	LITTLE	ROSETTE	SMOOTH	THORNY	WINTER
Survey (kg/tow) Time series basis Strata Set	Autumn 1963 – 1966 Offshore 1 – 30, 33-40	Autumn 1975-1998 Offshore 61-76, Inshore 15-44	Spring 1982-1999 Offshore 1-30, 33-40, 61-76, Inshore 1-66	Autumn 1967-1998 Offshore 61-76	Autumn 1963-1998 Offshore 1-30, 33-40	Autumn 1963-1998 Offshore 1-30, 33-40	Autumn 1967-1998 Offshore 1-30, 33-40, 61-76
1997	0.11	0.61	2.71	0.01	0.23	0.85	2.46
1998	0.09	1.12	7.47	0.05	0.03	0.65	3.75
1999	0.30	1.05	9.98	0.07	0.07	0.48	5.09
2000	0.29	1.03	8.60	0.03	0.15	0.83	4.38
2001	0.54	1.61	6.84	0.12	0.29	0.33	3.89
2002	0.78	0.89	6.44	0.05	0.11	0.44	5.60
2003	0.55	0.66	6.49	0.03	0.19	0.74	3.39
2004	1.30	0.71	7.22	0.05	0.21	0.71	4.03
2005	1.04	0.52	3.24	0.07	0.13	0.22	2.62
2006	1.17	0.53	3.32	0.06	0.21	0.73	2.48
2007	0.80	0.85	4.46	0.07	0.09	0.32	3.71
2008	1.09	1.73	7.34	0.03	0.10	0.21	9.50
2002-2004 3-year average	0.88	0.75	6.72	0.04	0.17	0.63	4.34
2003-2005 3-year average	0.96	0.63	5.65	0.05	0.18	0.56	3.34
2004-2006 3-year average	1.17	0.59	4.59	0.06	0.19	0.55	3.04
2005-2007 3-year average	1.00	0.64	3.67	0.06	0.14	0.42	2.93
2006-2008 3-year average	1.02	1.04	5.04	0.05	0.13	0.42	5.23
Percent change 2006-2008 compared to 2005-2007	1.9	62.9	37.2	-18.9	-7.6	-1.2	78.2
Percent change for overfishing status determination in FMP	-30	-30	-20	-60	-30	-20	-20
Biomass Target	1.62	0.77	7.03	0.048	0.29	4.12	5.6
Biomass Threshold	0.81	0.385	3.515	0.024	0.145	2.06	2.8
CURRENT STATUS	Not Overfished Overfishing is Not Occurring	Not Overfished Overfishing is Not Occurring	Not Overfished Overfishing is Not Occurring	Not Overfished Overfishing is Not Occurring	Overfished Overfishing is Not Occurring	Overfished Overfishing is Not Occurring	Not Overfished Overfishing is Not Occurring

Figure 5. Survey biomass trends and skate status determinations as of 2008 (Table from NEFMC 2009).

Management of Overfished/Rebuilding Stocks

For overfished skate species, the NEFMC monitors the trawl survey index as a proxy for stock biomass. As long as the three-year average of the species' weight per tow increases above the average for the previous three years, it is assumed that the stock is rebuilding to target levels (NEFMC 2005). If the three-year average of the appropriate survey mean-weight per tow declines below the average for the previous three years, then the NEFMC must take management action (NEFMC 2005).

Status of the Barndoor Skate

NMFS' fishery-independent surveys show that the barndoor skate was at its highest abundance in the 1960s, declining to historic lows in the 1980s (NOAA Fisheries 2004). In 1998, Casey and Myers brought this decline to the attention of the world, and linked the decline of the barndoor skate to the rise of directed trawl fisheries for skate and dogfish (Casey and Myers 1998). Under legal pressure from environmental groups, the barndoor skate has been considered for listing as threatened or endangered by both U.S. and Canadian fisheries managers (Federal Register 2002; DFO 1999). The International Union for the Conservation of Nature (IUCN) listed barndoor skate as a "vulnerable" species as early as 1994 (IUCN 2005) and, in 2003, listed the species as "endangered" (IUCN 2005).

Based on the available data, U.S. populations of barndoor skate were believed to be badly overfished when the 2003 Skate FMP was published (NEFMC 2003). Managers had proposed a target biomass of 1.62 kg/tow (the MSY level) and a minimum biomass threshold of 0.81 kg/tow (the overfishing threshold) for barndoor skate (NEFMC 2003). While NMFS' annual surveys showed an increasing trend in the late 1990s, absolute population was still very low, averaging 0.08 kg/tow in the 1996-1998 triennium and 0.17 kg/tow in updated figures for 1997-1999 (NEFMC 2003). The barndoor skate was listed as a species of special concern in 1998, and its decline has been seen as indicative of a trend likely to befall other skate species (NEFMC 2004).

However, two 2002 analyses by Canadian management scientists suggest that barndoor skate populations may have been underestimated by a factor of 10 (Kulka, Frank, and Simon 2002; Simon, Frank, and Kulka 2002). These studies combined Canadian management survey data with fisheries bycatch data collected by on-board observers in Canada's commercial trawl, longline, and other fisheries. While 99% of the Department of Fisheries and Oceans Canada (DFO) management surveys are conducted at depths of less than 450 meters, commercial fishers often venture deeper (Kulka, Frank, and Simon 2002). In the waters surveyed, barndoor skates are more common at depths greater than 1000 meters and are found as deep as 1600 meters (Simon, Frank, and Kulka 2002). A seminal reference used by both Canadian and U.S. managers asserts that skates are found no deeper than 400 meters (Bigelow and Schroeder 1953); however, analysis of observer-collected bycatch data revealed that both catch rate and percent-occurrence-per-set of barndoor skates in Canadian waters was ten times higher at depths greater than 450 meters. The authors relate the preferred depth of barndoor skate to water temperature. They affirm that Canadian management surveys documented a real decline in barndoor skate between the 1950s and 1990s in the shallower waters where management surveys take place; however, they conclude that the population has not declined, but moved deeper because of a gradual shift in water temperatures across the decades (Simon, Frank, and Kulka 2002). They also note that bycatch data reveals that the barndoor skate now ranges considerably further north than indicated by management surveys (Kulka, Frank, and Simon 2002). They conclude: "Collectively, the review of these data suggests that barndoor skate is sufficiently numerous to ease concerns about its conservation status" (Simon, Frank, and Kulka 2002).

The study conducted by Gedamke, DuPaul, and Musick (2005), which was discussed in Criterion 1, also provides evidence that the barndoor skate is better off than previously believed. In analyzing vertebral samples from barndoor skates taken as bycatch in commercial scallop dredges on the southern Georges Bank, Gedamke, DuPaul, and Musick (2005) determined that female barndoor skates mature at between 6.5 and 7.2 years of age and male barndoor skates at between 5.3 and 6.3 years, considerably younger than the 11 years determined for the European common skate. Gedamke, DuPaul, and Musick (2005) also found the barndoor skate's *k* value to lie between 0.14 and 0.18, considerably higher than the *k* value for the European common skate of 0.05. These results suggest that barndoor skate populations may be capable of quicker recovery than previously thought (Gedamke, DuPaul, and Musick 2005). However, the authors did caution that their samples were taken in a small, southerly, shallow-water portion of the range of the barndoor skate; therefore, the growth parameters they found may not apply across the barndoor skate's entire range (Gedamke, DuPaul, and Musick 2005). Also, the authors did not suggest that the barndoor skate is robustly resilient to fishing pressure, merely that its resilience may be more than previously believed (Gedamke, DuPaul, and Musick 2005). While

their new data suggest that the barndoor skate is not in imminent danger of extinction on the eastern Georges Bank, the authors concluded their paper with the caution that "the life history of this elasmobranch still renders it much more vulnerable to overharvest than the vast majority of bony fishes" (Gedamke, DuPaul, and Musick 2005).

The IUCN's Red List of Threatened Species, updated January 2005, lists barndoor skate as "endangered" (IUCN 2005). While aware of the new data expanding the range and depth at which the barndoor skate is now known to occur, IUCN scientists make the precautionary assumption that the deeper-water populations are much smaller than the shallow-water segments of the stock (IUCN 2005).

The barndoor skate is one of the two New England skates currently in a rebuilding program, the other being the winter skate (NEFMC 2005, NEFMC 2009a). The barndoor skate's 2006-2008 three-year average for the trawl survey index was 1.02 kg/tow (Figure 6). This skate's latest biomass index showed a rapid and significant rebuilding trend from 1999-2006, with a slight decrease since then (Figure 6) (NEFMC 2009a). The latest fall bottom survey shows that the barndoor skate's biomass is at a threshold level of 0.81 kg/tow, 62% of MSY (NEFMC 2009a). As of 2009, barndoor stock status is not overfished, nor is overfishing occurring. The stock continues to be rebuilding (NEFMC 2009a).

