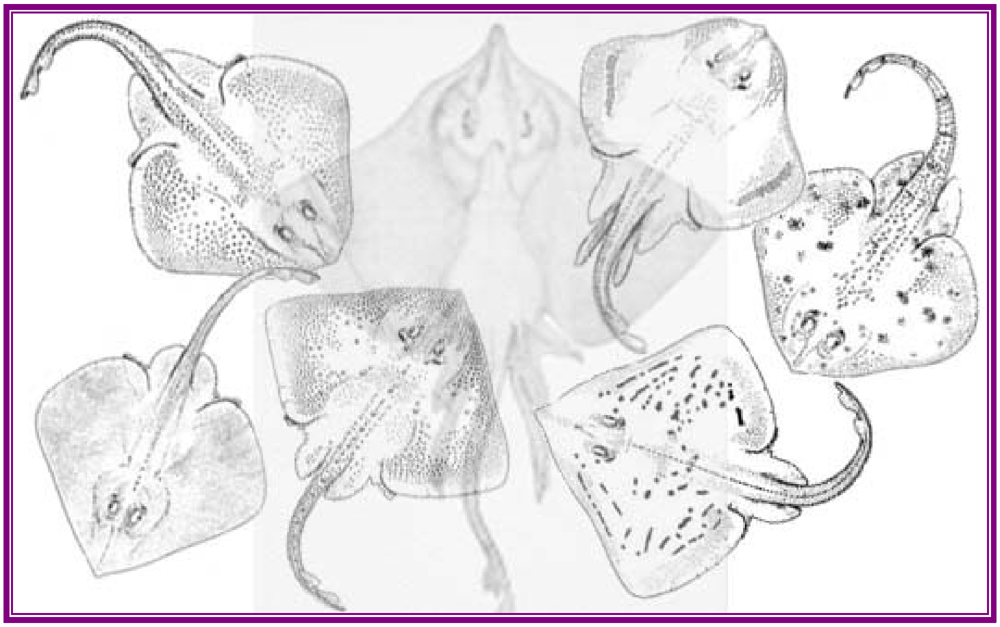
STOCK ASSESSMENT AND FISHERY EVALUATION (SAFE Report) REPORT

And

Affected Environment (FEIS) FOR SKATE AMENDMENT 3

2008



Prepared by the
New England Fishery Management Council
in consultation with
National Marine Fisheries Service

September 2008

7.0 SAFE REPORT

SAFE REPORT/AFFECTED ENVIRONMENT TABLE OF CONTENTS

7.1.1 LIST OF TABLES

7.1.2 LIST OF FIGURES

7.1.3 List of Maps

7.2 INTRODUCTION

This document serves two purposes: an update of the Stock Assessment and Fishery Evaluation Report (SAFE) and a Description of the Affected Environment (Section 7) for the Draft Environmental Impact Statement for Skate Amendment 3. Since the document serves as Section 7 of the DEIS in Amendment 3, it is numbered beginning with Section 7 in this stand-alone SAFE Report to reduce confusion. There is therefore no Sections 1-6 in the stand-alone SAFE Report.

This section is intended to provide background information for assessing the impacts, to the extent possible, of the proposed management measures on related physical, biological, and human environments. It includes a description of the stocks and the physical environment of the fishery as well as life history information, habitat requirements, and stock assessments for relevant stocks and a discussion of additional biological elements such as endangered species and marine mammals. This descriptive section also describes the human component of the ecosystem, including socioeconomic and cultural aspects of the commercial and recreational fisheries and the impacts of other human activities on the fisheries in question. Much of the information contained in this section is a compilation of information used to make choices from a range of alternatives during the development of the proposed management action.

This Stock Assessment and Fishery Evaluation (SAFE) Report was prepared by the New England Fishery Management Council's Skate Plan Development Team (PDT). It presents available biological, physical, and socioeconomic information for the northeast's region skate complex and its associated fisheries. It also serves as the Affected Environment description for the DEIS associated with Amendment 3.

Table 1 presents the seven species in the northeast region's skate complex, including each species common name(s), scientific name, size at maturity (total length, TL), and general distribution.

Table 1. Skate Species Identification for Northeast Complex

SPECIES COMMON NAME	SPECIES SCIENTIFIC NAME	GENERAL DISTRIBUTION	SIZE AT MATURITY cm (TL)	OTHER COMMON NAMES
Winter Skate	*Leucoraja ocellata*	Inshore and offshore Georges Bank (GB) and Southern New England (SNE) with lesser amounts in Gulf of Maine (GOM) or Mid Atlantic (MA)	Females: 76 cm Males: 73 cm 85 cm	Big Skate Spotted Skate Eyed Skate
Barndoor Skate	*Dipturus laevis*	Offshore GOM (Canadian waters), offshore GB and SNE (very few inshore or in MA region)	Males (GB): 108cm Females (GB): 116 cm	

SPECIES COMMON NAME	SPECIES SCIENTIFIC NAME	GENERAL DISTRIBUTION	SIZE AT MATURITY cm (TL)	OTHER COMMON NAMES
Thorny Skate	*Amblyraja radiata*	Inshore and offshore GOM, along the 100 fm edge of GB (very few in SNE or MA)	Males (GOM): 87 cm Females (GOM): 88 cm 84 cm	Starry Skate
Smooth Skate	*Malacoraja senta*	Inshore and offshore GOM, along the 100 fm edge of GB (very few in SNE or MA)	56 cm	Smooth-tailed Skate Prickly Skate
Little Skate	*Leucoraja erinacea*	Inshore and offshore GB, SNE and MA (very few in GOM)	40-50 cm	Common Skate Summer Skate Hedgehog Skate Tobacco Box Skate
Clearnose Skate	*Raja eglanteria*	Inshore and offshore MA	61 cm	Brier Skate
Rosette Skate	*Leucoraja garmani*	Offshore MA	34 – 44 cm; 46 cm	Leopard Skate

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

7.3 BIOLOGICAL ENVIRONMENT

The Essential Fish Habitat Source Documents prepared by the Northeast Fisheries Science Center (NEFSC) of the National Marine Fisheries Service for each of the seven skate species, provide most available biological and habitat information on skates. These technical documents are available at http://www.nefsc.noaa.gov/nefsc/habitat/efh/:

Life history, including a description of the eggs and reproductive habits

Average size, maximum size and size at maturity

Feeding habits

Predators and species associations

Geographical distribution for each life history stage

Habitat characteristics for each life history stage

Status of the stock (in general terms, based on the Massachusetts inshore and NEFSC trawl surveys)

A description of research needs for the stock

Graphical representations of stock abundance from NEFSC trawl survey and Massachusetts inshore trawl survey data

Graphical representations of percent occurrence of prey from NEFSC trawl survey data

7.3.1 Species Distribution

Maps of biomass distribution are included in Section 7.3.3, but additional maps of the abundance distribution for juveniles and adults are published in the 2002 SAFE Report (http://www.nefmc.org/skates/fmp/skate_SAFE.htm).

7.3.2 Stock assessment and status (SAW 44)

The Stock Assessment Review Committee (SARC) meeting of the 44th Northeast Regional SAW was held in the Aquarium Conference Room of the Northeast Fisheries Science Center's (NEFSC) Woods Hole Laboratory in Woods Hole, Massachusetts from October 24 – 26, 2006. The SARC Chairman was Dr. Paul Rago, Northeast Fisheries Science Center, NOAA, Woods Hole, Massachusetts. Members of the SARC included scientists from the NEFSC, NMFS Northeast Regional Office (NERO), NMFS Headquarters, the Mid-Atlantic Fishery Management Council (MAFMC), Atlantic States Marine Fisheries Commission (ASMFC), the States of Rhode Island and Massachusetts, DFO-Canada, and the Virginia Institute of Marine Sciences. The 44th SAW was held in Woods Hole in December 2007 and reviewed the SARC results. The SAW rejected the analytic assessment models that were presented by the SARC because they had not been adequately tested using simulated populations. The SAW recommended using the existing status determination criteria for determining whether skates were overfished or whether overfishing had occurred, as a proxy for MSY-based reference points. Preliminary results from SAW 44 were presented to the Council at its February 2007 meeting and the final results were published in May 2007 (http://www.nefsc.noaa.gov/nefsc/saw/).

The following Terms of Reference were provided by the SAW Steering Committee as the context for the assessment of the northeast region skate complex reviewed by SARC 44 in October 2006:

- Characterize the commercial and recreational catch including landings and discards.
- Estimate fishing mortality, spawning stock biomass, and total stock biomass for the current year and characterize the uncertainty of those estimates. If possible, also include estimates for earlier years.
- Either update or redefine biological reference points (BRPs; proxies for B_{MSY} and F_{MSY}).
- Evaluate current stock status with respect to the existing BRPs, as well as with respect to updated or redefined BRPs (from TOR 3).
- Review, evaluate and report on the status of the SARC/Working Group Research Recommendations offered in recent SARC-reviewed assessments.
- Examine the NEFSC Food Habits Database to estimate diet composition and annual consumptive demand for seven species of skates for as many years as feasible.

For the purposes of simplification, not all of the information contained in the SAW 44 documents is presented in this SAFE Report. The SAW 44 documents (see http://www.nefsc.noaa.gov/nefsc/saw/) are referenced in this SAFE Report and should be consulted for more information about population stock assessment, long term landings, long term discard estimates, and long term survey trends.

The SARC at SAW 30 developed the following biological reference points for each of the seven species of skates in the northeast complex. Alternative reference points were proposed by the SARC at SAW 44. However, these proposed reference points were rejected, resulting in the previous reference points being retained. An evaluation of each species' status in the context of the following reference points is provided in the following section of this document.

7.3.3 Research Survey Data

This section presents data collected through seasonal NEFSC trawl surveys and state research surveys. Information has been updated through the 2005 autumn survey and the 2006 spring survey.

Indices of relative abundance have been developed from NEFSC bottom trawl surveys for the seven species in the skate complex, and these form the basis for most of the conclusions about the status of the complex. All statistically significant NEFSC gear, door, and vessel conversion factors were applied to little, winter, and smooth skate indices when applicable (Sissenwine and Bowman, 1978; NEFSC 1991). For the aggregate skate complex, the spring survey index of biomass exhibited an increase in the late 1990s to early 2000s has recently begun to decline again (http://www.nefsc.noaa.gov/nefsc/publications/crd/crd0710/b.pdf).

The biomass of large-sized skates has steadily declined since the mid-1980s but has remained relatively stable since the late 1990s. An increase in little skate drove the higher abundance of small skates in 1999, but recently the abundance of little skate has declined.

7.3.3.1 Winter Skate

NEFSC bottom trawl surveys indicate that winter skate are most abundant in the Georges Bank (GB) and Southern New England (SNE) offshore strata, with few fish caught in the Gulf of Maine (GOM), or Mid-Atlantic (MA) regions **(**Map 1**)**.

The median length of winter skates sampled by the survey generally, in both the spring and autumn surveys, increased from the mid 1990s through 2002, and then declined slightly to about 45 – 52 cm TL (18 – 20 in). Length frequency distributions from the NEFSC spring and autumn surveys are presented in the SAW 44 documents and are not reproduced in this SAFE Report. Truncation of the length distributions is evident in the NEFSC spring and autumn series since 1990.

Recent spring survey catches have equated to 3.1 fish or 3.0 kg per tow in 2006; recent autumn catch equates to 1.7 fish or 2.6 kg per tow in 2005 (Table 3 and Table 4). The 2006 stratified mean catch is 18.2 fish per tow or 32.4 kg per tow, the highest index since 1991(Table 5). NEFSC survey indices of winter skate abundance are below the time series mean, at about the same value as during the early 1970s. This downward trend is observed in the fall, spring and summer surveys (Figure 1). Current NEFSC indices of winter skate biomass are about 38% of the peak observed during the mid 1980s.

In 2007, winter skate was determined to be overfished, because the biomass index dropped below the threshold. This status remained unchanged in 2008 upon examination of the autumn 2007 survey data. Overfishing is not occurring on this species because the consecutive three-year moving average of the biomass indices did not exceed the maximum threshold which according to the FMP defines when overfishing is occurring.

Table 2. Summary by species of recent survey indices, survey strata used and biomass reference points.

	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
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
Percent change 2005-2007 compared to 2004-2006	-14.2	8.1	-20	12.7	-22.4	-23.7	-3.6
Percent change for overfishing status determination in FMP	-30	-30	-20	-60	-30	-20	-20
Biomass Target	1.62	0.56	6.54	0.029	0.31	4.41	6.46
Biomass Threshold	0.81	0.28	3.27	0.015	0.16	2.2	3.23
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 Occurring	Overfished Overfishing is Not Occurring

Distribution of winter skate in Canadian waters was examined using research surveys and commercial fishery data by Simon et al. (2003). Winter skate are found from Georges Bank north into the Gulf of St. Lawrence (Simon et al. 2003). Lower concentrations are found on the southern part of the Grand Banks and in nearshore areas of Newfoundland. Research surveys conducted on Georges Bank indicate a higher abundance of winter skate on the USA side of the Bank. No trend in abundance was found in the Georges Bank region; the series average is 1.8 million individuals. In the Gulf of St Lawrence, declines have been evident in the Southern Gulf (decadal averages range from 650,000 individuals in the 1970s, 450,000 individuals in the 1980s, and 170,000 individuals in the 1990s) but have remained stable in the northern area. Since 1998 a noted decline in abundance was observed on the Scotian Shelf; the average from 1998 to 2003 was 1.4 million individuals, which is below the long-term series average of 2.6 million individuals. Frisk et al. (2008) propose that connectivity exists between skate populations, in particular between the Scotian Shelf and Georges Bank. If this connectivity really exists, movement between the two populations would partially explain the increase in winter skate on Georges Bank during the 1980s, if Georges Bank indeed received an influx of winter skates from the Scotian Shelf.

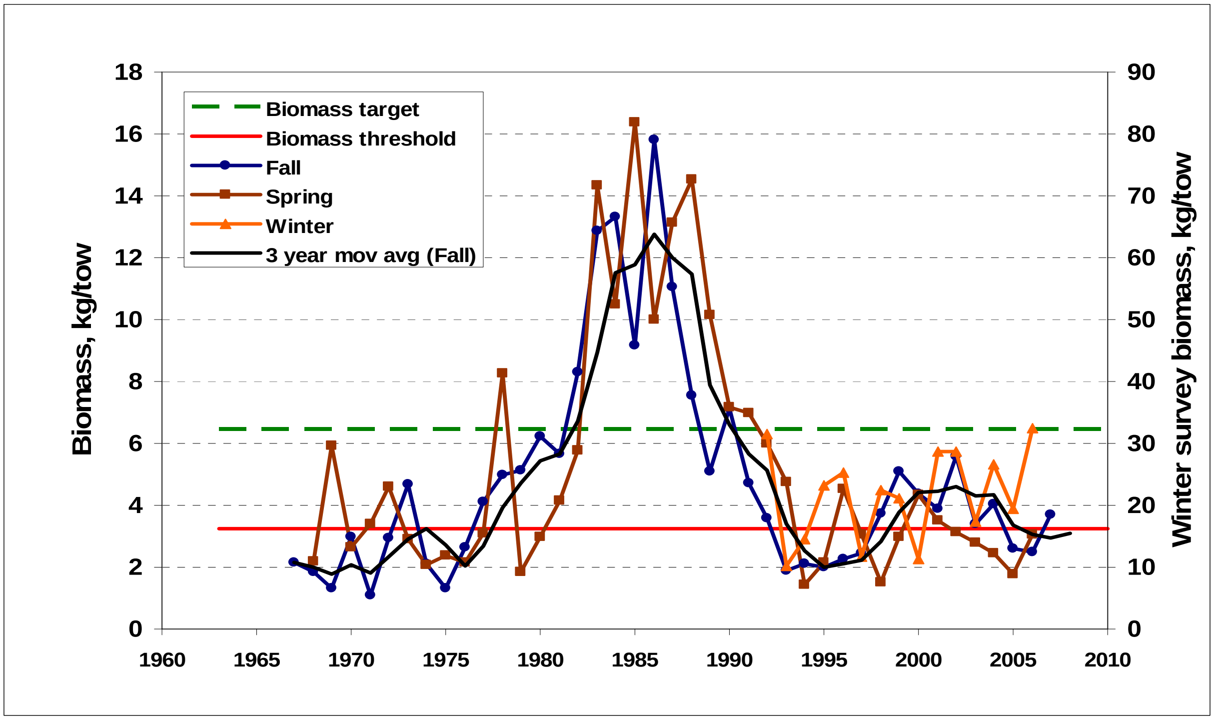
Biological data are limited for this species in Canadian waters. For part of the Scotian Shelf region (NAFO division 4VsW) 50% maturity was considered to be at 75cm total length for both sexes (Simon et al. 2003). In Division 4VsW, the number of mature individuals has been declining throughout the time series, with no individuals above 75cm being caught in 2001 and 2002. Maturity at length estimates are not available for other regions.

In 2005, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) released a status assessment on winter skate that designated this species to be endangered, threatened, and is of special concern and data deficient, based primarily on its life history characteristics and the low frequency of occurrence in catches (Anonymous, 2005).

Indices of abundance for winter skate are available from the Massachusetts Division of Marine Fisheries (MADMF) spring and autumn research trawl surveys in the inshore waters of Massachusetts during 1978-2006. The spring survey index rebounded to moderate levels during 1992-1996 before dropping again to low values in the late 1990s and remaining low through 2006 (SAW44 2006). The autumn index is more variable, but generally shows the same pattern. Indices of abundance for winter skate are also available from the Connecticut Department of Environmental Protection (CTDEP) spring and autumn finfish trawl surveys in Long Island Sound during 1984-2006. Annual CTDEP survey catches have ranged from 0 to 115 skates. CTDEP survey indices suggest that after increasing to a time series high from 1984 through 1989, winter skate in Long Island Sound has declined slightly (SAW44 2006).

Figure 1. Winter skate stratified mean weight and number per tow for the winter, spring, and fall NEFSC trawl surveys.

Survey Biomass (kg/tow)



Survey Abundance (#/tow)

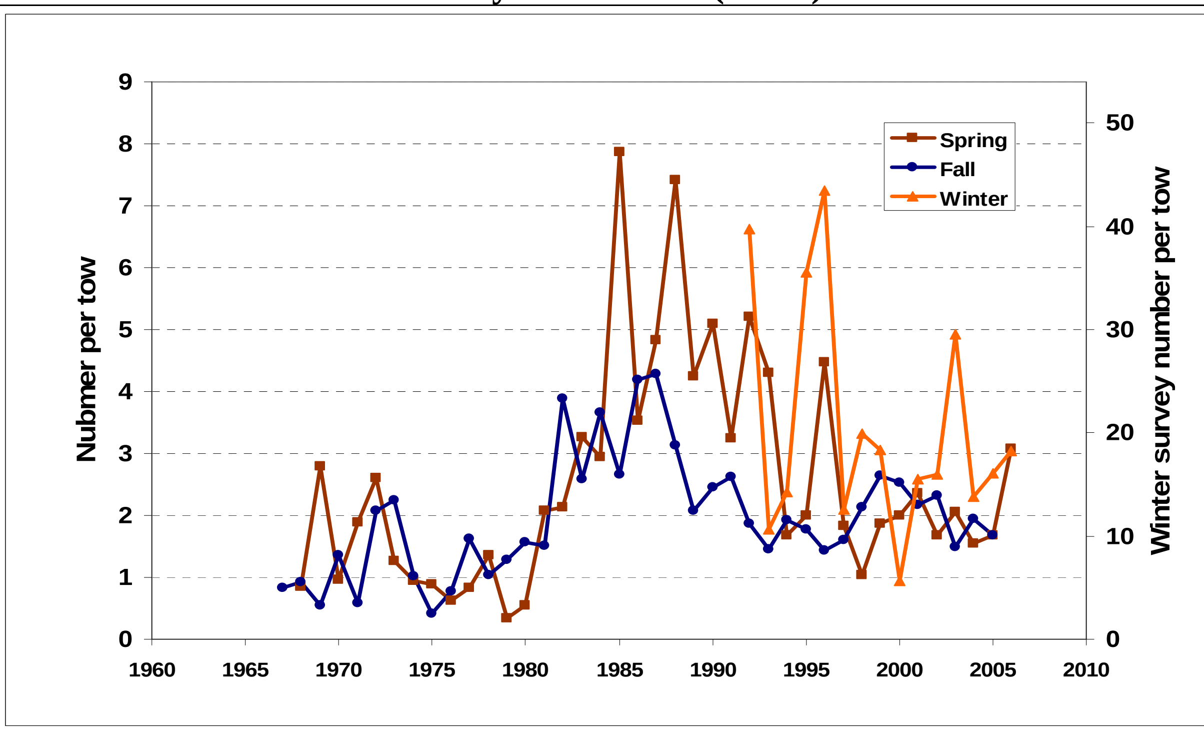


Table 3. Abundance and biomass from NEFSC spring surveys for winter skate for the Gulf of Maine to Mid-Atlantic region (offshore strata 1-30,33-40,61-76). The mean index, 95% confidence intervals, individual fish weight, minimum, mean, and maximum length, 5th, 50th, and 95th percentiles of length, number of nonzero tows, and number of fish caught are presented for 2000-2006.

	Weight/tow			**Number/tow**				**Length (cm TL)**						**nonzero**	
	Mean	Lower	Upper	Mean	Lower	Upper	Ind wt	Min	5%	50%	Mean	95%	Max	Tows	No fish
2000	4.358	2.273	6.443	1.998	1.041	2.954	2.181	15	34	62	62.2	82	99	57	457
2001	3.496	1.889	5.103	2.350	0.912	3.787	1.488	20	27	44	52.1	82	100	48	556
2002	3.132	1.650	4.614	1.688	0.949	2.426	1.856	15	29	59	58.6	82	93	48	407
2003	2.799	1.471	4.127	2.047	1.164	2.931	1.367	15	29	49	53.4	82	100	61	606
2004	2.446	1.512	3.379	1.547	1.015	2.080	1.581	18	29	50	54.6	85	97	58	356
2005	1.757	0.869	2.645	1.672	0.470	2.874	1.051	15	30	45	48.6	75	97	52	375
2006	3.041	1.020	5.062	3.067	0.465	5.668	0.992	15	24	43	47.2	75	99	55	779

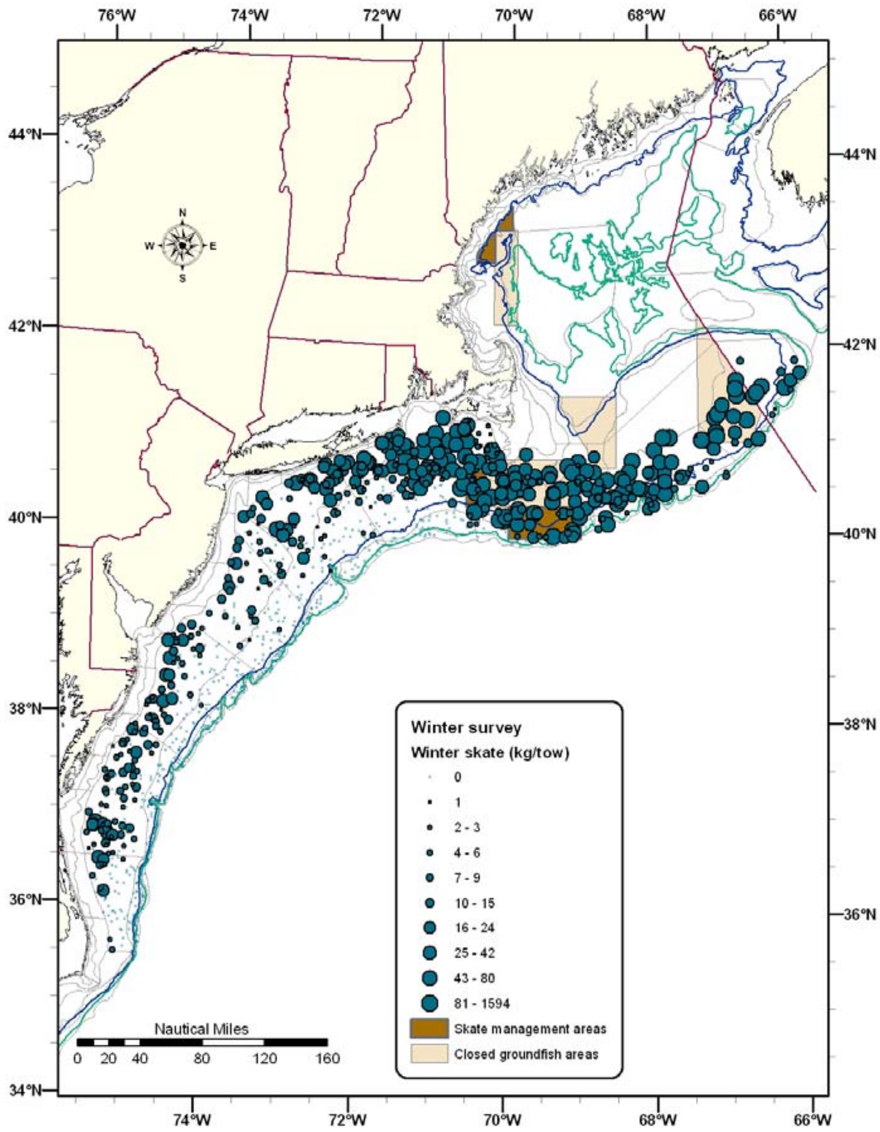
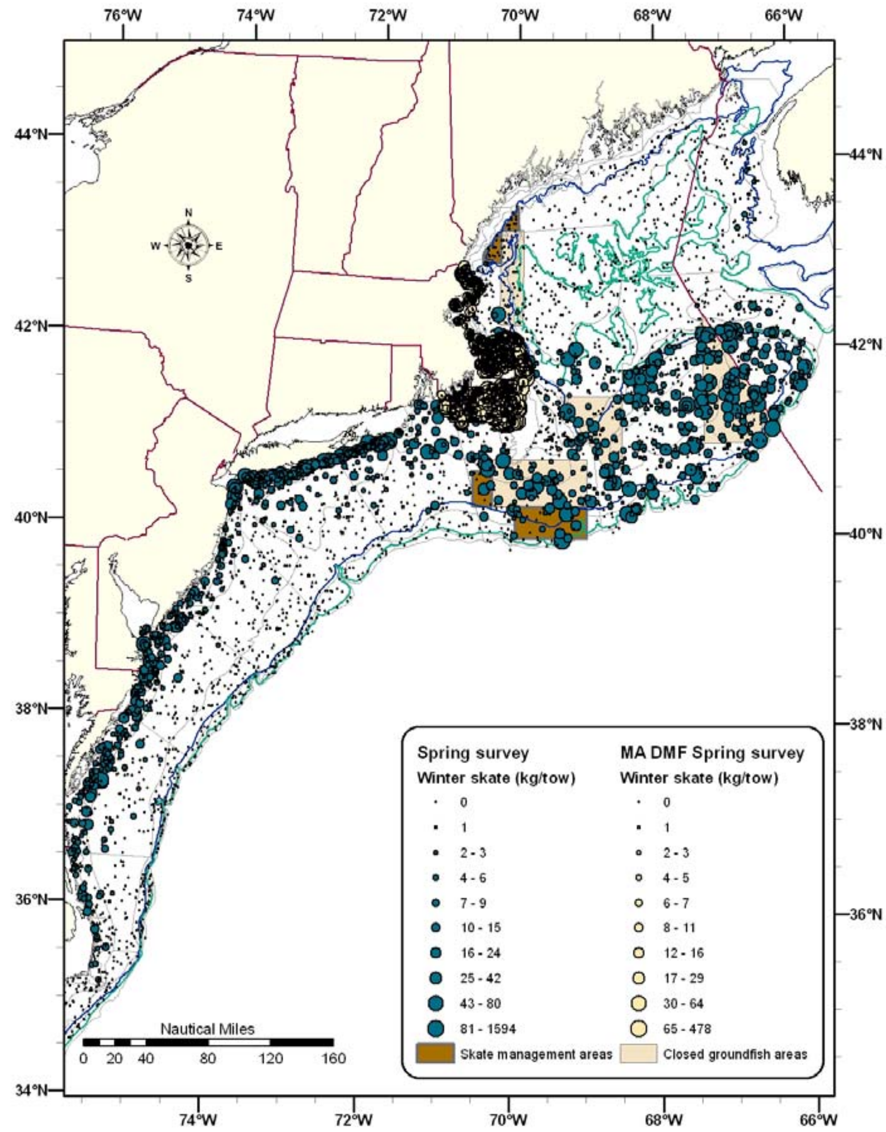
Table 4. Abundance and biomass from NEFSC autumn surveys for winter skate for the Gulf of Maine to Mid-Atlantic region (offshore strata 1-30, 33-40, 61-76). The mean index, 95% confidence intervals, individual fish weight, minimum, mean, and maximum length, 5th, 50th, and 95th percentiles of length, number of nonzero tows, and number of fish caught are presented for 2000-2005.

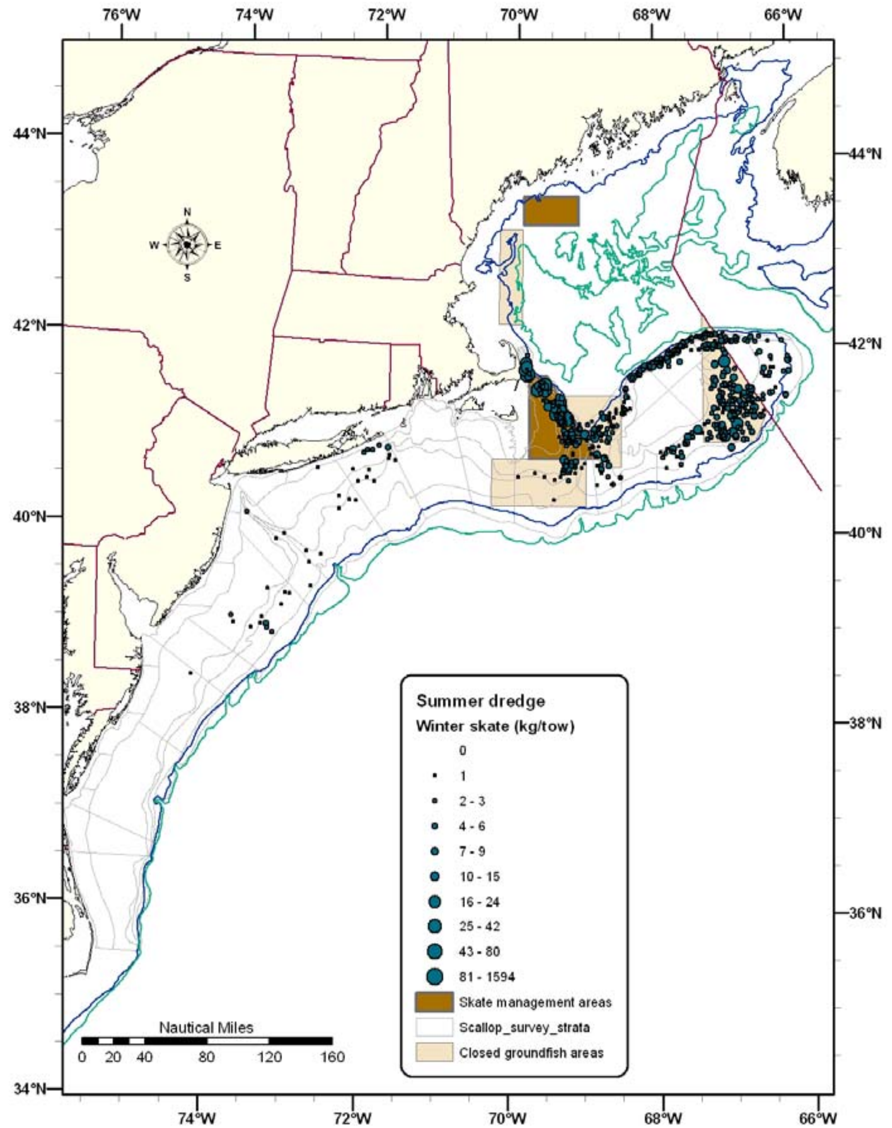
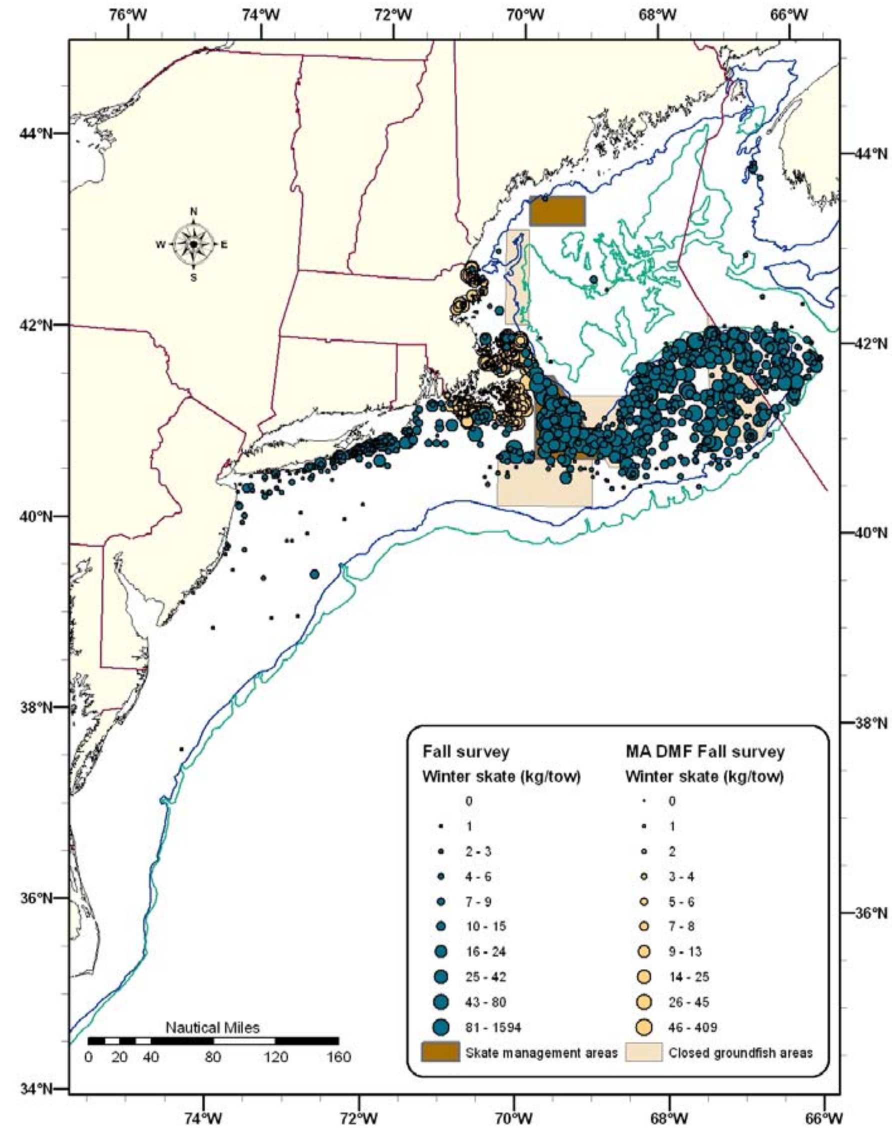
	Weight/tow			**Number/tow**				**Length (cm TL)**						**nonzero**	
	Mean	Lower	Upper	Mean	Lower	Upper	Ind wt	Min	5%	50%	Mean	95%	Max	Tows	No fish
2000	4.378	2.390	6.366	2.535	1.351	3.718	1.727	18	25	56	55.5	82	99	45	756
2001	3.887	2.442	5.333	2.165	1.415	2.914	1.796	15	32	58	57.8	83	98	53	601
2002	5.600	3.417	7.782	2.323	1.535	3.111	2.411	16	33	66	63.9	87	101	55	743
2003	3.386	2.111	4.662	1.498	0.928	2.068	2.260	16	33	62	63.0	87	104	43	435
2004	4.031	2.632	5.430	1.942	1.343	2.542	2.075	26	33	62	60.4	87	102	50	611
2005	2.615	1.791	3.439	1.671	1.005	2.337	1.565	18	31	52	55.1	81	98	54	475