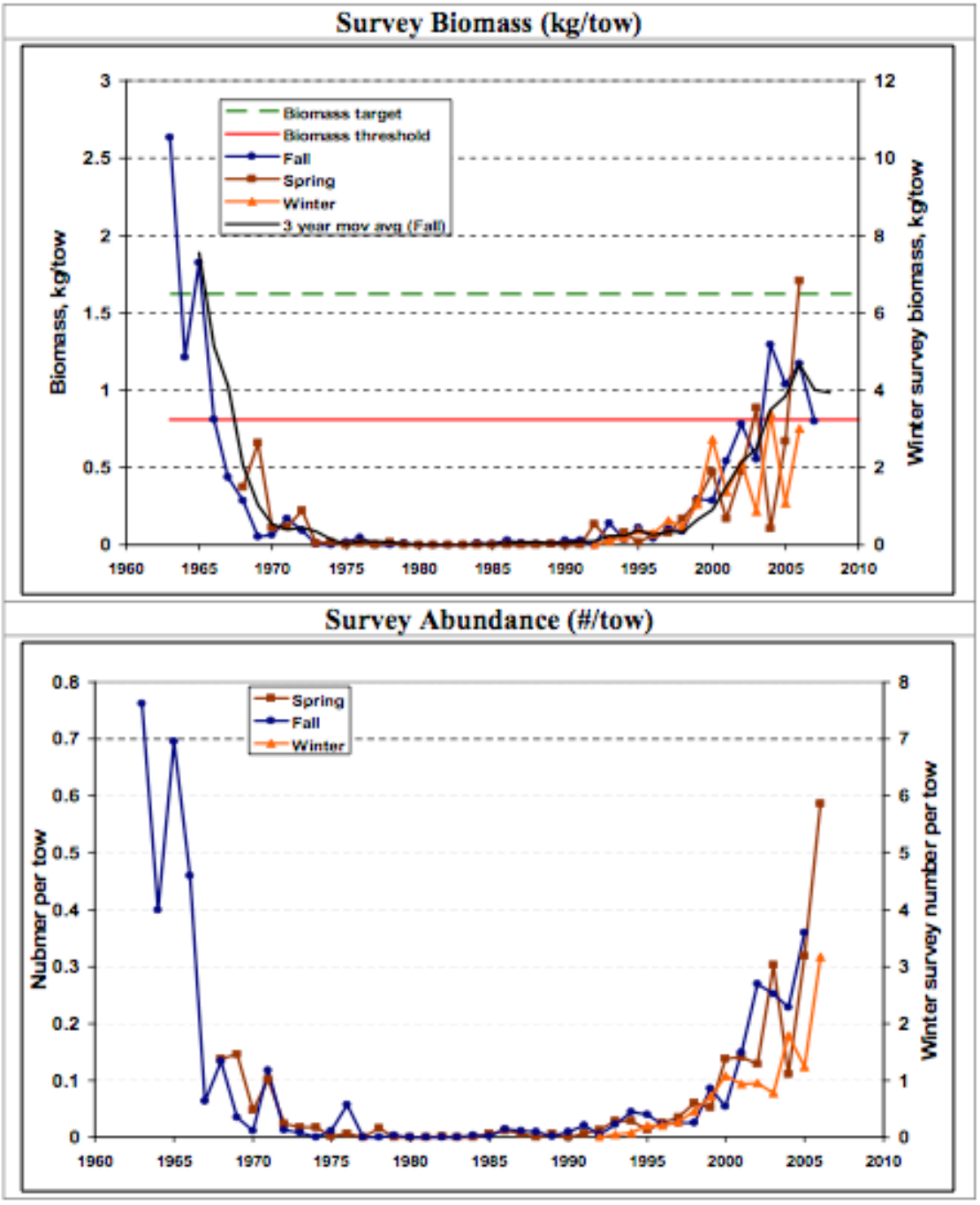


Figure 6 Abundance and biomass of barndoor skate from the NESFC spring and fall bottom trawl surveys from 1963-2006.. Source: SAFE Report 2008 (NEFMC 2009). Note that the 2006-2008 three-year average for the trawl survey index was 1.02kg/tow above the biomass threshold but below the biomass target.

Status of the Winter Skate

According to the NEFMC, winter skate is the primary species caught for skate wings and comprises 10% of bait skate landings (NEFMC 2005). In 2000, overfishing was thought to be occurring on the winter skate (NMFS 2004). In the 2003 Skate FMP, managers stated: "Fishing mortality estimates for winter skate are not considered to be reliable, so it is not possible to determine whether or not overfishing is still occurring on winter skate" (NEFMC 2003). In 2006, the NEFMC considered the winter skate "not overfished" with "overfishing occurring" (NEFMC 2006), as this large skate is the primary species caught commercially (NEFMC 2005). Winter skate abundance and biomass indices from the NEFSC autumn surveys were stable but very low during the 1960s and 1970s, increased and peaked in the mid 1980s, and began to decline in the late 1980s (Figure 7). The 2006- 2008 fall surveys of winter skate biomass showed an increase of 78.2%, as compared to the 2005-2007 fall surveys. While the most recent (fall) stock biomass survey (3.71 kg/tow in 2007) was still below the biomass target of 6.46 kg/tow, it was above the biomass threshold of 3.23 kg/tow (Figure 7) (NEFMC 2009a). The most recent stock assessment indicates that winter skate is not overfished, nor is overfishing occurring. The stock is rebuilding (NEFMC 2009a).

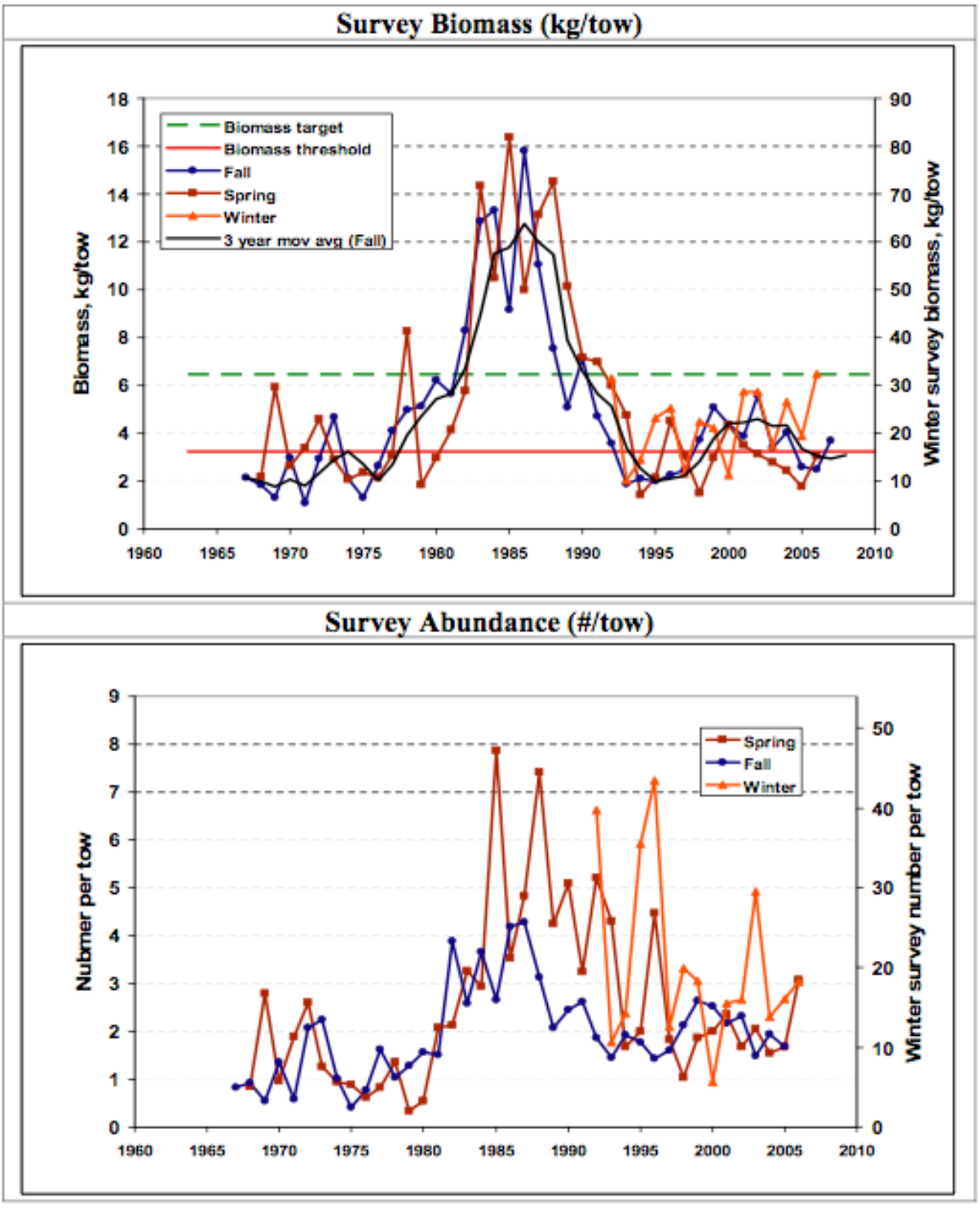


Figure 7. Abundance and biomass of winter skate from the NESFC spring and autumn bottom trawl surveys from 1967-2007 in the Gulf of Maine to Mid-Atlantic offshore region (Figure from SAFE Report 2008). Note that the most recent fall survey (blue line) shows biomass at 3.71kg/tow, below the biomass target but above the biomass threshold (top figure).

Status of the Thorny Skate

In 2000, overfishing was thought to be occurring on the thorny skate. Further analysis and three years of additional data showed thorny skate to be in an ongoing overfished condition at the time that the 2003 Skate FMP was published (NEFMC 2003). Although more research has been focused upon the barndoor skate, some authorities consider the thorny skate population to be in worse shape (Gedamke 2005). By 2004, the thorny skate was considered a "species of special concern"[1] by NMFS (NMFS OPR 2004). The thorny skate's 2004-2006 three-year average for the trawl survey index was 0.55 kg/tow. The target biomass level for the thorny skate is 4.12 kg/tow. However, current biomass indices of thorny skate show a decline from 0.55 kg/tow to 0.42 kg/tow (2006-2008 average), which is more than the maximum 20% decline that defines overfishing (NEFMC 2009a). As of April 2009, the thorny skate is 80% below the threshold level of 2.06 kg/tow (Figure 8). The stock is considered overfished but is not experiencing overfishing (NEFMC 2009). The NEFMC concedes that this stock is rebuilding more slowly than that of the barndoor skate (NEFMC 2005). NEFMC (2009a) estimates that the rebuilding period for thorny skate will be defined at 25 years, which is calculated to be "10 years plus one generation time".