Table 5. Abundance and biomass from NEFSC winter surveys for winter skate for the Georges Bank to Mid-Atlantic region (offshore strata 1-3,5-7,9-11,13-14,16,61-63,65-67,69-71,73-75). The mean index, 95% confidence intervals, individual fish weight, minimum, mean, and maximum length, 5th, 50th, and 95th percentiles of length, number of nonzero tows, and number of fish caught are presented for 2000-2006. Stratum 16 not sampled in 1993, 2000, 2002-2006. Strata 13 and 14 not sampled in 2003. Stratum 63 not sampled in 1993. Stratum 14 not sampled in 2005.

	Weight/tow			**Number/tow**				**Length (cm TL)**						**nonzero**	
	Mean	Lower	Upper	Mean	Lower	Upper	Ind wt	Min	5%	50%	Mean	95%	Max	Tows	No fish
2000	11.315	4.814	17.815	5.697	2.799	8.596	1.968	18	27	56	57.6	88	101	33	486
2001	28.634	19.682	37.585	15.555	9.234	21.875	1.841	16	30	58	57.5	84	100	76	2025
2002	28.733	17.246	40.220	15.982	6.565	25.400	1.798	15	24	49	55.1	88	107	53	1849
2003	17.425	7.871	26.979	29.540	-6.318	64.399	0.590	15	15	28	34.8	75	99	34	1662
2004	26.618	13.793	39.444	13.833	9.244	18.422	1.924	15	31	55	58.0	86	102	58	1342
2005	19.424	8.976	29.872	16.081	6.327	25.836	1.208	16	26	48	50.3	76	95	46	972
2006	32.411	12.125	52.697	18.233	9.593	26.874	1.778	15	30	56	57.4	86	102	60	1776

Map 1. Winter skate biomass distribution in the winter trawl (2000-2007), spring trawl (2000-2008), summer dredge (2000-2007), and autumn trawl (2000-2007) surveys.

Winter (Feb/Mar)	Spring (Apr/May)
	

Summer (Jul/Aug)	Autumn (Sep/Oct)
	

7.3.3.2 Little Skate

NEFSC bottom trawl surveys indicate that little skate are abundant in the inshore and offshore strata in all regions of the northeast US coast, but are most abundant on Georges Bank and in Southern New England **(**Map 2**)**. In the NEFSC autumn surveys (1975-2005), the annual total catch of little skate in offshore strata reached 6,523 fish in 2003. Calculated on a per tow basis, these spring survey catches equate to maximum stratified mean number per tow indices for the GOM-MA inshore and offshore strata autumn maximum catches equate to indices of 18 fish, or 7.7 kg, per tow in 2003 (Table 6 and Table 7). Recent spring catches have equated to 7.9 fish or 3.3 kg per tow in 2006; recent autumn catch equates to 7.6 fish or 3.8 kg per tow in 2005 (Table 6 and Table 7). NEFSC winter survey (2000-2006) annual catches of little skate reached a low of 8,870 fish in 2003, equating to a maximum stratified mean catch per tow of 151 fish or 64 kg per tow (Table 8).

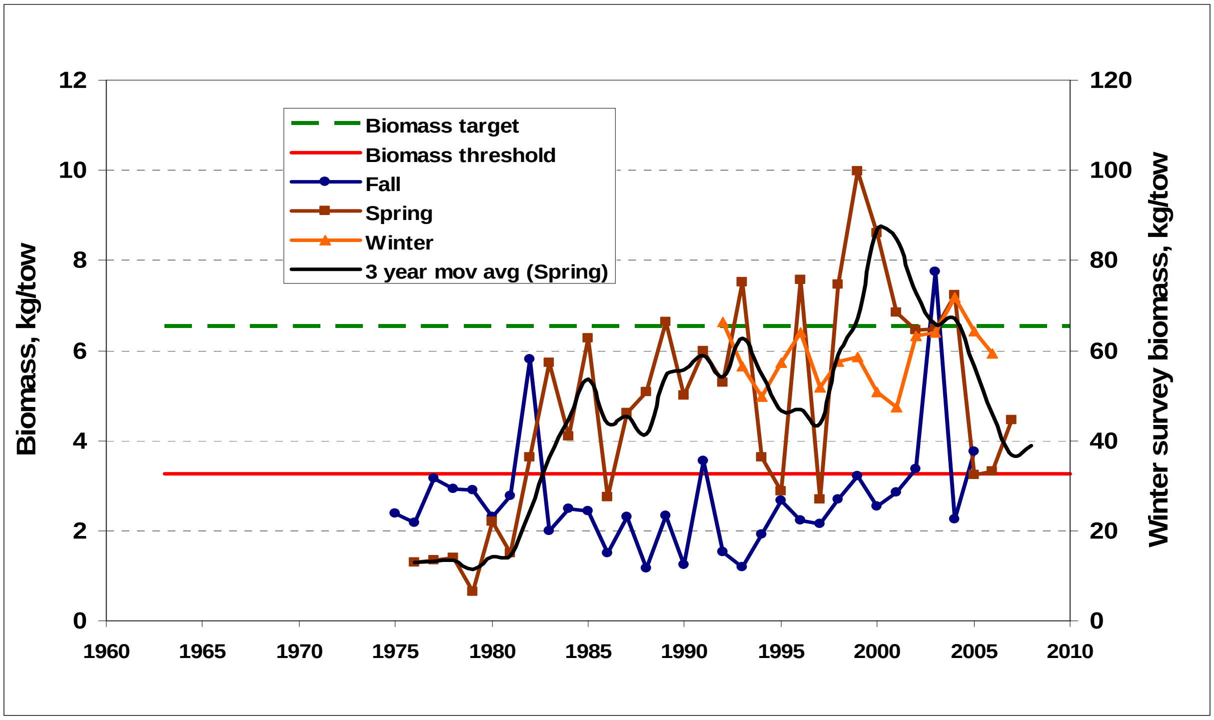
Indices of little skate abundance and biomass from the NEFSC spring survey were stable, reached a peak in 1999, and declined thereafter. Autumn survey indices slightly increased in recent years. Little skate biomass decreased in the spring survey since 1999. Little skate was approaching an overfished status as a result of this decline. However, an increase in biomass in 2007 produced an increase in the three year moving average, resulting in little skate not being listed as overfished in the latest assessment. Abundance of little skate closely reflects patterns in biomass (Figure 2). Autumn survey biomass and abundance are generally lower than those of spring or winter surveys.

The median length of little skates sampled in the survey reached 44 cm TL in the 2005 autumn survey. The median length of the survey catch was generally stable over the duration of the spring and autumn surveys and is currently about 42 cm TL in the spring and 43 cm TL in the autumn (SAW 44 2006). Length frequency distributions from the NEFSC spring and autumn surveys are presented in the SAW 44 documents and are not reproduced in this SAFE Report. In general, the length frequency distributions for little skate show several modes, most often at 10, 20, 30, and 45 cm, which are believed to represent ages 0, 1, 2, and 3 and older little skate.

Indices of abundance for little skate are available from Massachusetts Division of Marine Fisheries (MADMF) spring and autumn research trawl surveys in the inshore waters of Massachusetts during 1978-2006. Since the mid 1990s, MADMF biomass indices have fluctuated without trend. Indices of abundance for little skate are available from Connecticut Department of Environmental Protection (CTDEP) spring and autumn finfish trawl surveys in Long Island Sound during 1984-2006 (1992 and later only for biomass). Little skate are the most abundant species in the skate complex in Long Island Sound, with annual CTDEP survey catches ranging from 142 to 837 skates. CTDEP survey indices suggest a decline in recent years (SAW 44 2006).

Figure 2. Little skate stratified mean weight and number per tow for the winter, spring, and fall NEFSC trawl surveys.

Survey Biomass (kg/tow)



Survey Abundance (#/tow)

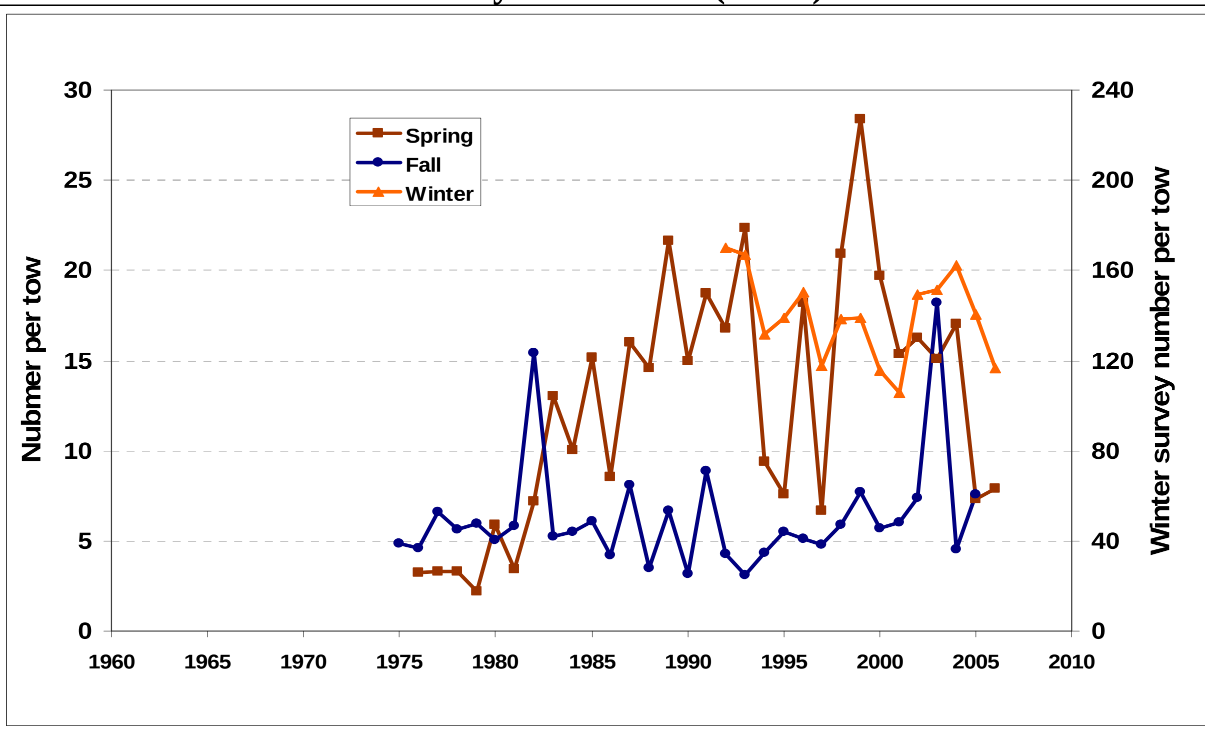


Table 6. Abundance and biomass from NEFSC spring surveys for little skate for the Gulf of Maine to Mid-Atlantic region (offshore strata 1-30, 33-40, 61-76, and inshore strata 1-66). The mean index, 95% confidence intervals, individual fish weight, minimum, mean, and maximum length, 5th, 50th, and 95th percentiles of length, number of nonzero tows, and number of fish caught are presented for 2000-2006.

	Weight/tow			**Number/tow**				**Length (cm TL)**						**nonzero**	
	Mean	Lower	Upper	Mean	Lower	Upper	Ind wt	Min	5%	50%	Mean	95%	Max	Tows	No fish
2000	8.596	6.647	10.545	19.677	15.270	24.083	0.437	9	21	41	38.9	47	57	179	15367
2001	6.835	4.297	9.372	15.347	9.900	20.794	0.445	8	18	42	39.5	48	58	154	6978
2002	6.444	4.546	8.341	16.280	11.306	21.254	0.396	8	11	42	37.7	48	57	154	11983
2003	6.486	4.505	8.486	15.116	10.195	20.036	0.429	9	22	42	40.1	48	55	169	6919
2004	7.219	5.374	9.064	17.039	11.917	22.162	0.424	7	25	42	39.9	47	57	147	9866
2005	3.241	2.305	4.177	7.328	5.515	9.141	0.442	8	13	43	38.9	48	53	138	3108
2006	3.323	1.892	4.753	7.878	4.544	11.211	0.422	7	11	42	38.4	48	55	138	2771

Table 7. Abundance and biomass from NEFSC autumn surveys for little skate for the Gulf of Maine to Mid-Atlantic region (offshore strata 1-30,33-40,61-76, and inshore strata 1-66). The mean index, 95% confidence intervals, individual fish weight, minimum, mean, and maximum length, 5th, 50th, and 95th percentiles of length, number of nonzero tows, and number of fish caught are presented for 2000-2005.

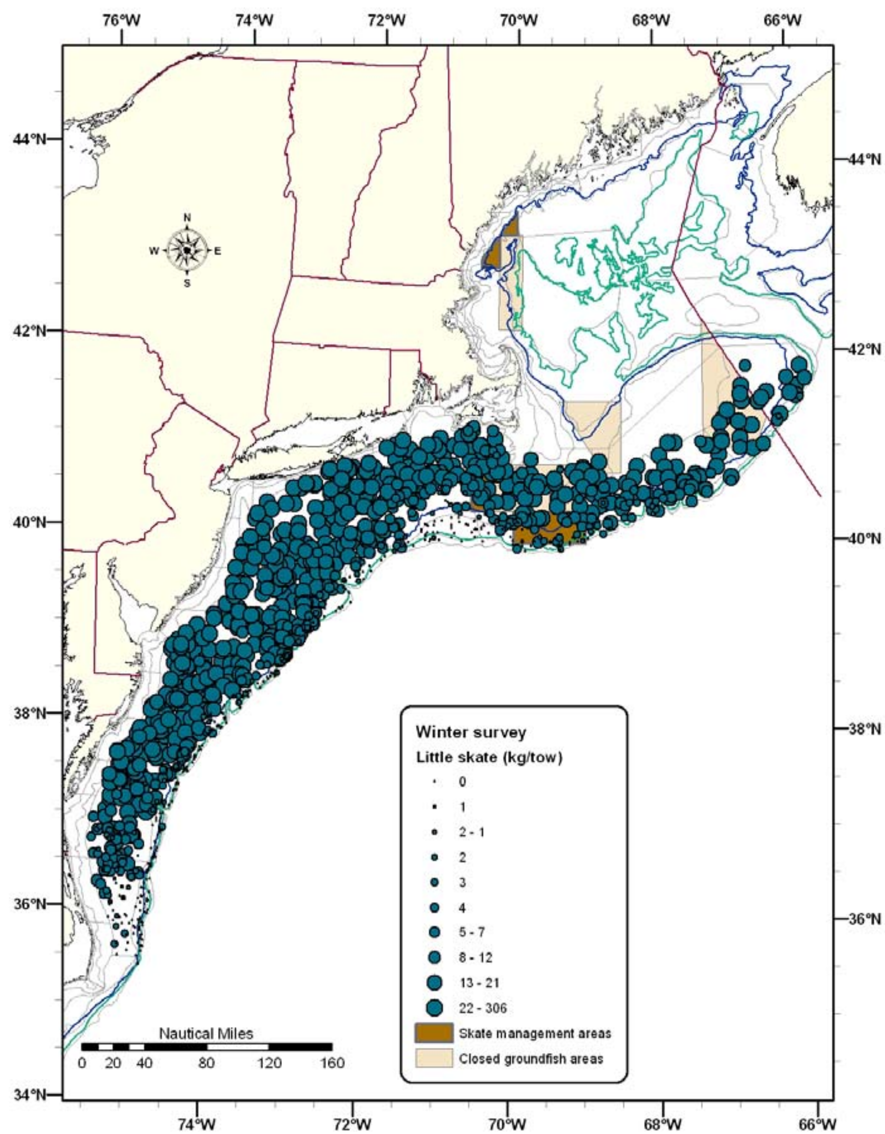
	Weight/tow			**Number/tow**				**Length (cm TL)**						**nonzero**	
	Mean	Lower	Upper	Mean	Lower	Upper	Ind wt	Min	5%	50%	Mean	95%	Max	Tows	No fish
2000	2.550	1.607	3.493	5.711	3.761	7.661	0.447	10	22	43	40.1	49	63	116	1759
2001	2.845	2.032	3.658	6.044	4.265	7.823	0.471	10	22	43	41.4	49	57	130	1985
2002	3.375	2.371	4.379	7.358	5.170	9.545	0.459	9	23	43	40.8	49	54	135	2515
2003	7.740	5.218	10.261	18.199	11.697	24.702	0.425	10	18	41	39.3	48	55	141	6523
2004	2.265	1.388	3.141	4.556	2.714	6.399	0.497	8	26	43	42.3	49	57	122	2270
2005	3.766	2.281	5.252	7.606	4.698	10.515	0.495	9	21	44	41.8	49	55	122	2437

Table 8. Abundance and biomass from NEFSC winter surveys for little skate for the Georges Bank to Mid-Atlantic region (offshore strata 1-3,5-7,9-11,13-14,16,61-63,65-67,69-71,73-75). The mean index, 95% confidence intervals, individual fish weight, minimum, mean, and maximum length, 5th, 50th, and 95th percentiles of length, number of nonzero tows, and number of fish caught are presented for 2000-2006. Stratum 16 not sampled in 1993, 2000, 2002-2006. Strata 13 and 14 not sampled in 2003. Stratum 63 not sampled in 1993. Stratum 14 not sampled in 2005.

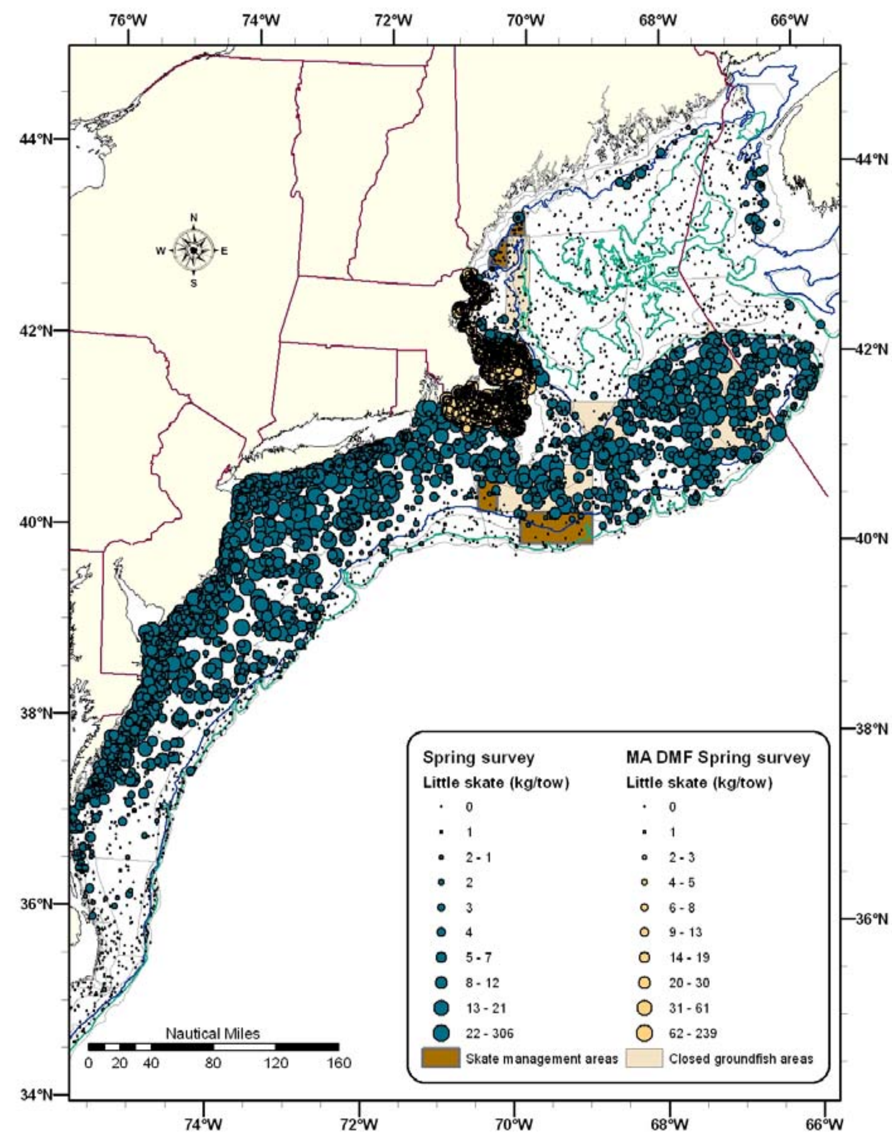
	Weight/tow			**Number/tow**				**Length (cm TL)**						**nonzero**	
	Mean	Lower	Upper	Mean	Lower	Upper	Ind wt	Min	5%	50%	Mean	95%	Max	Tows	No fish
2000	50.7247	37.806	63.643	115.572	87.597	143.547	0.439	8	20	42	39.5	47	53	92	10722
2001	47.429	38.584	56.274	105.749	85.050	126.447	0.449	8	11	42	39.7	48	63	120	12956
2002	63.3207	49.704	76.937	149.228	116.464	181.993	0.424	8	23	42	40.2	48	56	110	17329
2003	63.943	44.340	83.546	151.185	105.428	196.943	0.423	9	24	41	40.0	48	54	62	8870
2004	71.8027	50.398	87.208	162.456	128.807	196.106	0.442	10	25	41	40.5	47	54	94	13822
2005	64.149	45.820	82.478	140.444	93.239	187.648	0.457	9	25	42	40.9	47	54	68	9544
2006	59.2538	48.374	70.134	116.433	96.399	136.467	0.509	9	23	43	42.1	49	55	87	12687

Map 2. Little skate biomass distribution in the winter trawl (2000-2007), spring trawl (2000-2008), summer dredge (2000-2007), and autumn trawl (2000-2007) surveys.

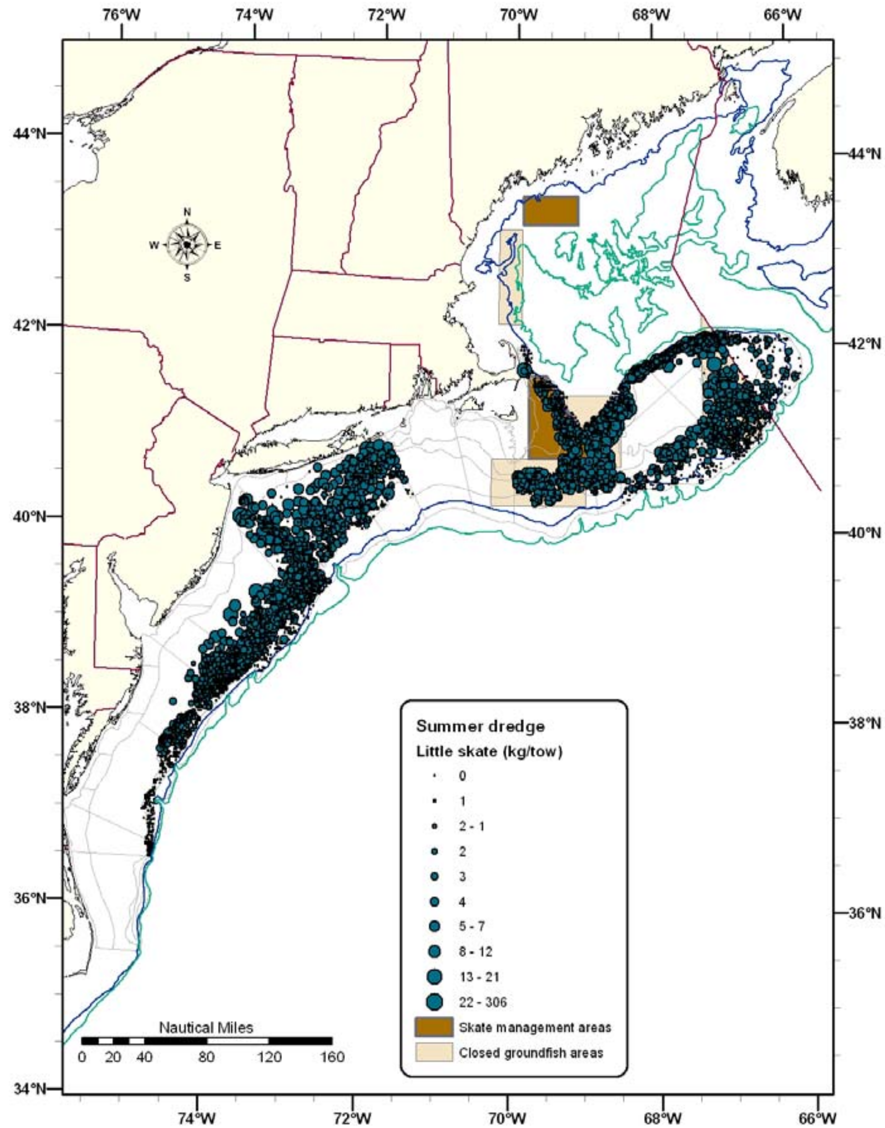
Winter (Feb/Mar)

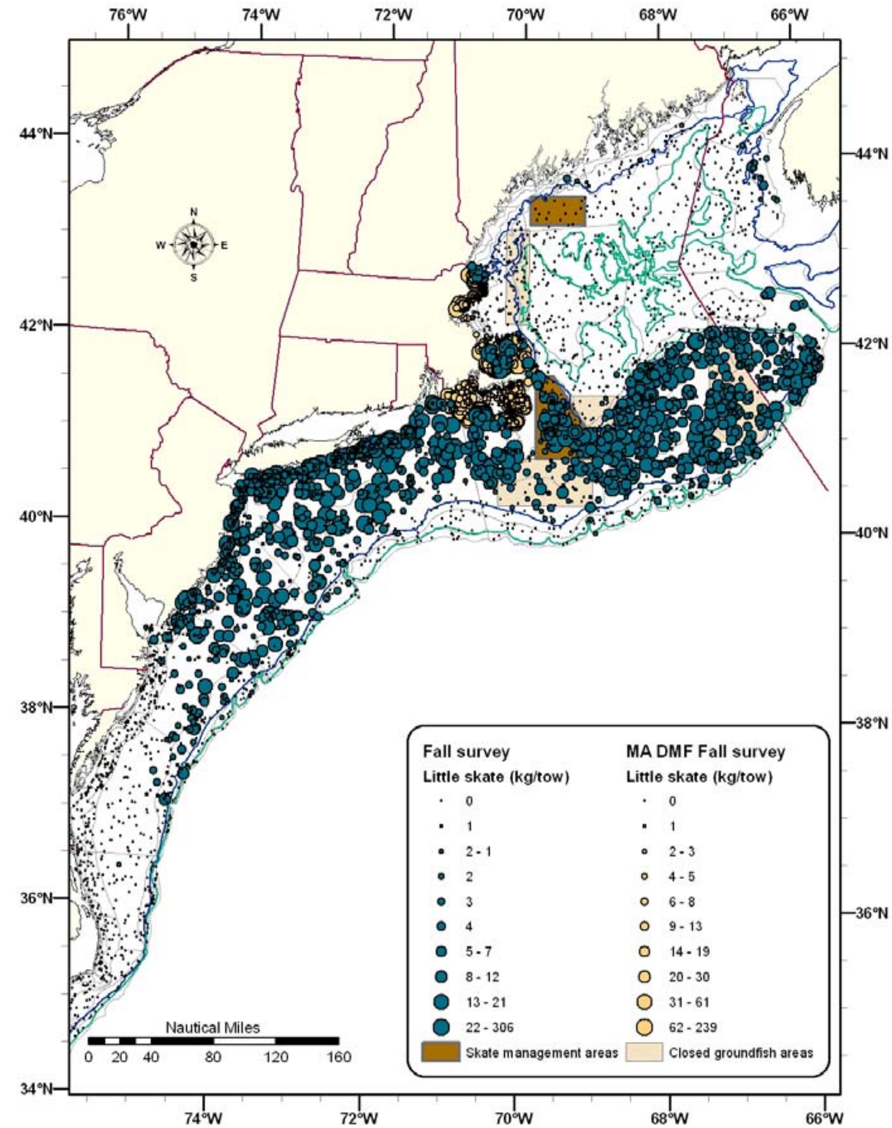


Spring (Apr/May)



Summer (Jul/Aug)	Autumn (Sep/Oct)