[1] The definition of "species of special concern" varies across different state and federal fisheries and wildlife management agencies, but generally indicates strong and credible scientific evidence that the species is in a state of population decline (CA DFG 2005; MN DNR 2005; NPS 2005; NOAA Fisheries 2004; NOAA Fisheries 2005). "Special concern" is one level of concern below a listing of "threatened" under the U.S. Endangered Species Act (ESA). Species of special concern are not afforded any special protection under the ESA, but are singled out for special attention or protection by state or federal management agencies (CA DFG 2005; MN DNR 2005; NPS 2005; NOAA Fisheries 2004; NOAA Fisheries 2005). To round out these definitions, the term "endangered species" means any species which is in danger of extinction throughout all or a significant portion of its range; and the term "threatened species" means any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range (ESA 1973). The ESA specifies protective measures that must be put in place whenever a plant or animal is listed as threatened; such measures increase in stringency for an endangered species (ESA 1973). Under the ESA, all "take" (killing, harm, or harassment) of an endangered species must cease (ESA 1973). A listing of "species of special concern" indicates the species is judged not so rare that all take must cease, but will qualify for listing as "threatened" if its decline continues.

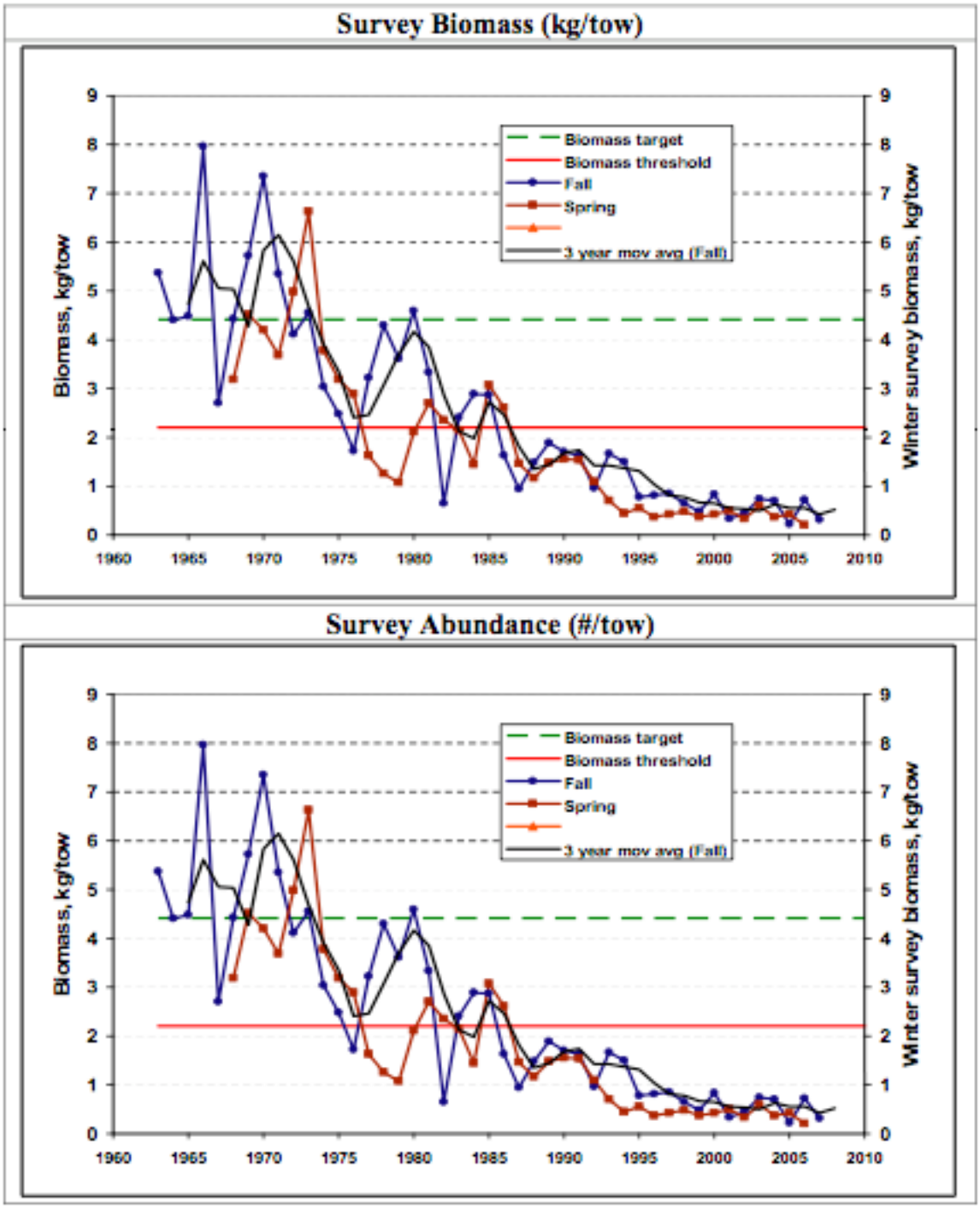


Figure 8. Thorny skate stratified mean weight and number per tow for the winter, spring, and fall NEFSC trawl surveys (Figure from SAFE Report 2008).

Status of the Smooth Skate

Fishing for smooth skate has been halted in the Gulf of Maine. In 2003, NMFS believed the smooth skate to be undergoing overfishing (NMFS 2003). By 2005, the NEFMC found that

smooth skate was not overfished and no overfishing was occurring (NEFMC 2005). Its biomass index graph shows the population had been hovering just at its overfished threshold since the early 1980s (NEFMC 2005) (Figure 9). The 2007 fall biomass survey was 0.09 kg/tow. In 2008, the smooth skate was determined to be overfished, based on the 2007 fall survey data, because the three year running average dropped below the threshold of 0.16 kg/tow (Figure 9) (NEFMC 2009a). The most recent assessment states that smooth skate is considered to be overfished, but overfishing is not occurring (NEFMC 2009a).

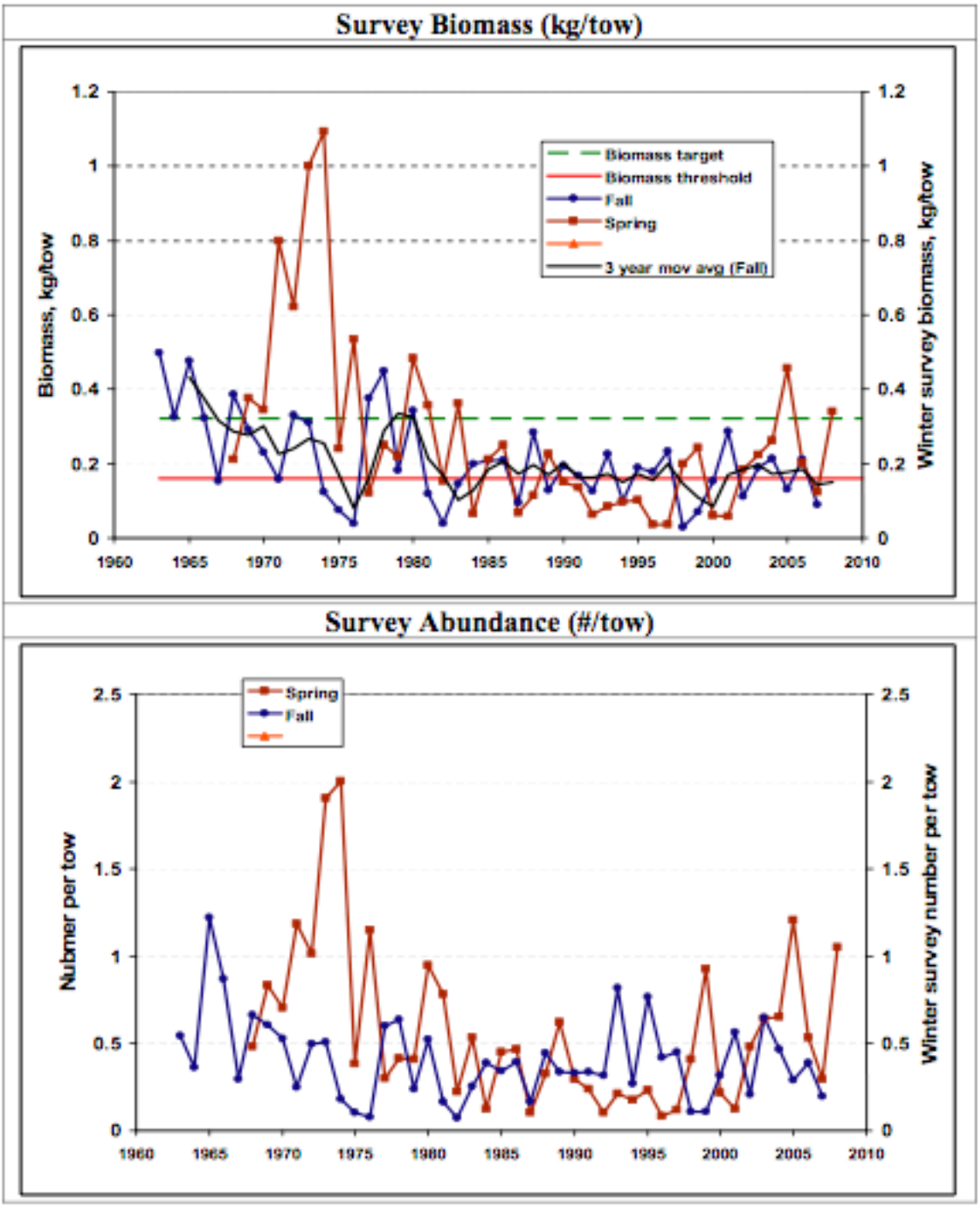


Figure 9. Smooth skate stratified mean weight and number per tow for the winter, spring, and fall NEFSC trawl surveys (Figure from SAFE Report 2008). Note that biomass from the 2007 fall survey (blue line) and three year average (black line) is below the biomass threshold (top figure).