7.3.3.3 Barndoor Skate

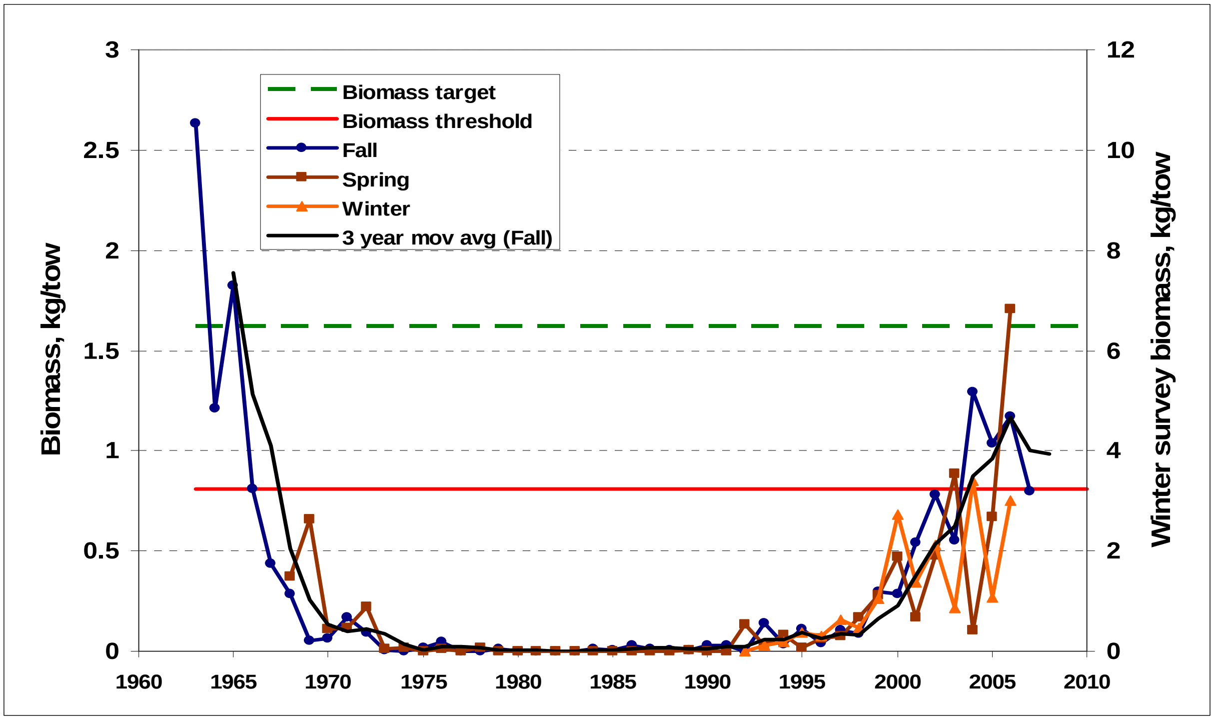
Barndoor skate are most abundant in the Gulf of Maine, Georges Bank, and Southern New England offshore strata, with very few fish caught in inshore (< 27 meters depth) or Mid- Atlantic regions (Map 3**)**. In the NEFSC spring survey (1968-2006), the annual total catch of barndoor skate has ranged from 0 fish (several years during the 1970s and 1980s) to 196 fish in 2006. The NEFSC autumn survey (1963-2005), has exhibited a similar trend. Recent spring catches have equated to 0.6 fish or 1.7 kg per tow in 2006; recent autumn catch equates to 0.4 fish or 1.0 kg per tow in 2005 (Table 9 and Table 10). Barndoor skate appear to be in a rebuilding phase that began in the 1990s. Since 1990, both spring and autumn survey indices have steadily increased, with the spring survey at the highest value in the time series and the autumn survey nearing the peak values found in the 1960s. In 2007, the NEFSC autumn survey showed a decline in biomass (Figure 3). This reduced the three year moving average; however it remains above the biomass threshold and is not considered to be overfished (Figure 3).

Annual catches of barndoor skate in the NEFSC winter survey (1992-2006) have been higher than those in the spring and autumn surveys. However, no fish were caught in 1992. This increased to 355 in 2006, equating to a maximum stratified mean catch per tow of 3.2 fish or 3.0 kg per tow in 2006 (Table 11).

The minimum length of barndoor skate caught in NEFSC surveys is 20 cm TL (8 in), and the largest individual caught was 136 cm TL (54 in) total length, during the 1963 autumn survey in the Gulf of Maine. The median length of barndoor skate in the survey has been stable in recent years in both the spring and autumn surveys, and is currently 70-75 cm TL (28-30 in NEFSC 2007). Recent catches include individuals as large as those recorded during the peak abundance of the 1960s, and the large number of fish between 40 and 80 cm TL evident during the 1960s is now apparent in recent surveys.

Figure 3. Barndoor skate stratified mean weight and number per tow for the winter, spring, and fall NEFSC trawl surveys.

Survey Biomass (kg/tow)



Survey Abundance (#/tow)

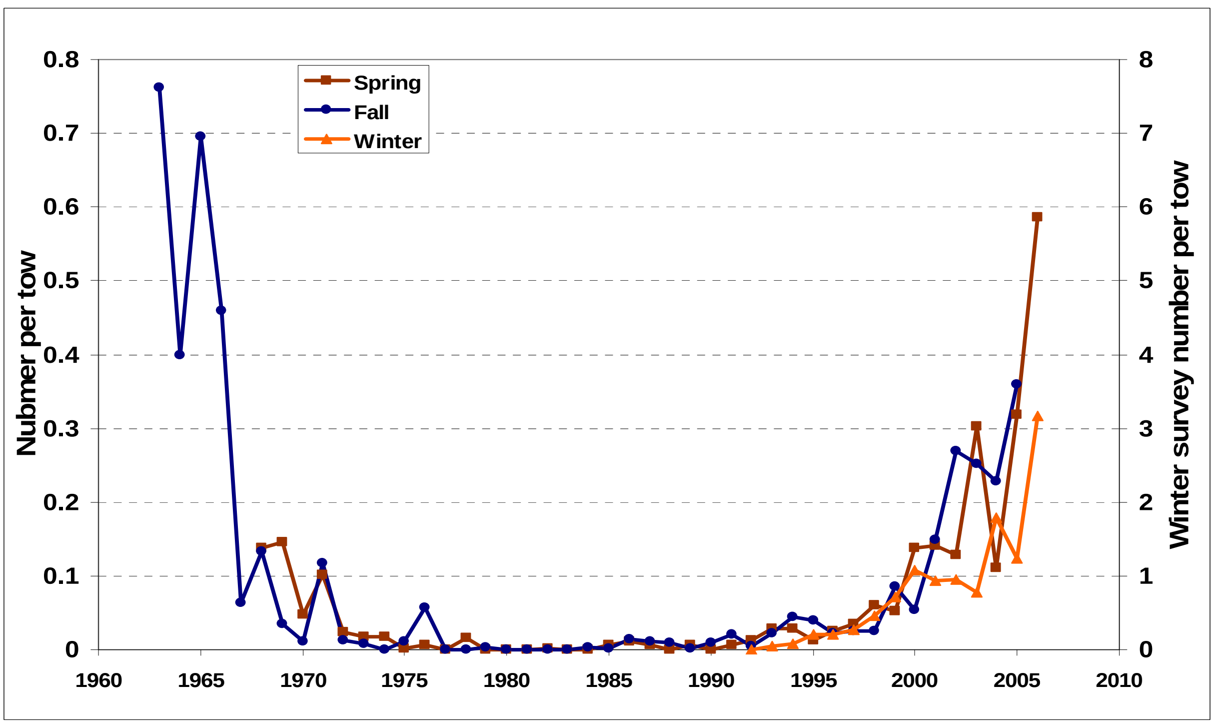


Table 9. Abundance and biomass from NEFSC spring surveys for barndoor skate for the Gulf of Maine to Southern New England region (offshore strata 1-30, 33-40). The mean index, 95% confidence intervals, individual fish weight, minimum, mean, and maximum length, 5th, 50th, and 95th percentiles of length, number of nonzero tows, and number of fish caught are presented for 2000-2006.

	Weight/tow			**Number/tow**				**Length (cm TL)**						**nonzero**	
	Mean	Lower	Upper	Mean	Lower	Upper	Ind wt	Min	5%	50%	Mean	95%	Max	Tows	No fish
2000	0.473	0.246	0.699	0.138	0.076	0.200	3.419	19	20	68	71.4	125	127	14	29
2001	0.170	0.032	0.307	0.141	0.048	0.234	1.200	20	20	52	54.8	77	115	13	30
2002	0.477	0.233	0.721	0.129	0.047	0.212	3.690	35	35	66	77.3	127	133	13	26
2003	0.885	0.341	1.429	0.302	0.172	0.432	2.928	19	19	54	64.0	126	132	23	64
2004	0.103	0.039	0.167	0.111	0.032	0.189	0.928	19	19	55	50.6	81	89	12	24
2005	0.670	0.120	1.221	0.319	0.073	0.565	2.101	26	33	68	68.1	109	122	15	59
2006	1.706	-0.995	4.407	0.586	-.0.87	1.260	2.910	19	19	69	69.9	123	134	22	196

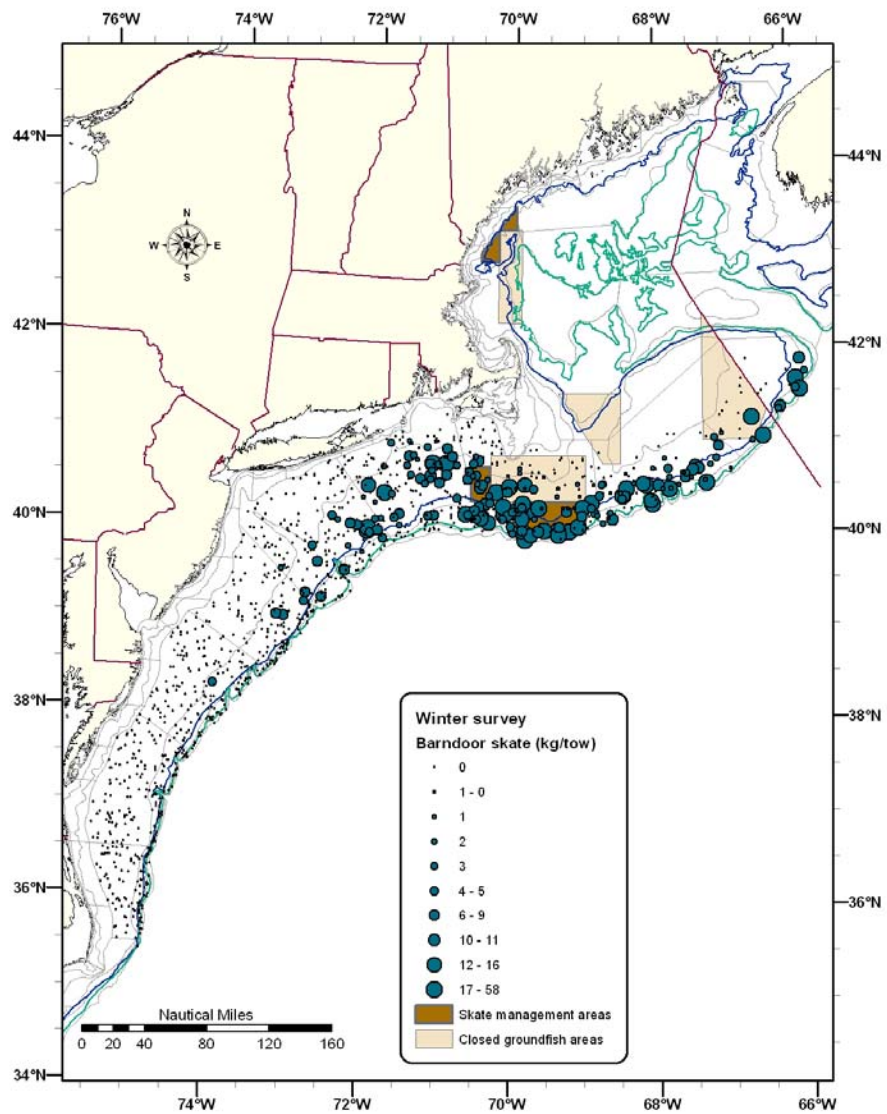
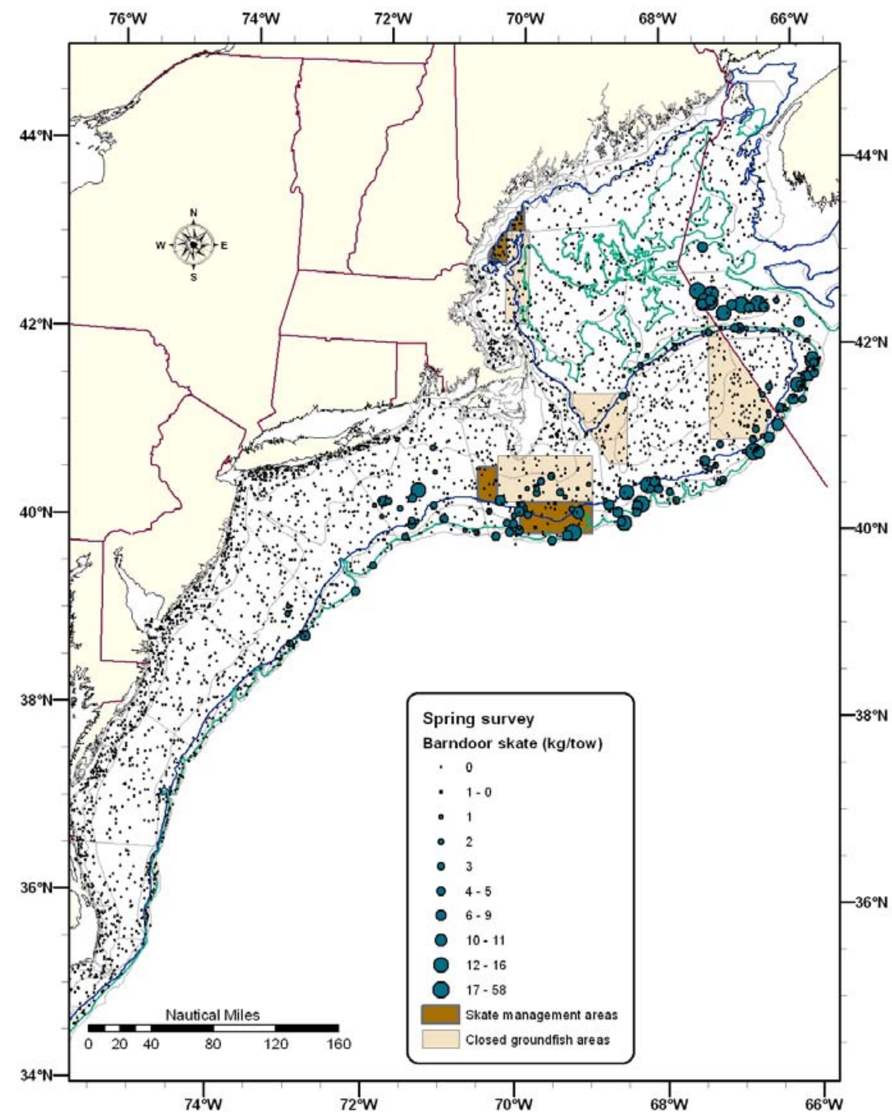
Table 10. Abundance and biomass from NEFSC autumn surveys for barndoor skate for the Gulf of Maine to Southern New England region (offshore strata 1-30, 33-40). The mean index, 95% confidence intervals, individual fish weight, minimum, mean, and maximum length, 5th, 50th, and 95th percentiles of length, number of nonzero tows, and number of fish caught are presented for 2000-2005.