Status of the Little, Clearnose, and Rosette Skates

Stock trends published in 2000 (Sosebee 2000) and NEFMC's 2003 analysis via the B_{MSY}-proxy method (NEFMC 2003) suggested that the little, clearnose, and rosette skates had not been

overfished. In the 2005 annual review, the little, clearnose, and rosette skates were considered "not overfished" with "no overfishing occurring" by the NEFMC (although the clearnose skate was close to its overfishing threshold) (NEFMC 2005). As of April 2009, the little, clearnose, and rosette skates remain not overfished, nor is overfishing occurring (NEFMC 2009a). The rosette and clearnose skates are above MSY while the little skate is 72% of MSY (NMFS 2010). However, all three stocks are considered to be above their respective minimum biomass thresholds (Figure 10) (NEFMC 2009a).

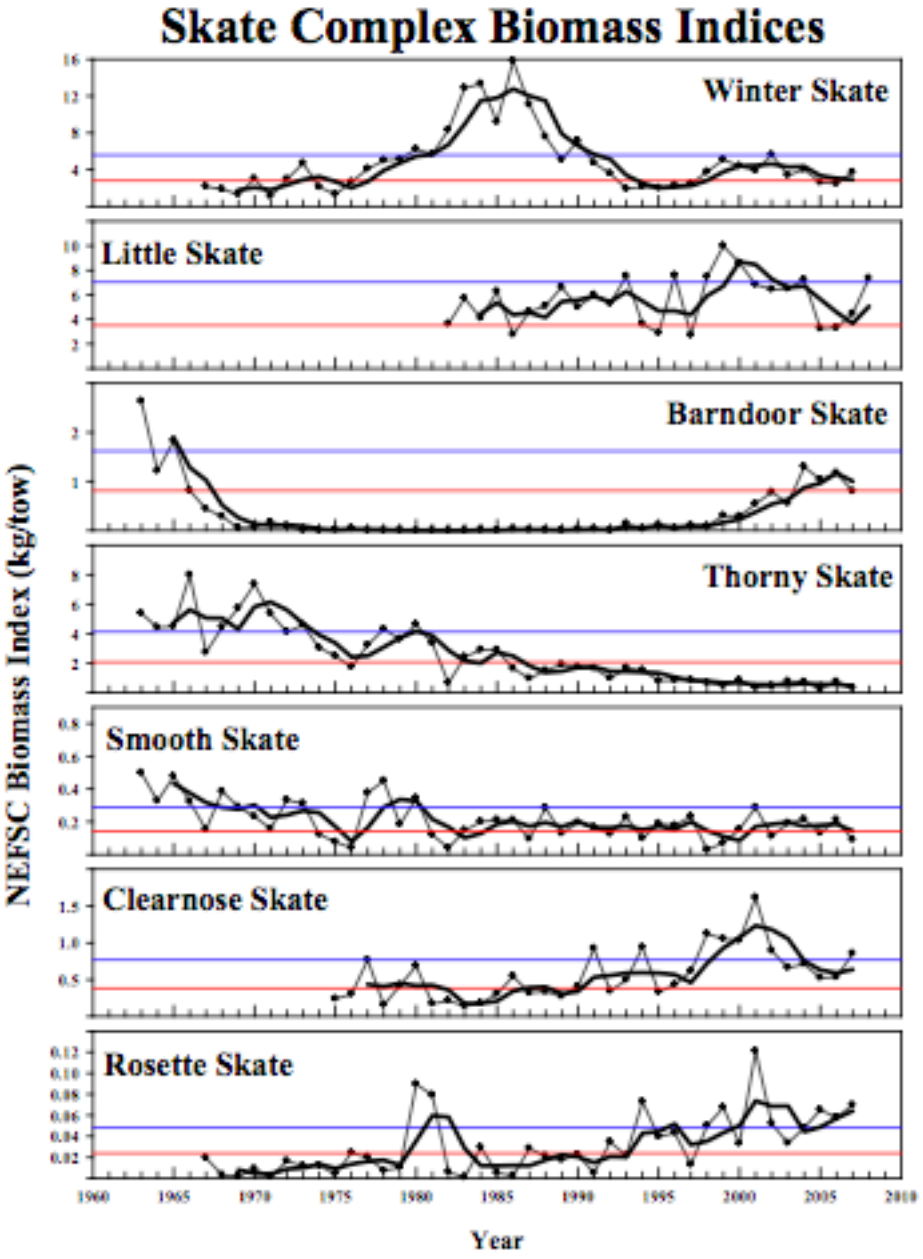


Figure 10. Skate stock biomass in kilograms/tow, 1960-2007. Thin lines with dots are annual indices; thick lines are 3-year moving averages. The red horizontal line is the biomass threshold for overfished condition and the blue horizontal line is the biomass target (Figure from NEFMC 2009a).

Synthesis

Given the many unknowns about skate stock structure and fishing mortality, it is difficult for managers to accurately assess skate stock status. The parameters for "overfished" or "overfishing" employed by managers are currently best guesses, made in the face of a severe shortage of relevant data. Fisheries data are incomplete; many of the educated guesses are based on the fisheries-independent groundfish trawl survey, which began in 1963 and which managers now conduct three times a year.

The barndoor skate has been in recognized decline for decades. In 2005, the barndoor skate was downgraded from "threatened" to "endangered" on the IUCN Red List. While new data suggest that the barndoor skate has a larger range, lower age at maturity, and faster growth rate than previously believed, scientists still consider it and other large skates extremely vulnerable to overfishing. These factors might lead Seafood Watch® to rank the status of the barndoor skate as of "critical conservation concern"; however, its latest biomass index shows a rapid and significant rebuilding trend which started about 1999 and lasted through 2006, and biomass is currently at 62% of MSY (NEFMC 2009). The species is no longer considered to be overfished and overfishing is not occurring. Although rebuilding, stock biomass has not yet to rebuild to the 1.62 kg/tow biomass target (NEFMC 2009a). The stock status of the barndoor skate therefore ranks as a moderate conservation concern.

The latest biomass index for the winter skate shows that the stock has been hovering around management minimums since the early 1990s, and since 2005, the stock has rebuilt to 93% of MSY (NEFMC 2009). Given the recent increase in stock biomass, winter skate is not overfished and overfishing is not occuring (NEFMC 2009). Seafood Watch© ranks the winter skate stock status as a moderate conservation concern.

The thorny skate has been in a steady decline for decades (NEFMC 2005). It is currently designated a "species of special concern" by NMFS. Scientists consider large skates, like the thorny skate, extremely vulnerable to overfishing. In 2009, the NEFMC declared that the thorny skate stock is overfished but not experiencing overfishing**.** Only the smallest rebuilding trend can be discerned in its biomass index, and at its current biomass (0.42 kt/tow in 2007), it is estimated that it would take an average annual increase of 13.2% to rebuild the stock to the 4.41 kg/tow target by 2028 (NEFMC 2009a). The stock status of the thorny skate therefore ranks as a critical conservation concern.

In 2009, NEFMC estimated that while no overfishing is occurring, the smooth skate is currently overfished (NEFMC 2009a). The biomass index graph shows the smooth skate population has been hovering just at its overfishing threshold since the early 1980s, but has since declined below the minimum threshold level as of 2007(NEFMC 2009a). The smooth skate's stock status is ranked as a critical conservation concern.

According to the latest fisheries-independent survey data, the clearnose, little, and rosette skates are not in short-term decline (NEFMC 2003; NEFMC 2005; NEFMC 2009a). As of 2009, the little, clearnose, and rosette skates are not overfished and overfishing is not occurring (2009). Rosette and clearnose skates are above MSY, while the little skate is 72% of MSY (NEFMC

2009). Therefore, Seafood Watch® considers rosette and clearnose skates to be a low conservation concern, and the little skate to be a moderate conservation concern.

Status of Wild Stocks Ranks:

Clearnose skate, Rosette skate:

Healthy Moderate Poor Critical

Barndoor skate, Little skate, Winter skate:

Healthy **Moderate** Poor Critical

Thorny skate, Smooth skate:

Healthy Moderate Poor **Critical**

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/or managed in some way.

Most of the skates taken in the Northeast fishery are caught with bottom trawl gear, specifically otter trawls (NEFMC FMP/EIS Errata 2003). About 60% of total skate landings are marketed for human consumption, and the majority of these are taken as incidental catch in the Northeast multispecies groundfish fishery, which uses otter trawls. The remaining 40% of skate landings are for use as bait; this bait fishery is the only directed segment of the skate fishery (NEFMC FMP/EIS Errata 2003). The vast majority (94.4%) of the skate sold as bait is taken by otter trawls, with very small amounts taken via traps, seines, scallop dredges, bottom gillnets, hook and line gear, or "unknown gear" (NEFMC FMP/EIS Errata 2003). About 3% of total skate landings are incidental catch in the directed monkfish fishery, which uses bottom-set gillnets (NEFMC FMP/EIS Errata 2003). Gillnet-caught skates may be sold for either human consumption or bait, depending on their size and market factors (NEFMC FMP/EIS Errata 2003).

In summary, the vast majority (97.7%) of Northeast skate is taken by otter trawls (Figure 11), and the Seafood Watch® evaluation of bycatch therefore focuses on the bycatch effects of otter trawling.