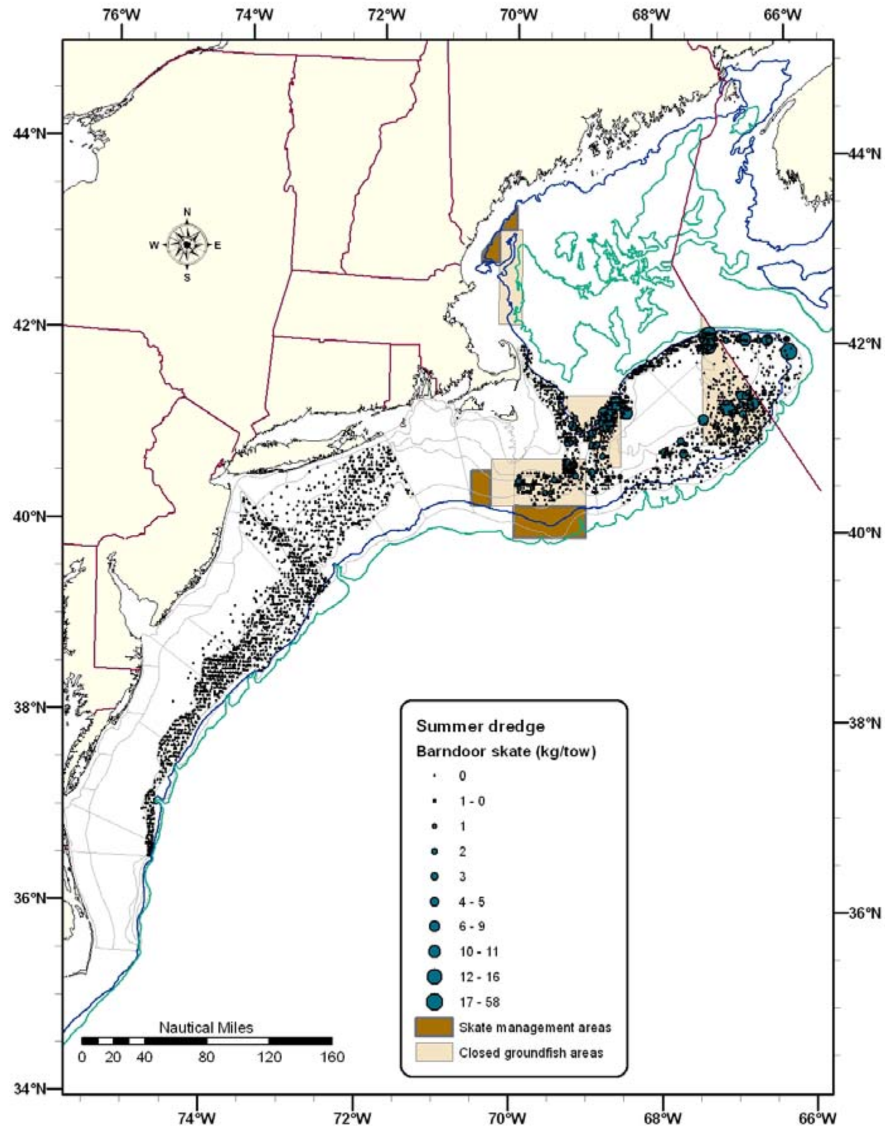
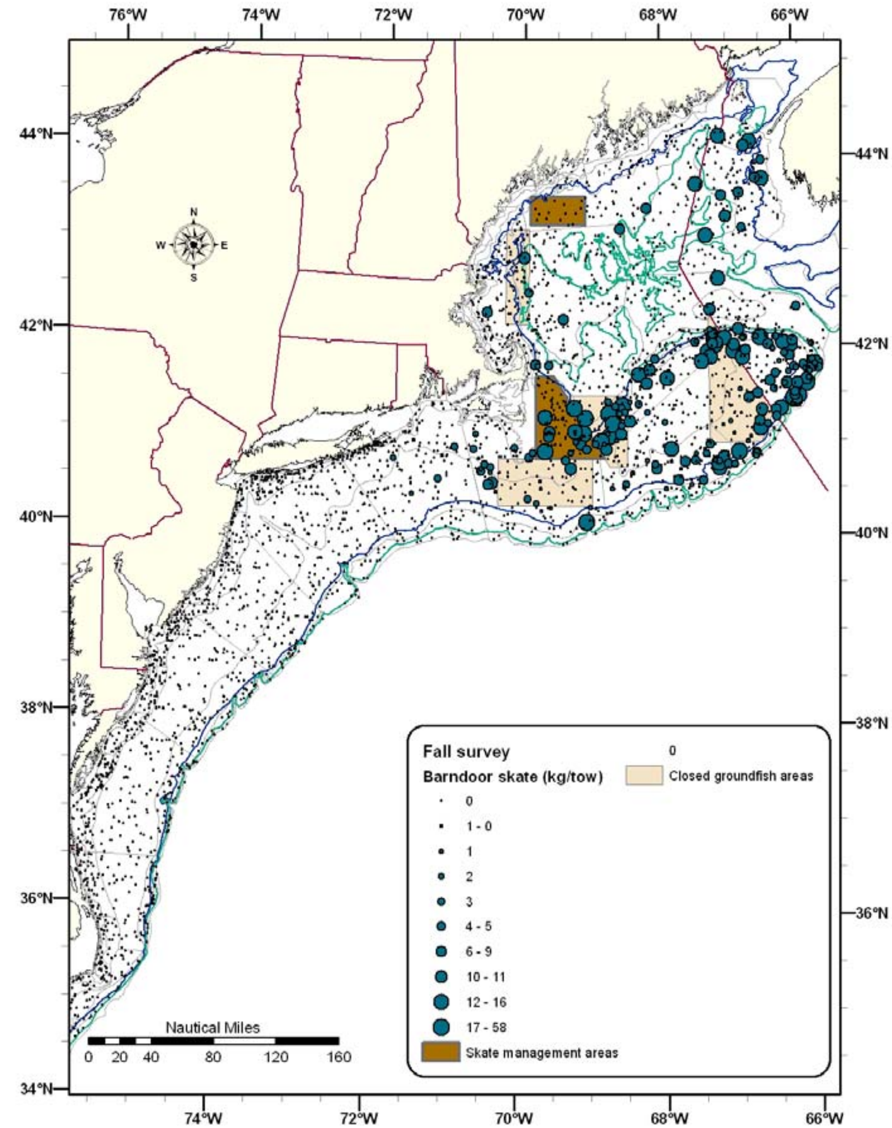
	Weight/tow			**Number/tow**				**Length (cm TL)**						**nonzero**	
	Mean	Lower	Upper	Mean	Lower	Upper	Ind wt	Min	5%	50%	Mean	95%	Max	Tows	No fish
2000	0.288	0.054	0.521	0.054	0.023	0.085	5.360	29	29	89	85.5	121	122	12	15
2001	0.543	0.050	1.036	0.149	0.052	0.247	3.635	24	40	75	75.5	121	126	16	34
2002	0.778	0.351	1.205	0.269	0.130	0.407	2.893	26	27	59	68.0	119	129	24	59
2003	0.553	0.255	0.852	0.251	0.157	0.345	2.203	22	22	48	57.1	115	120	29	55
2004	1.295	0.677	1.913	0.229	0.122	0.336	5.662	42	47	80	90.1	124	128	23	58
2005	1.036	0.482	1.590	0.360	0.207	0.513	2.877	18	25	64	68.1	118	132	29	73

Table 11. Abundance and biomass from NEFSC winter surveys for barndoor skate for the Georges Bank to Mid-Atlantic region (offshore strata 1-3,5-7,9-11,13-14,16,61-63,65-67,69-71,73-75). The mean index, 95% confidence intervals, individual fish weight, minimum, mean, and maximum length, 5th, 50th, and 95th percentiles of length, number of nonzero tows, and number of fish caught are presented for 2000-2006. Stratum 16 not sampled in 1993, 2000, 2002-2006. Strata 13 and 14 not sampled in 2003. Stratum 63 not sampled in 1993. Stratum 14 not sampled in 2005.

	Weight/tow			Number/tow				Length (cm TL)						nonzero	
	Mean	Lower	Upper	Mean	Lower	Upper	Ind wt	Min	5%	50%	Mean	95%	Max	Tows	No fish
2000	11.315	4.814	17.815	5.697	2.799	8.596	1.968	18	27	56	57.6	88	101	33	486
2001	28.634	19.682	37.585	15.555	9.234	21.875	1.841	16	30	58	57.5	84	100	76	2025
2002	28.733	17.246	40.220	15.982	6.565	25.400	1.798	15	24	49	55.1	88	107	53	1849
2003	17.425	7.871	26.979	29.540	-6.318	64.399	0.590	15	15	28	34.8	75	99	34	1662
2004	26.618	13.793	39.444	13.833	9.244	18.422	1.924	15	31	55	58.0	86	102	58	1342
2005	19.424	8.976	29.872	16.081	6.327	25.836	1.208	16	26	48	50.3	76	95	46	972
2006	32.411	12.125	52.697	18.233	9.593	26.874	1.778	15	30	56	57.4	86	102	60	1776

Map 3. Barndoor skate biomass distribution in the winter trawl (2000-2007), spring trawl (2000-2008), summer dredge (2000-2007), and autumn trawl (2000-2007) surveys.

Winter (Feb/Mar)	Spring (Apr/May)
	

Summer (Jul/Aug)	Autumn (Sep/Oct)
	

7.3.3.4 Thorny Skate

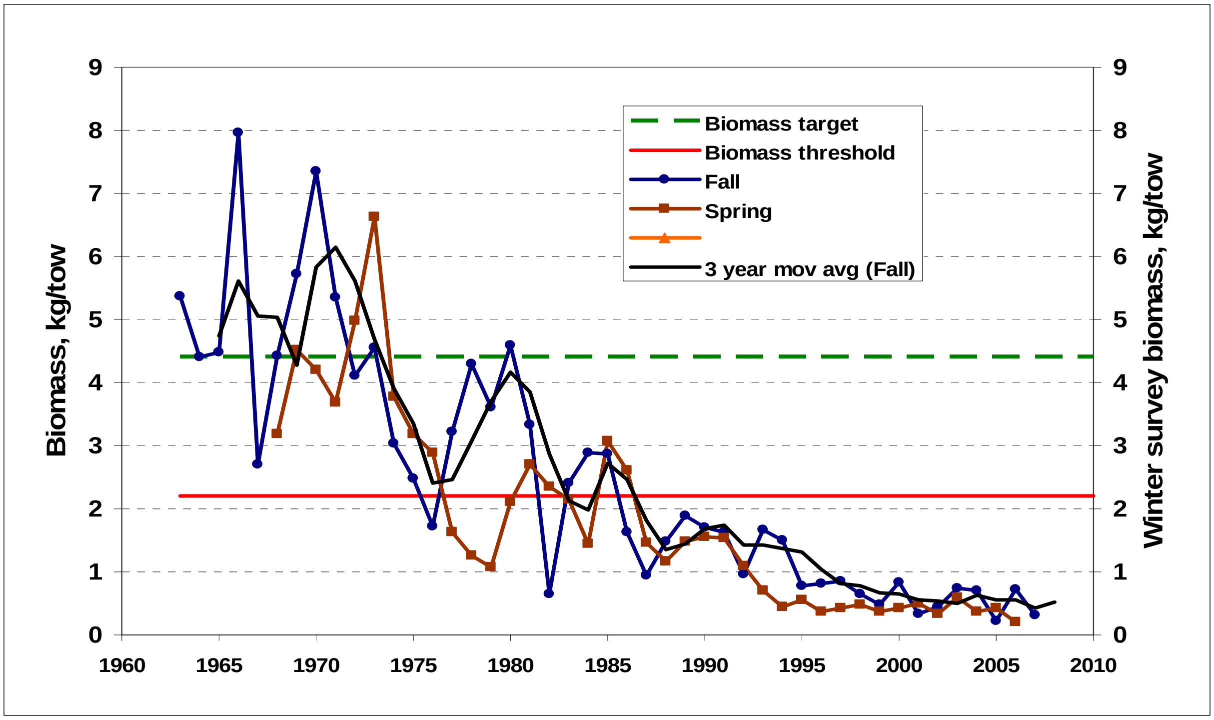
NEFSC bottom trawl surveys indicate that thorny skate are most abundant in the Gulf of Maine and Georges Bank offshore strata, with very few fish caught in inshore (< 27 meters depth), Southern New England, or Mid-Atlantic regions (Map 4). NEFSC spring and autumn survey indices for thorny skate have declined continuously over the last 40 years. NEFSC survey indices of thorny skate abundance declined steadily since the late 1970s, reaching historically low values in 2005 and 2006 that are less than 10% of the peak observed in the 1970s (Figure 4). The annual total catch of thorny skate in the NEFSC spring survey declined to 29 fish in 2006. This downward trend was also seen in the NEFSC autumn surveys reaching 35 fish in 2005. This equates to 0.2 fish or 0.2kg per tow in spring 2006 and 0.2 fish or 0.2 kg per tow in autumn 2006 (Table 12 and Table 13).

The median length of thorny skate in the survey catch ranged from 23 cm TL in the 2003 autumn survey to 63 cm in the 1971 autumn survey. The median length of the survey catch trended downward through most of the survey time series, but was stable in recent years in autumn surveys, and is currently 40-50 cm TL (16-20 in; SAW44 2006). Length frequency distributions from the NEFSC spring and autumn show a pattern of decline in abundance of larger individuals consistent with an increase in total mortality over the survey time series.

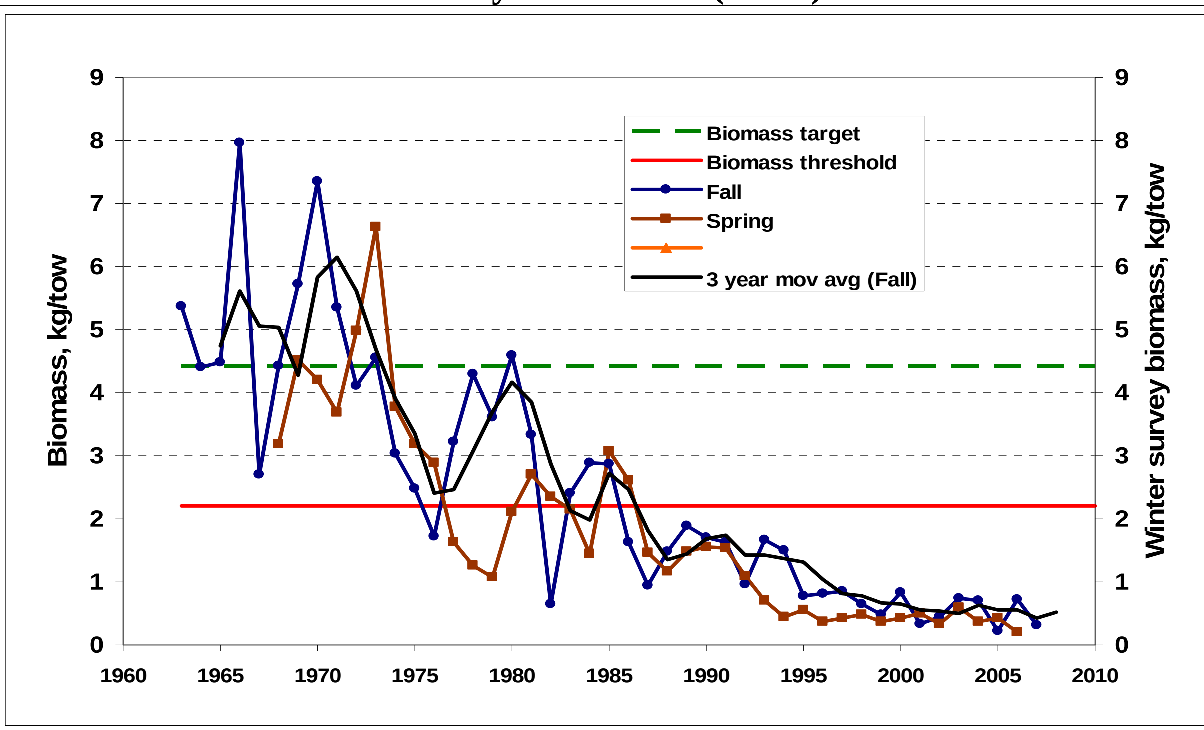
When the skate FMP was implemented in 2003, thorny skate was listed as overfished. This status remained unchanged since 2003. In 2007, overfishing was determined to be occurring on thorny skate as the 2005 – 2007 index was lower than the 2004 – 2006 index by 24%.

Figure 4. Thorny skate stratified mean weight and number per tow for the winter, spring, and fall NEFSC trawl surveys.

Survey Biomass (kg/tow)



Survey Abundance (#/tow)



Thorny skate dominates Canadian catches of skate species, comprising approximately 90% of rajids caught in survey trawls (Kulka and Miri, 2003). Thorny skate populations in Canadian waters are considered to be a single stock based on movement analyses (Kulka et al. 2006; Templeman, 1984) and biological characteristics. Two surveys are used to examine trends in thorny skate abundance in Canada; these are done in the spring and autumn. The spring survey catches fewer skates than the autumn survey, because the skates move to deeper waters in the spring season. However, the spring survey is the primary survey used in analyses because it is conducted throughout the entire area, whereas the autumn survey does not include a number of NAFO Divisions (Kulka et al. 2006). Similar to USA trends, Canadian indices of thorny skates declined in recent years. In the early 1990s, thorny skate abundance reached its lowest level in history. This was followed by a slight increase; the population stabilized at a low abundance in recent years. While the biomass has remained stable, the areal extent of this species has declined with density increasing near the center of the distribution indicating that hyper-aggregation is probably occurring in this species. This change in distribution is thought to be associated with temperature, because the area of high density coincides with the area of warmest bottom temperatures. Average weight in the spring survey has declined from 2 kg in the early 1970s to 1.2kg in 1996, with recent years being around 1.6 kg. The population was divided into immature and mature classes based on length. Immature thorny skates have experienced the largest fluctuations in the skate complex. Since the 1990s, the proportion of mature fish has increased while a decrease is evident in immature fish. A stock-recruitment relationship is evident in this population as a linear relationship exists between female spawning stock and young of the year. Age-based stock assessments are not currently possible owing to a lack of age and growth studies. An index of exploitation or relative F, defined as reported commercial catch/spring research survey biomass index, was examined (Kulka et al. 2006). Relative F has tripled since the mid-1980s, reaching 14% in 2003-2004. Reduced landings in 2005-2006 lowered the relative F to 4% (Kulka and Miri, 2007). It is estimated that a relative F of approximately 10% (equating to catches of 11,000 to 13,000 t) would allow recovery of the stock. Since 1999 average catch has been approximately 10,000 tons (average relative F or 9%) (Kulka et al. 2006).