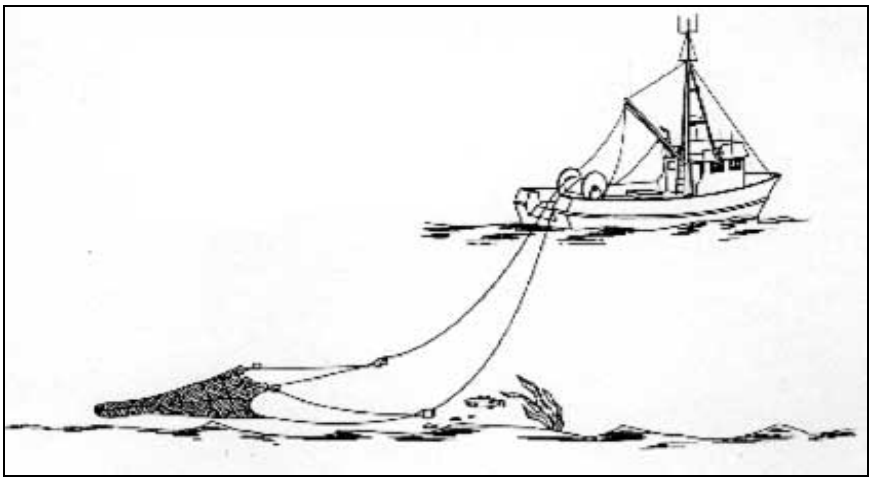


Figure 11. General diagram of an otter trawl, courtesy Matt Squillante.

About 120 vessels take part in the directed bait skate fishery, but 21 vessels take about 80% of the landings. Most of the directed skate vessels work from ports in Rhode Island (NEFMC FMP/EIS Errata 2003). These vessels make an estimated 1,300 trawling trips per year in search of skates (NEFMC FMP/EIS Errata 2003). The exact amount of effort devoted to skates in the Northeast multispecies groundfish fishery is unknown, but at last count in 2000, this fishery was composed of some 1,888 vessels (NEFMC Large-Mesh 2003)—mostly small to medium sized, 30-50 feet in length (NEFMC Multispecies FMP 2003).

The Northeast Multispecies Groundfish Fishery Management Plan covers fifteen species (nineteen stocks) of groundfish. As discussed above, most of the skate sold for human consumption is taken as incidental catch in the groundfish fishery (NEFMC 2003), and so the details of this fishery are of interest when evaluating bycatch as an issue in skate production. The species targeted by the Northeast multispecies groundfish fishery include Atlantic cod, haddock, pollock, yellowtail flounder, witch flounder, winter flounder, windowpane flounder, American plaice, Atlantic halibut, redfish, ocean pout, white hake, silver hake (whiting), red hake, and offshore hake (NEFMC Multispecies FMP 2003). The majority of these groundfish are taken by otter trawlers (NEFMC Multispecies FMP 2003). Bottom trawling is inherently unselective; in addition to the targeted species, bycatch of unwanted or undersized animals has been common in the Northeast multispecies groundfish fishery (NEFMC Multispecies FMP 2003). Bycatch mitigation measures are in place for this fishery; these include a 2002 rule requiring larger mesh sizes on many trawl nets (to allow undersized individuals to escape) (NEFMC Multispecies FMP 2003) and requirements that trawlers install bycatch reduction devices, such as the Nordmore grate (NOAA 2002). In addition, as declines in many groundfish force changes to fishing regulations, managers have taken steps to minimize “regulatory discards” of otherwise marketable fish (NOAA 2002). Northeast area groundfish trawlers are required to report all discards via logbooks, and there is some observer coverage on multispecies groundfish vessels. However, observers cover only about 5% of New England multispecies groundfish trips (NOAA Observers Website 2004). Because the fishery was unregulated before 2003, neither logbooks nor observers have ever been required on directed bait skate fishing vessels (NEFMC FMP/EIS Errata 2003), and skate data are reported only sporadically in the

multispecies groundfish fishery (NEFMC Multispecies FMP 2003). Information about bycatch and discards in skate fisheries is, at best, incomplete.

However, the Northeast Multispecies Groundfish FMP, last amended December 2003, offers some clues regarding bycatch and discard rates. In the multispecies groundfish fishery, bycatch is reported by gear type, rather than by target species (NEFMC Multispecies FMP 2003). Commercial discard estimates are available for eleven of the nineteen stocks covered by the Multispecies FMP. For some stocks, discard estimates are available for over thirty years. However, the bycatch summaries presented in the Multispecies FMP have focused on discard estimates since 1994, when new bycatch-management regulations came into force. NEFMC notes that "the precision of the estimates varies from stock to stock, as does the level of detail" (NEFMC Multispecies FMP 2003). There are no recent (post-1994) discard estimates available for halibut, pollock, redfish, windowpane flounder, or ocean pout (NEFMC Multispecies FMP 2003). For some species, recent discard estimates are available, but managers do not use them in abundance matrices because of concerns about reliability of the data; these include Georges Bank cod, Georges Bank winter flounder, white hake, and Gulf of Maine haddock. Managers have recent, reliable discard data for Gulf of Maine cod, Georges Bank haddock, yellowtail flounder (all stocks), Gulf of Maine winter flounder, Southern New England/Mid-Atlantic winter flounder, American plaice, witch flounder, windowpane flounder, and halibut (see Table 3, below).

A summary of metric tons discarded in the Northeast multispecies groundfish fishery, species by species and gear by gear, is given in Table 3, below. In general, the NEFMC considers bycatch an issue of moderate concern to New England groundfish populations. Time, area, and gear changes have all been introduced to minimize discards, but discards are not reported to be a matter of critical management concern for these fisheries (NEFMC Multispecies FMP 2003). It might be noted that where fish are sought by multiple gears, otter trawling is often the method that takes the heaviest percentage of discards (Table 4 and Figures 12, 13, and 14).

It should be noted that, in a 2000 policy statement, the American Fisheries Society expressed particular concern about the extinction risk to skates and other elasmobranches taken in mixed-species fisheries (Musick et al. 2000): "The greatest threat to sharks and rays may be from mixed-species fisheries where the sharks and rays, with lower intrinsic rates of increase, may be fished to collapse or extirpation while the more productive fishes continue to drive the fishery" (Musick et al. 2000).

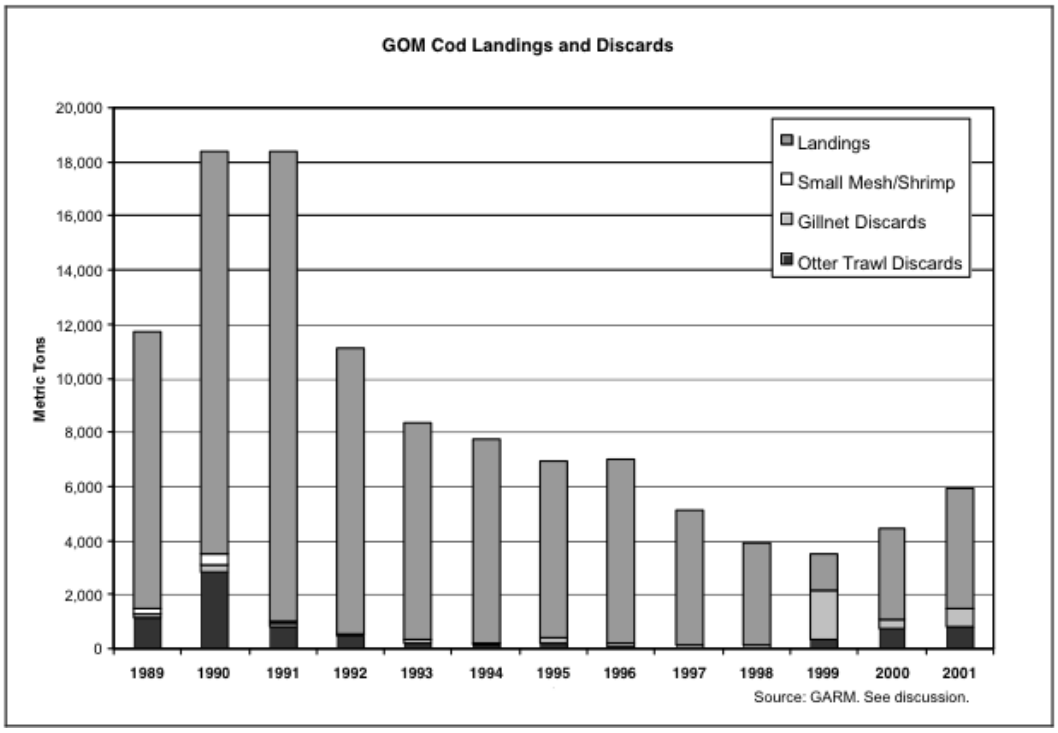


Figure 12. Estimates of discards, Gulf of Maine cod, by gear type. Note that heaviest discards are from the otter trawl fishery. (Source: NEFMC Multispecies FMP 2003)

Table 3: Estimates of discards in New England multispecies groundfish fishery, by species and gear, in metric tons. Based on 2002 measurements. (Source: NEFMC Multispecies FMP 2003)

Stock	Most Recent Estimates (mt except for Rec.)								Source
	Otter Trawl	Gillnet	Shrimp Trawl/ Small Mesh	Longline	Scallop Dredge	Rec. (number)	Landings (U.S.)	Year	
GOM Cod	828	663				724,000	4,416	2001	Comm.: GARM – 2002 Rec.: SAW – 34 (2000)
GB Cod	*199*	*56*					*10,635*	*2001*	*GARM - 2002*
GB Haddock									TRAC 2001; insignificant discards
GOM Haddock	*								SAW – 34 estimated discard rates
GB Yellowtail	44				461		3,800	2001	GARM - 2002
CC/GOM Yellowtail	446	3	4		30		2,505	2001	SAW - 36
SNE/MA Yellowtail							1,000	2001	SAW – 36: 66 mt commercial discards
GOM Winter	8	4	3			98,000	571	2001	SAW - 36
GB Winter	*27*						*1,677*	*2000*	*SAW – 34; discard estimates unreliable*
SNE/MA Winter						81,000	4,448	2001	SAW – 36; 83 mt commercial discards
Plaice	496		27				4,479	2001	GARM - 2002
Pollock									
Redfish									
White Hake	*374*	*65*					*3,482*	*2001*	*GARM - 2002*
Witch Flounder	278		0.84				3,186	2002	SAW – 37
Windowpane (north)									
Windowpane (south)									
Ocean Pout									
Halibut									

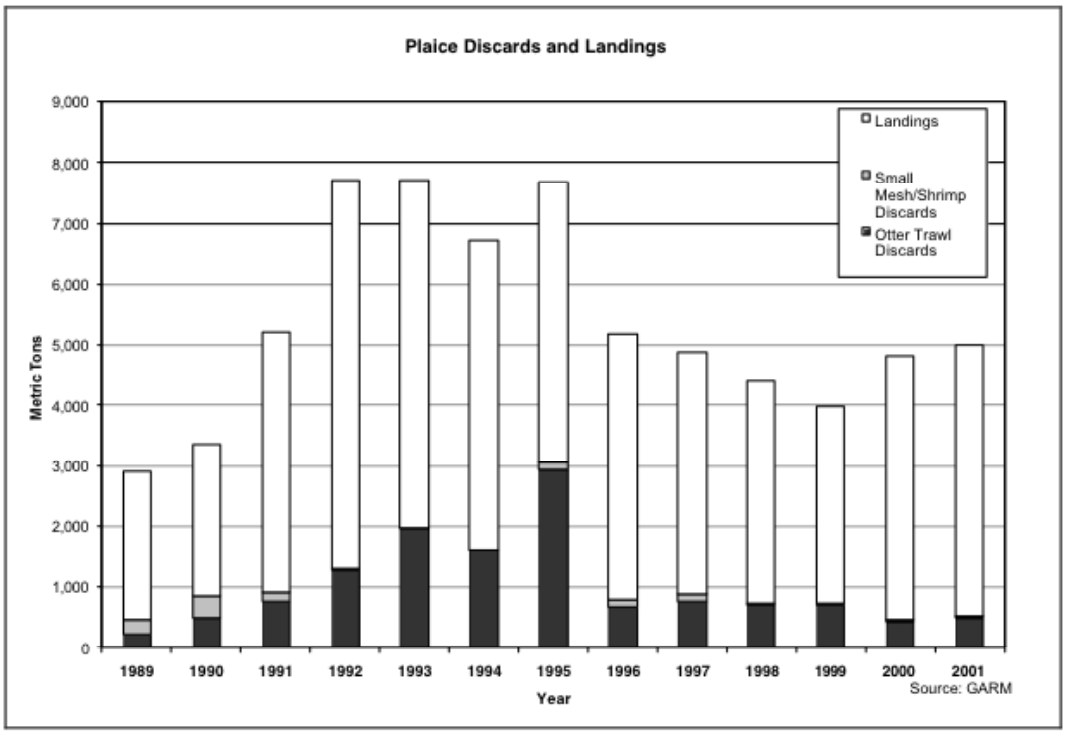


Figure 13. Estimates of discards, American plaice, by gear type. Note that heaviest discards are from the otter trawl fishery. (Source: NEFMC Multispecies FMP 2003)

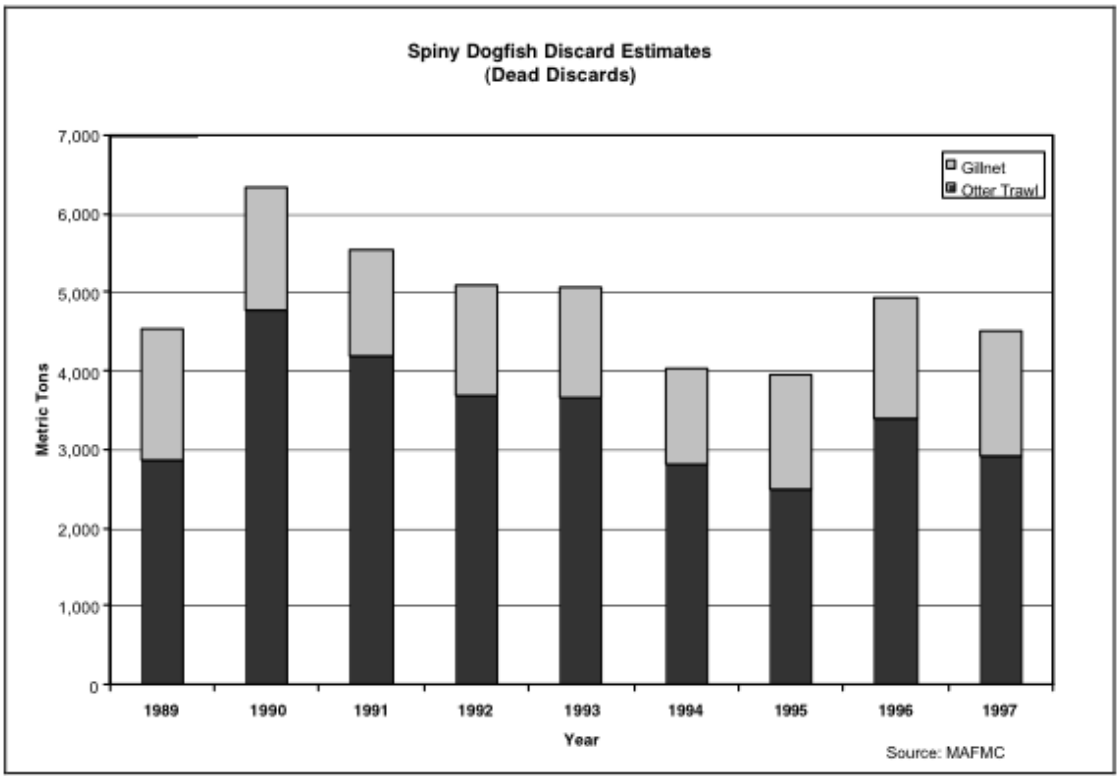


Figure 14. Estimates of discards, spiny dogfish, by gear type. Note that heaviest discards are from the otter trawl fishery. (Source: NEFMC Multispecies FMP 2003)

Skates are often discarded as bycatch by otter trawlers targeting groundfish and by dredges and trawls targeting sea scallops (NEFMC 2003). Observer data from 2000-2001 showed 720,459 skate discards in the Georges Bank scallop fishery alone (Rago 2002). Therefore, measures to track and regulate the take of skates are being worked into the Northeast Multispecies Groundfish FMP (covering most groundfishes), the Sea Scallop FMP, and the Monkfish FMP (NEFMC 2003). Managers believe that such coordinated management of skates, taking into consideration all fisheries, is critical to the rebuilding of overfished skate stocks (NEFMC 2003).

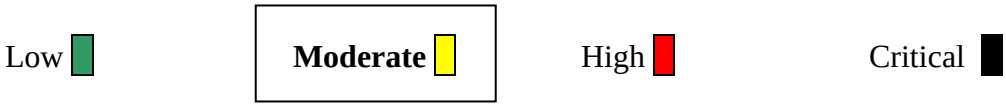
The NEFMC (2005) notes the recent implementation of several new gear modifications that should minimize bycatch of skates. In the sea scallop fishery, where 6-inch twine tops are standard on nets, the use of 10-inch twine tops had been suggested to allow finfish a better chance to escape. Ten-inch twine tops have been required for all scallop dredges since July 2004 (NEFMC 2005). In a 2003 study on Georges Bank, the 10-inch twine tops reduced all skate bycatch by median values of 38.4-47.7%. Barndoor skate bycatch was reduced by 16-56% (Smolowitz et al. 2004). This was a small study—only 16 paired-trawl passes were conducted—but the researchers concluded that there was "moderately strong evidence" that 10-inch twine tops would substantially reduce bycatch of barndoor skates in the sea scallop fishery (Smolowitz et al. 2004). Similarly, a new framework adjustment to the Northeast Multispecies FMP will require trawlers to use a haddock separator on their nets (NEFMC 2005). This gear has been shown to reduce skate bycatch significantly; a 1992 Canadian study found that separator trawls almost completely eliminated bycatch of skates (NEFMC 2005).

While interaction with cetaceans, sea turtles, and other protected species is also possible in the Northeast multispecies trawl fishery (NEFMC FMP/EIS Errata 2003), actual interactions are rare, and the fishery has consistently rated "Category III" (least risk to marine mammals) on NMFS' List of Fisheries prepared to satisfy requirements of the Marine Mammal Protection Act (NEFMC FMP/EIS Errata 2003).

Synthesis

The vast majority (97.7%) of skates are caught by otter trawling, an unselective method. Whether skates are taken as incidental catch in fisheries targeting groundfish, monkfish, or scallops, or in the directed bait fishery, otter trawling entails moderate bycatch and discards of many species. Managers are taking steps to integrate skate management with that of other groundfish species to minimize bycatch and regulatory discards. Bycatch is an ongoing concern in the Northeast multispecies groundfish fishery, and the majority of finfish discards in this mixed fishery result from the use of otter trawls. Bycatch mitigation devices are required on the groundfish vessels that take ~60% of skate. Managers have no concern about interactions with protected species in this fishery or in the directed skate bait trawl fishery; however, otter trawling remains an unselective fishing method, and bycatch of various unmarketable species will undoubtedly continue even as skate becomes part of the regulated catch. For this reason, bycatch ranks a "moderate" conservation concern for the Northeast skate complex.