Indices of abundance for thorny skate are available from MADMF spring and autumn research trawl surveys in the inshore waters of Massachusetts for the years 1978-2006. MADMF indices of thorny skate biomass have been variable over the time series, but there is a decreasing trend evident in both the spring and autumn time series. The spring index has stabilized around the median of 0.2 kg/tow throughout the 2000s, while the autumn index has been below the median of 0.6 kg/tow since 1994 except for 2001 and 2002 (SAW44 2006).

Table 12. Abundance and biomass from NEFSC spring surveys for thorny skate for the Gulf of Maine to Southern New England region (offshore strata 1-30, 33-40). The mean index, 95% confidence intervals, individual fish weight, minimum, mean, and maximum length, 5th, 50th, and 95th percentiles of length, number of nonzero tows, and number of fish caught are presented for 2000-2006.

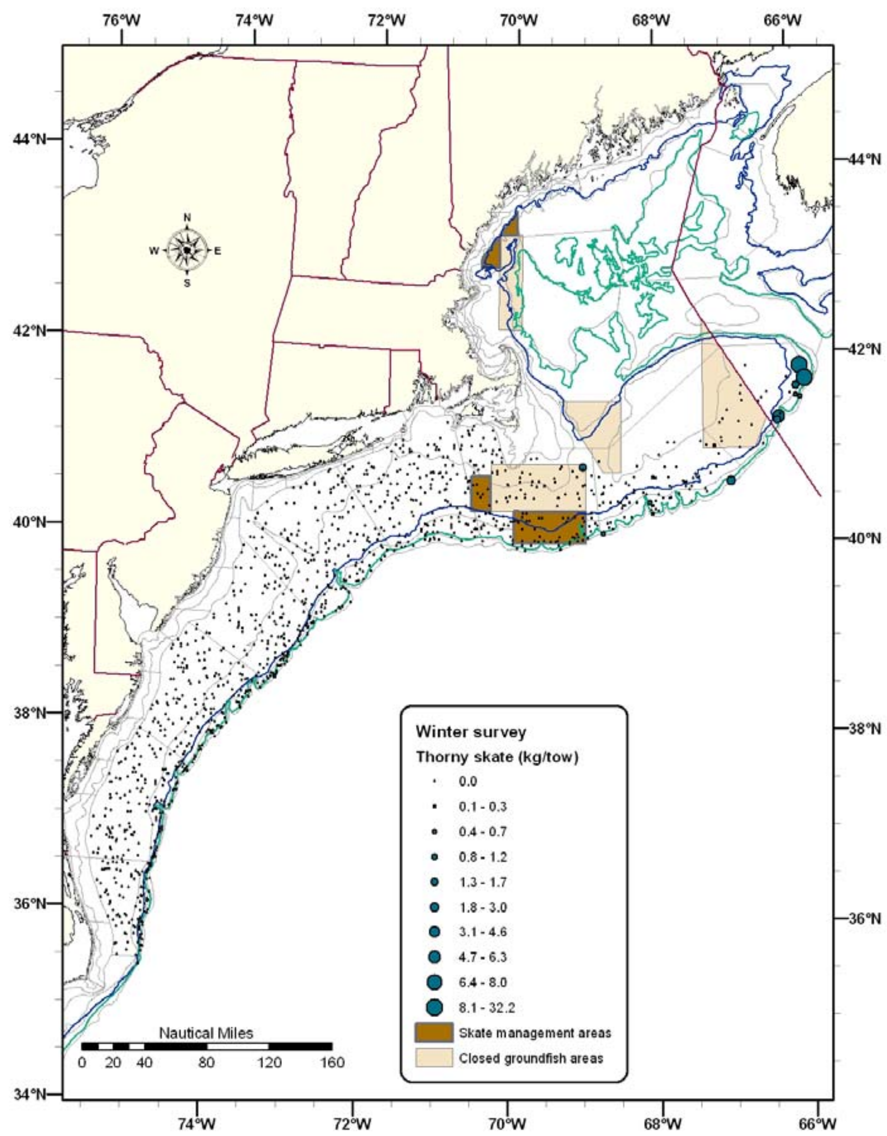
	weight/tow			**number/tow**				**Length (cm TL)**						**nonzero**	
	mean	lower	upper	mean	lower	upper	ind wt	min	5%	50%	mean	95%	max	tows	no fish
2000	0.423	0.166	0.68	0.47	0.013	0.927	0.9	12	12	24	34	82	89	28	13
2001	0.493	0.217	0.769	0.221	0.08	0.362	2.234	14	33	56	57.7	80	92	16	35
2002	0.333	0.138	0.529	0.248	0.127	0.369	1.34	13	15	38	42	88	93	24	53
2003	0.594	0.268	0.92	0.332	0.203	0.461	1.79	19	19	50	50.9	86	102	30	57
2004	0.368	0.178	0.557	0.212	0.128	0.296	1.731	15	15	47	49.3	91	95	22	48
2005	0.435	0.154	0.716	0.371	0.167	0.576	1.171	16	17	44	44.4	76	89	19	62
2006	0.201	0.035	0.366	0.186	0.02	0.352	1.079	12	14	41	41.9	83	87	15	29

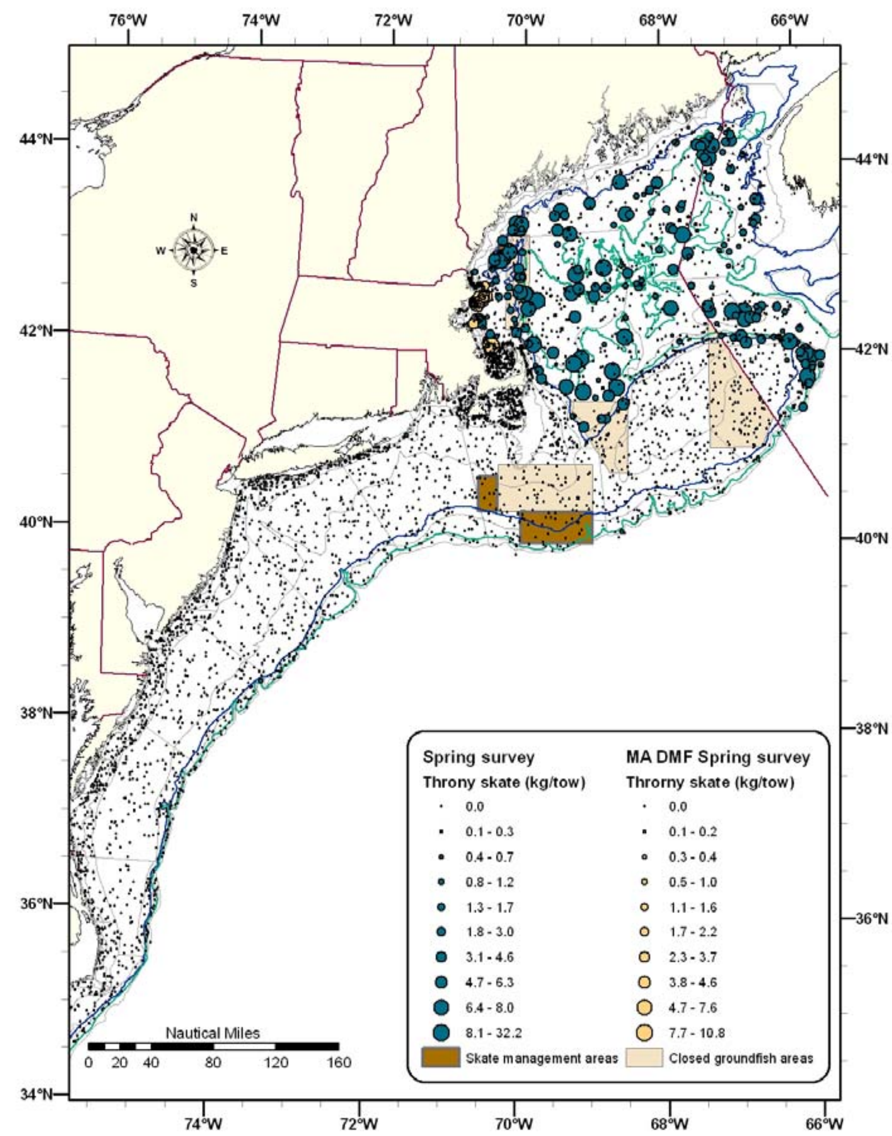
Table 13. Abundance and biomass from NEFSC autumn surveys for thorny skate for the Gulf of Maine to Southern New England region (offshore strata 1-30, 33-40). The mean index, 95% confidence intervals, individual fish weight, minimum, mean, and maximum length, 5th, 50th, and 95th percentiles of length, number of nonzero tows, and number of fish caught are presented for 2000-2005

	weight/tow			**number/tow**				**Length (cm TL)**						**nonzero**	
	mean	lower	upper	mean	lower	upper	ind wt	min	5%	50%	mean	95%	max	tows	no fish
2000	0.832	0.391	1.274	0.374	0.239	0.51	2.224	13	17	49	52.7	92	102	27	70
2001	0.332	0.087	0.577	0.294	0.157	0.43	1.129	16	17	44	44.1	74	82	23	60
2002	0.436	0.188	0.684	0.26	0.126	0.393	1.679	14	15	35	44.2	85	95	25	52
2003	0.742	0.45	1.035	0.93	0.168	1.691	0.798	12	14	23	34.2	74	89	34	175
2004	0.71	0.272	1.148	0.358	0.167	0.55	1.98	14	18	45	50.1	87	90	23	65
2005	0.224	0.092	0.357	0.205	-0.034	0.443	1.096	13	18	39	42.6	76	90	17	36

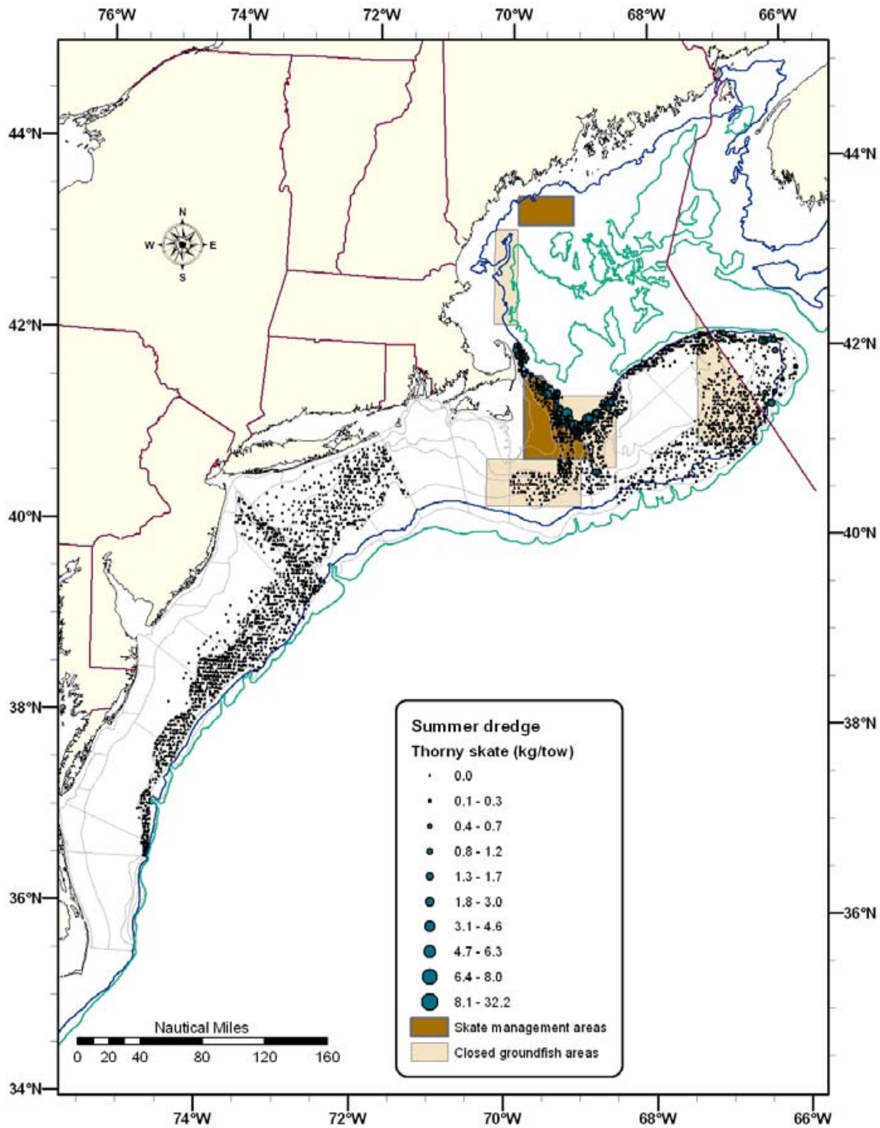
Map 4. Thorny skate biomass distribution in the winter trawl (2000-2007), spring trawl (2000-2008), summer dredge (2000-2007), and autumn trawl (2000-2007) surveys.

Winter (Feb/Mar)	Spring (Apr/May)

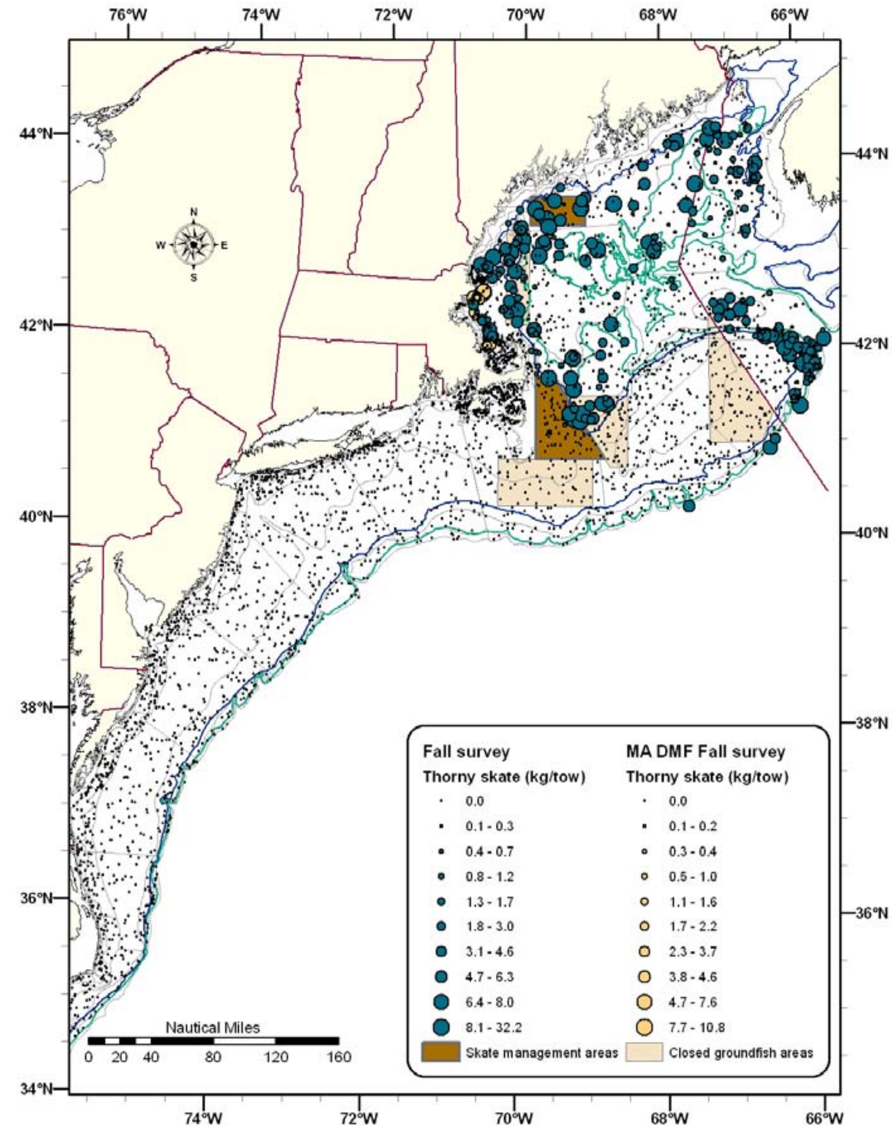




Summer (Jul/Aug)



Autumn (Sep/Oct)



7.3.3.5 Smooth Skate

NEFSC bottom trawl surveys indicate that smooth skate are most abundant in the Gulf of Maine and Georges Bank offshore strata regions, with very few fish caught in inshore (< 27 meters depth), Southern New England, or Mid-Atlantic regions (Map 5). Since 2000, the total annual catch of smooth skate in the NEFSC spring surveys has ranged from 30 fish in 2000 to 71 fish in 2006 (Table 14). Since 2000, the total annual catch of smooth skate in the NEFSC autumn surveys has ranged from 55 fish in 2000 to 44 fish in 2006 (Table 15).