Nature of Bycatch Rank:



Criterion 4: Effect of Fishing Practices on Habitats and Ecosystems

As noted in Criterion 3, the vast majority (97.7%) of Northeast skate landings are taken by otter trawls (NEFMC FMP/EIS Errata 2003). Trawling impacts sea-floor communities by scraping the seafloor and causing sediment re-suspension (turbidity), sediment smoothing, removal of and/or damage to non-target species, and destruction of three-dimensional habitat through disturbance of biotic structure (such as seafans) and abiotic structure (such as boulders) (Collie 1999; Smolowitz 1999; Auster and Langton 1999). Peer-reviewed evidence is mounting that bottom trawling can alter benthic ecosystems, as well as reduce survival of commercially-valuable marine species, by reducing or altering habitat and food resources. The degree of impact is determined by the natural resilience of the seabed, the type and weight of trawl gear, and the amount and frequency of the disturbance. Peer-reviewed studies of bottom trawling disturbance have been collected and reviewed several times in the last few years, notably by Barnette (2001), Dayton, Thrush, and Coleman (2002), and the National Research Council (2002).

Many studies on the effects of bottom trawling have focused on the heavily trawled fishing grounds in the northwestern Atlantic off the northeast coasts of the United States and Canada (Auster 1998; Auster et al. 1996; Auster and Langton 1999; Collie, Valentine, and Auster 1997; Collie 1998; Collie, Escanero, and Valentine 1997; Collie et al. 2000; Fogarty and Murawski 1998; Frid, Clark, and Hall 1999; Gilkinson, Paulin, Hurley, and Schwinghamer 1998; Gordon et al. 1998; Langton 1998; Lindholm, Auster, and Kaufman 1999; Messieh, Rowell, Peer, and Cranford 1991; Norse and Watling 1999; Pilskaln, Churchill, and Mayer 1998; Prena et al. 1999; Snelgrove 1999; Thrush et al. 1998; Veale et al. 2000; Watling and Norse 1998). Prena et al. (1999) conducted an experimental trawl study on the Grand Banks off Newfoundland and reported that otter trawling on sandy substrate produced detectable changes to both benthic habitat and benthic communities. They particularly note a significant reduction in the biomass of large epibenthic fauna. At a 2002 workshop assessing the effects of fishing gear on northeastern U.S. marine habitats, experts concluded that the greatest impacts from otter trawls occur in gravel habitats and hard clay outcroppings (NOAA 2002). Collie (1999) demonstrated that undisturbed gravel bed sites exhibit higher species abundance, biomass, and diversity than those disturbed by trawling or dredging. Undisturbed areas are characterized by fragile species such as sponges, nudibranches, worms, and small fish, while sites that have been trawled or dredged are dominated by such scavengers as hermit crabs and sea stars (Collie 1999). While gravel habitats that have been trawled or dredged can recover, it takes a minimum of six months for recovery to begin (Collie 1999).

The degree of disturbance to the seabed depends on substrate type (rock, sand, mud, etc.) and gear type (dredge, beam, otter trawl, etc.). Some types of trawl gear cause less damage, and some substrates—and their associated ecosystems—are more resilient in the face of disturbance. In a review of fishing effects on marine habitat, Collie et al. (2000) found that fauna associated with coarse, sandy sediments were less affected by disturbance than those in soft, muddy sediments or rocky habitats. Recovery rates were slower in muddy and rocky habitats, while mobile sandy sediment communities withstood two or three trawl passes per year without significant adverse change (Collie et al. 2000).

The bathymetry of the Atlantic continental shelf is such that East Coast groundfish trawlers encounter all three types of substrate (i.e., rock, sand, and mud) (see Appendix I). Therefore, habitat effects of the Northeast multispecies groundfish trawl fishery range from moderate to severe, depending upon the type of substrate trawled. As noted above, about 60% of skate landings are taken as incidental catch in this fishery (NEFMC FMP/EIS Errata 2003). Offshore otter trawling has been ranked as causing less disturbance than other types of bottom fishing, such as inter-tidal trawling and scallop dredging (Collie et al. 2000; NOAA 2002).

The NEFMC examined the habitat effects of the directed fishery for skates (bait fishery) and concluded that the habitat effects of this relatively small fishery were insignificant compared to the impacts of other directed trawl fisheries in New England (NEFMC FMP/EIS Errata 2003). They noted that most of the directed skate fishery takes place off Rhode Island over sandy sediments. The NEFMC concluded that habitat effects of this fishery are moderate, and that no special provisions are required to protect essential fish habitat (EFH) impacted by the bait skate fishery (NEFMC FMP/EIS Errata 2003).

The fishing grounds of the Gulf of Maine, Georges Bank, and the continental shelf off New England comprise one of the most productive oceanic ecosystems in the world. Analyses of food web structure show that this area has a higher degree of complexity and connectivity than other documented ecosystems (Brodziak and Link 2002). Consequently, heavy fishing pressure over the last few centuries has resulted in a notable shift from largely benthic fish fauna towards largely pelagic fish fauna (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 those affecting predator-prey interactions, species survival rates, decreased overall productivity, and perturbation of food web dynamics (Brodziak and Link 2002). One example is increased predation on groundfish larvae by small pelagic species such as mackerel and herring, and a shift in the dominant fish predator from cod to spiny dogfish, during the 1980s (Brodziak and Link 2002). It must be noted that, in addition to fishing impacts, environmental shifts such as climate change may be at work changing this ecosystem, and separating these effects may be impossible.

Synthesis

About 97.7% of Northeast skate landings are taken with bottom trawls. Based on the published literature noting the adverse effects of trawling on the various habitat types where skates occur, as well as the substantial amount of fishing effort along the Northeast's continental shelf over the last 50 years, Seafood Watch® concludes that trawling for benthic species (including skates) has likely substantially altered or damaged a large portion of the Northeast's seabed. The ability of the habitat to recover from trawling damage is largely unknown. Bottom trawling is suspected of causing severe adverse impact to muddy and rocky habitats off New England, where approximately 60% of the skates landed are taken. Ecosystem effects are uncertain, but likely include changes in relative species abundance and changes in trophic relationships. The effect of fishing practices on habitats and ecosystems overall ranks "severe".

Effect of Fishing Practices Rank:

Benign | Moderate | **Severe** | Critical

Criterion 5: Effectiveness of the Management Regime

Managers of the Northeast skate complex actively observe skate abundance patterns with three trawl surveys each year (spring, summer, and winter); these fisheries-independent stock data extend back to 1963 (NEFMC 2001). However, fisheries-dependent data are almost entirely lacking for all seven skate species in the Northeast skate complex (NEFMC 2003). Because skates were, until recently, considered a "trash fish" and seldom landed commercially, there were no provisions in place to collect species-specific catch and effort data. As skates have become a more important component of the New England commercial catch, and as severe declines have been recognized in several skate species, federal and state managers have moved to improve the management regime for Northeast skates. Spurred by the effort to get the barndoor skate listed as threatened or endangered under the federal Endangered Species Act, the first Northeast skate stock assessment was published in 2001, and the first Fishery Management Plan for Northeast skates was implemented in March 2003 (NEFMC 2003). Yearly stock-status updates are now required; the first was published in February 2005 (NEFMC 2005).

Dulvy et al. (2000) emphasized the importance of species-specific data in effective management of skate populations. Specifically, they noted that smaller skate species often increase in number as larger species are fished out, citing the example of Europe's northeast Atlantic skate fishery. Therefore, mere aggregate reporting of skate landings (by weight, not species) may mask severe declines of certain species within the complex (Dulvy et al. 2000). In 2003 and 2004, the NEFMC began redesigning its monitoring and reporting channels to collect species-specific catch and effort information for skates. Federal managers are also reaching out to state fisheries authorities to begin to collect data on skates taken within state waters (out to 3 miles from shore) (NEFMC 2003). Managers have been creative in devising a method to set overfished and overfishing limits based on the fisheries-independent annual surveys; however, it will be several years before managers have the necessary fisheries-dependent data to calculate a classic F and MSY for any species of the Northeast skate complex.

Skates have been less studied than traditional groundfish staples such as cod, haddock, and flounders. Managers lack many basic biological parameters for all of the skate species treated in this report. In the 2003 Skate FMP, managers reported that they could not determine fecundity or maturity for any skate species (NEFMC 2003). Managers are currently researching population structure, fecundity, and abundance of New England skates, but much information is not yet published.

All U.S. regional fisheries councils are required to prevent, mitigate, or minimize any adverse effect from fishing if there is evidence that a fishing practice is having an identifiable adverse effect on essential fish habitat (NEFMC 1998). The NEFMC has responded with closed areas

and restrictions on days-at-sea (fishing time) for sensitive habitat in the Gulf of Maine, Georges Bank, and elsewhere within the range of the seven Northeast skate species (NEFMC 1998; Boelke 2005).

Northeast area groundfish trawlers are required to report all discards via logbooks, and there is some observer coverage on multispecies groundfish vessels. However, observers cover only about 5% of New England multispecies groundfish trips (NOAA Observers Website 2004), and because the fishery was unregulated before 2003, neither logbooks nor observers have ever been required on directed skate (bait fishery) vessels (NEFMC FMP/EIS Errata 2003). Management information about bycatch and discards in skate source fisheries is, at best, incomplete.

In September 2004, parties to the North Atlantic Fishing Organization (NAFO) agreed upon total catch limits for thorny skate on the Grand Banks. This is the world's first international fishing limit for a species of skate. U.S. fisheries managers had proposed to the NAFO catch limits for thorny skate unsuccessfully in 2002 and 2003. In 2004, with leadership from U.S. and Canadian fisheries managers, NAFO members agreed to a total allowable catch (TAC) of 13,500 mt/year for thorny skate in Canadian and international waters around the Grand Banks, beginning in 2005. It should be noted, however, that NAFO scientists had called for a TAC of no more than 11,000 mt (The Ocean Conservancy 2004).

Synthesis

Until recently, Northeast fisheries managers largely ignored skates. While mangers have tracked skate abundance via groundfish surveys since 1963, the skate fishery was unregulated before 2003, and basic fisheries-dependent (catch and effort) data were never collected. This means that management is currently unable to define basic regulatory parameters such as F_{MAX} and MSY. It is known, however, that several skate species suffered drastic population declines throughout the 1980s and 1990s; in the case of the barndoor skate and the thorny skate, these declines led to listings as "species of special concern" by NMFS (and the barndoor skate has been a candidate for listing as threatened or endangered). However, over the past four years, state and federal authorities have taken significant steps to improve skate management. The first Northeast skate stock assessment was published in 2001, and the first Fishery Management Plan for Northeast skates was implemented in March 2003 (NEFMC 2003). In 2004, the NEFMC began redesigning its monitoring and reporting channels to collect species-specific catch and effort information for skates. However, it will be some years before it can be determined whether these new measures reverse the decline of Northeast skates. Because the new management measures have been in place only a short time, and because previous management practices failed to prevent the critical decline of thorny and smooth skates, management is rated as "moderately effective".

Effectiveness of Management Rank:

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

Overall Evaluation and Seafood Recommendation

All seven skate species now managed as the "Northeast skate complex" are ranked inherently vulnerable to fishing pressure, as they tend to mature late and have low fecundity. However, because these species have historically been of minor interest to commercial fishermen, basic biological parameters, including fecundity, age at maturity, and natural mortality, are uncertain or unknown for the skate species. Additionally, basic fisheries-dependent (catch and effort) data had not been collected for skates until recently. Research into life history characteristics and collection of fisheries-dependent data has just begun for the Northeast skates, and much critical data for the evaluation of inherent vulnerability and stock status of these skates is not yet available. At this time, given the information available, stock status ranks as a critical conservation concern for smooth and thorny skates, a moderate conservation concern for the barndoor, little, and winter skates, and a low conservation concern for the clearnose and rosette skates. About 98% of skates are fished with bottom trawls, an unselective method that can result in substantial levels of bycatch. However, most skate landings (60%) are taken as part of the Northeast multispecies groundfish trawl fishery, and bycatch reduction measures are in place for that fishery. Bycatch therefore ranks as a "moderate conservation concern". A wealth of peer-reviewed literature has documented bottom trawling as causing severe adverse impact to mud, gravel, and rocky seafloor habitats off New England; therefore, habitat effects rank "severe". While management has recently implemented the first Northeast skate stock assessment and the first FMP for Northeast skates, the record of skate declines and the newness of the regime lead to a management ranking of moderately effective. The critical stock status of smooth and thorny skates, and the high inherent vulnerability and severe habitat impacts for the other skates results in an overall seafood recommendation of **Avoid** for all Northeast skate species.

Table of Sustainability Ranks

	Conservation Concern			
Sustainability Criteria	**Low**	**Moderate**	**High**	**Critical**
Inherently Vulnerability			**√ All spp.**	
Status of Stocks	**√ Clearnose, Rosette**	**√ Barndoor, Little, Winter**		**√ Smooth, Thorny**
Nature of Bycatch		**√ All spp.**		
Habitat Effects			**√ All spp.**	
Management Effectiveness		**√ All spp.**		

Overall Seafood Recommendation:

Little, clearnose, rosette, barndoor, thorny, winter, and smooth skates:

Best Choice Good Alternative **Avoid**

Acknowledgements

Seafood Watch® thanks Sonya Fordham of The Ocean Conservancy, Deirdre Boelke of the New England Fishery Management Council, and Todd Gedamke of the Virginia Institute of Marine Science for reviewing this document for scientific accuracy and completeness.

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

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Appendix I. Geomorphology of the New England fishing grounds. (From NMFS 1998)

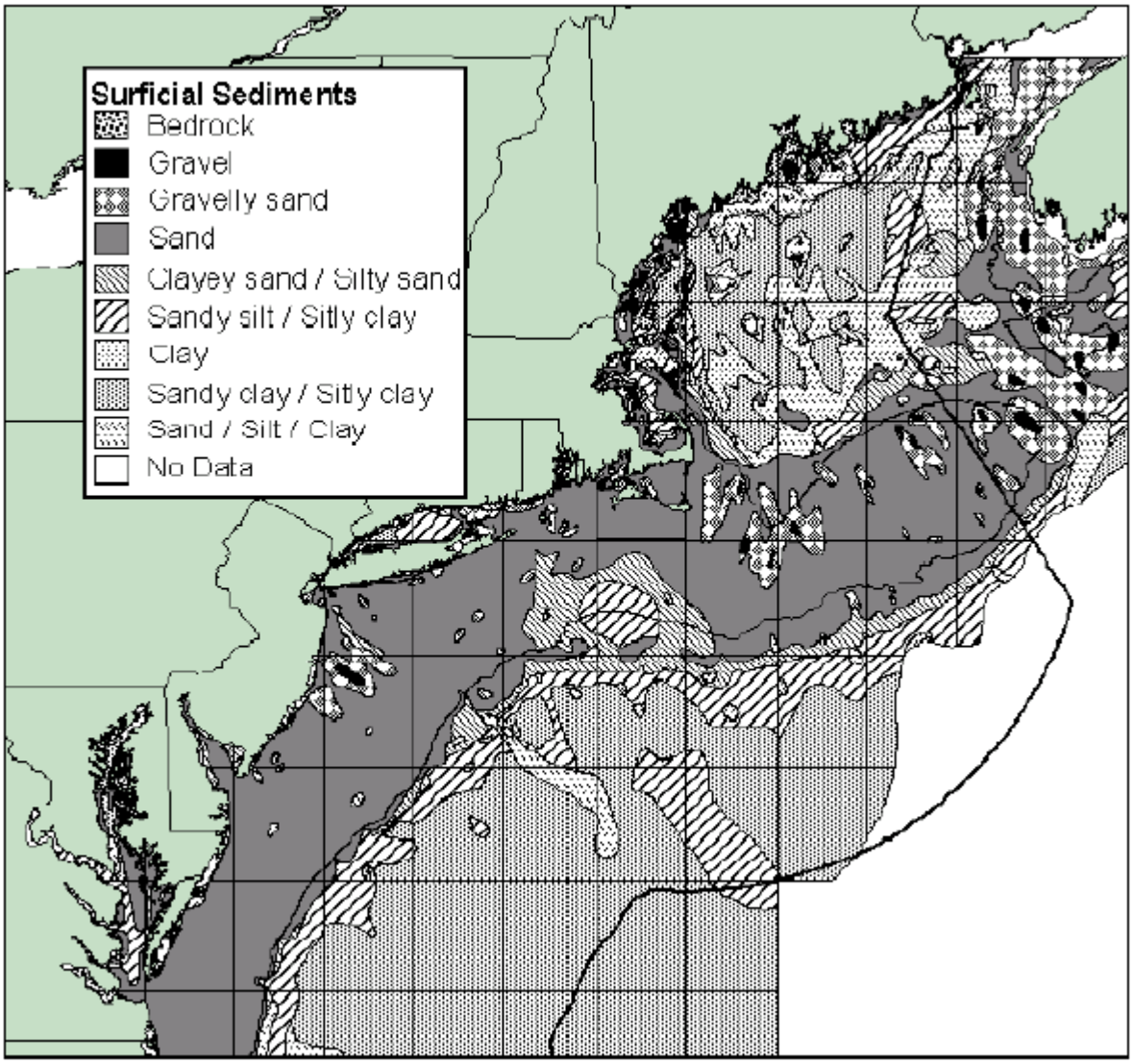

Figure 1a. Map showing distribution of surface sediments in the Gulf of Maine, Georges Bank, and Southern New England. Southern New England surface sediment distribution is similar to the Mid-Atlantic Bight region. (Figure reproduced from Poppe et al. 1989)

Appendix 2: Update to Stock Status

August 20, 2010 by Dana Wingfield

According to the 2009 Amendment 3 Report to the Northeast Skate Complex by NEFMC and the NMFS 2010 Status of US Fisheries 2nd quarter update, clearnose, little, and rosette skates are not experiencing overfishing and are not overfished. The clearnose and rosette skate stocks biomass is above MSY and are still considered healthy by Seafood Watch®. However, the little skate's biomass is only 72% of MSY; therefore, Seafood Watch® now considers the stock to be a moderate concern. The barndoor skate is no longer considered overfished, and the winter skate is no longer experiencing overfishing; therefore, both stocks are not overfished and not experiencing overfishing. Seafood Watch® has moved their stock status ranking from a high conservation concern to a moderate conservation concern. The smooth skate is now overfished but overfishing is still not occurring. However, the biomass trends are decreasing. As such, Seafood Watch® has moved the stock status of smooth skate from a high conservation concern to a critical conservation concern. The thorny skate is still considered to be a "species of special concern" by NMFS and the stock is overfished. Therefore, the status of the stock remains critical according to Seafood Watch®. The overall recommendation for skates has not changed from Avoid – smooth and thorny skates receive an Avoid recommendation due to their critical stock status, and the other skates receive an Avoid recommendation due to high inherent vulnerability and severe habitat impacts.