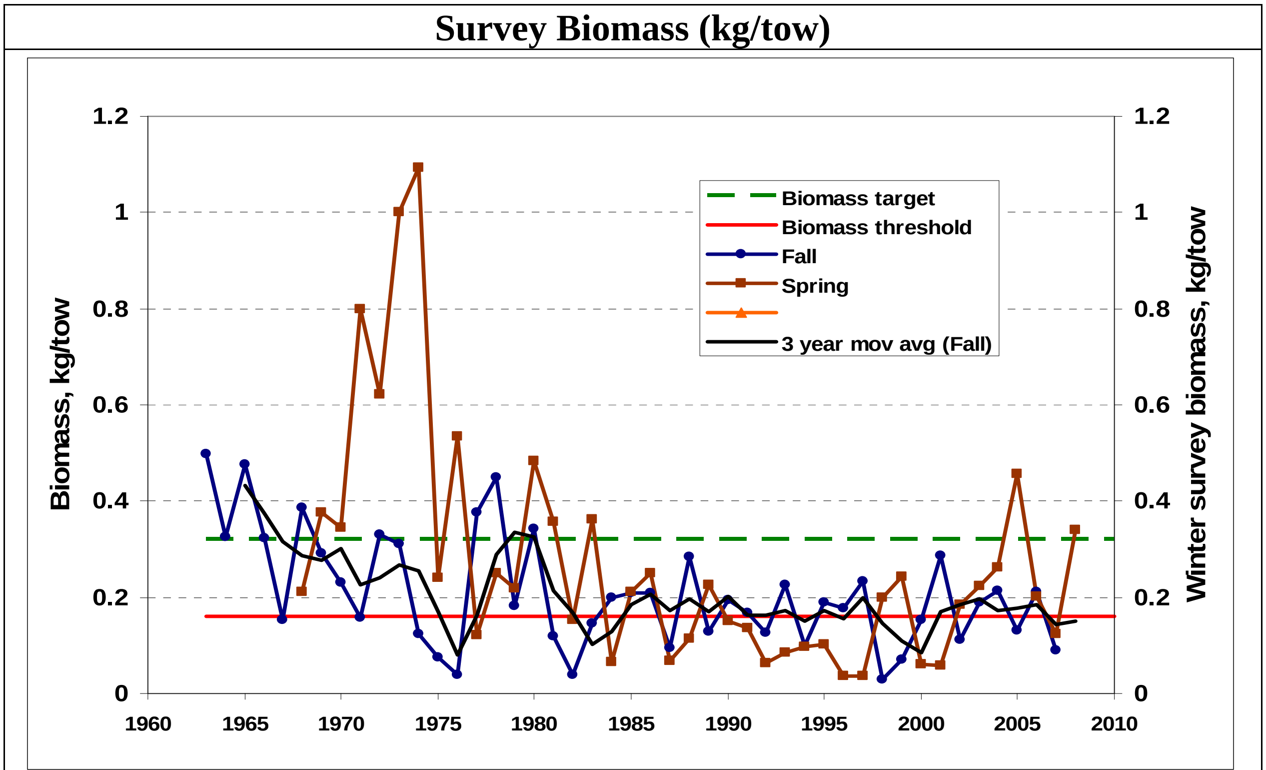
The median length of smooth skate in the survey catch in the GOM-SNE offshore region shows no trend over the full survey time series, and is currently at about 40 cm TL (16 in) (SAW44 2006). Length frequency distributions from the NEFSC spring and autumn surveys are presented in NEFSC 2007. In general, the length frequency distributions from the NEFSC spring and autumn surveys in the GOM offshore region show modes at 30 and 50 cm TL.

Indices of smooth skate abundance and biomass from the NEFSC surveys were at a peak during the early 1970s for the spring series and the late 1970s for the autumn series (Figure 5). NEFSC survey indices declined during the 1980s, before stabilizing during the early 1990s at about 25% of the autumn and 50% of the spring survey index values of the 1970s. In 2008, smooth skate was determined to be overfished based on the 2007 autumn survey data, because the three year moving average dropped below the threshold. Overfishing is not occurring on this species because the consecutive three-year moving average of the biomass indices did not exceed the maximum threshold which according to the FMP defines when overfishing is occurring

.

Smooth skate has been divided into five Designatable Units (DUs) based on their distribution in Canadian waters. For more detailed information regarding the 5 DUs, refer to McPhie (2006). Latitudinal differences in depth are apparent; depth increases with latitude. Changes in abundance are variable throughout the DUs. Smooth skate has generally declined throughout its range since the 1970s (Kulka et al. 2006b). The Funk DU appears to have experienced the greatest decline (91% for both adults and juveniles); declines in other DUs have been also been high (approximately 80%). In contrast to this, in the Hopedale Channel, an increase has occurred. The overall decline in abundance can be partially attributed to fishing activity but other factors are thought to play a role in the trend. The period of decline corresponds to cold water temperatures; an equivalent recovery in abundance has not occurred with the return of warmer water temperatures. Preliminary genetic analysis suggests a difference exists between smooth skate from Grand Banks and the Scotian Shelf; however, this is based on a limited number of samples and requires further analysis (Kulka et al. 2006b).

Figure 5. Smooth skate stratified mean weight and number per tow for the winter, spring, and fall NEFSC trawl surveys.



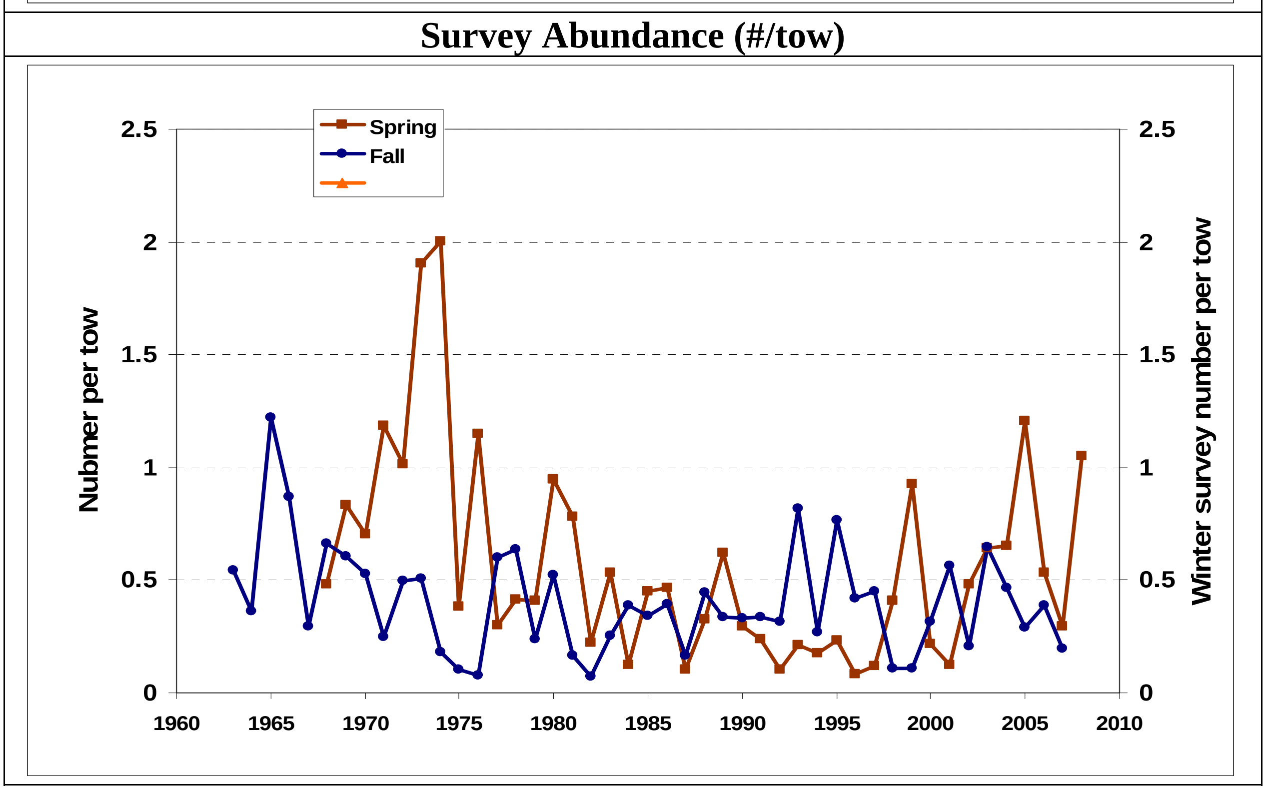


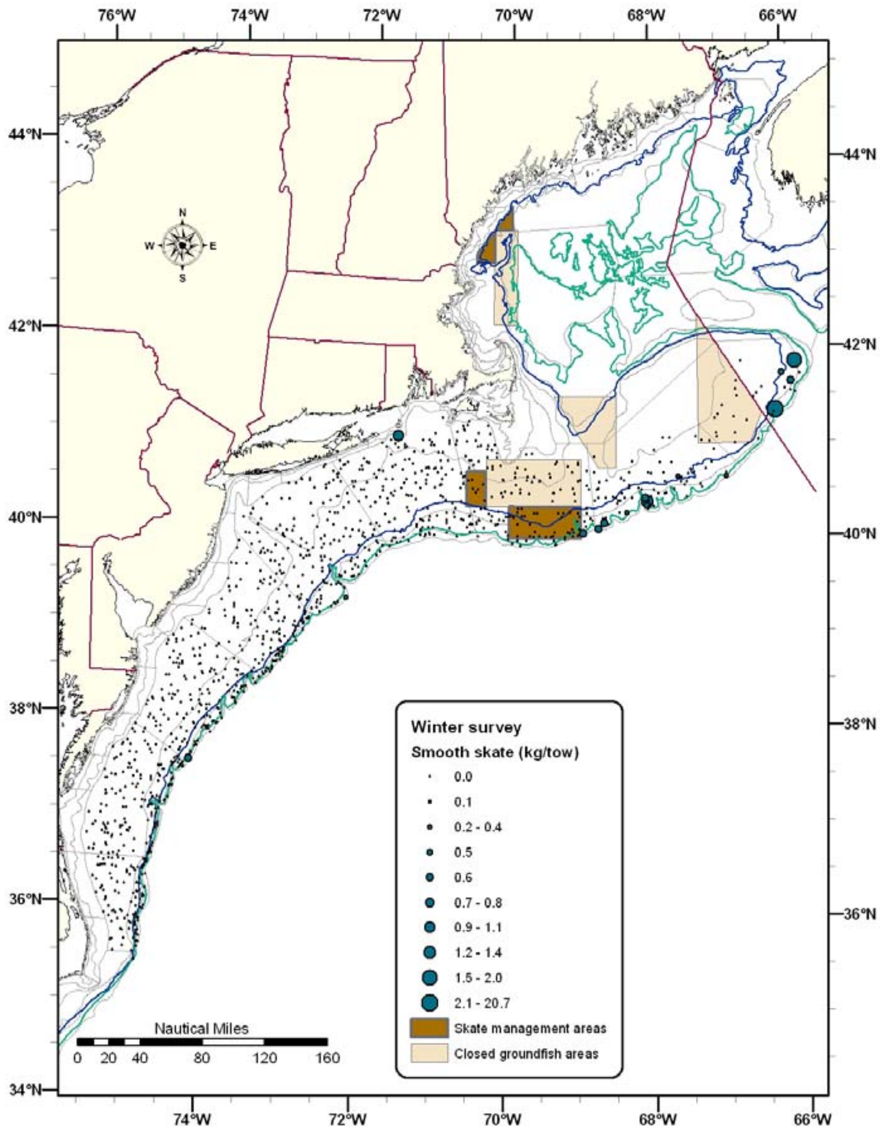
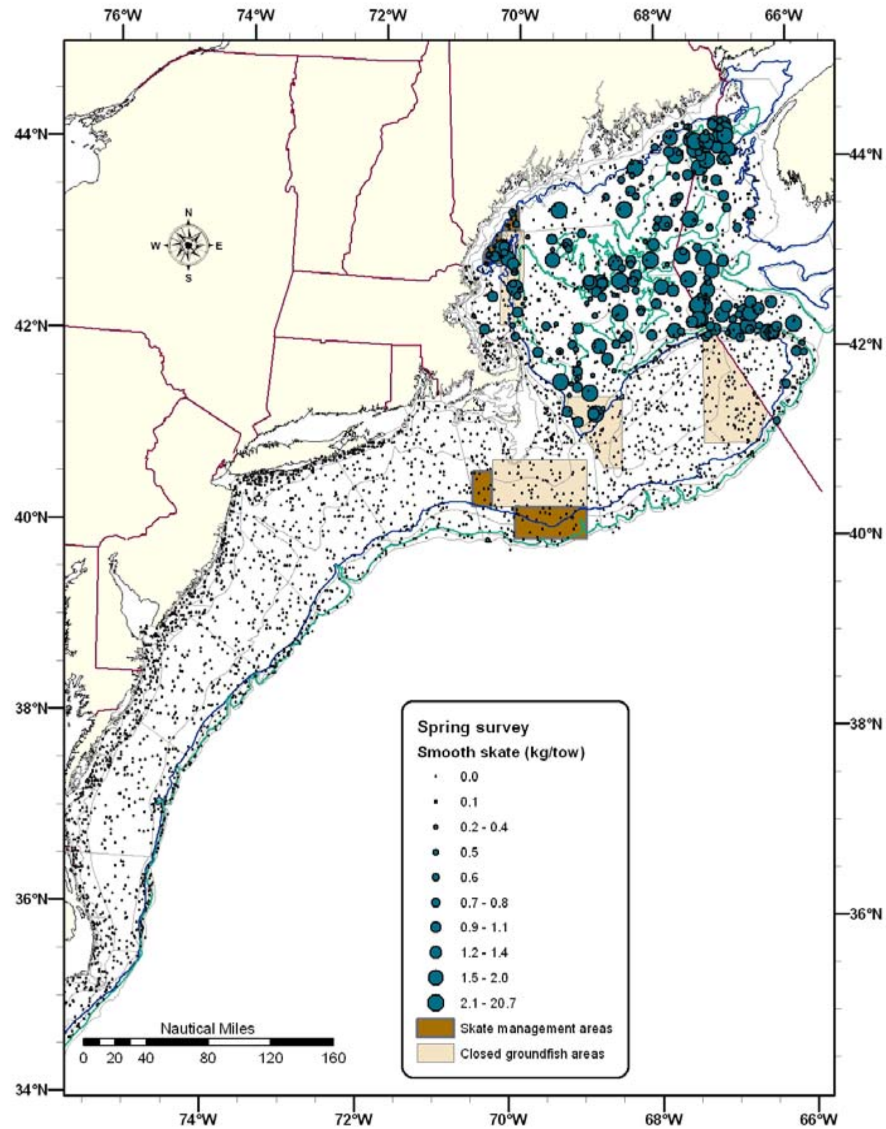
Table 14. Abundance and biomass from NEFSC spring surveys for smooth skate for the Gulf of Maine to Southern New England region (offshore strata 1-30, 33-40). The mean index, 95% confidence intervals, individual fish weight, minimum, mean, and maximum length, 5th, 50th, and 95th percentiles of length, number of nonzero tows, and number of fish caught are presented for 2000-2006.

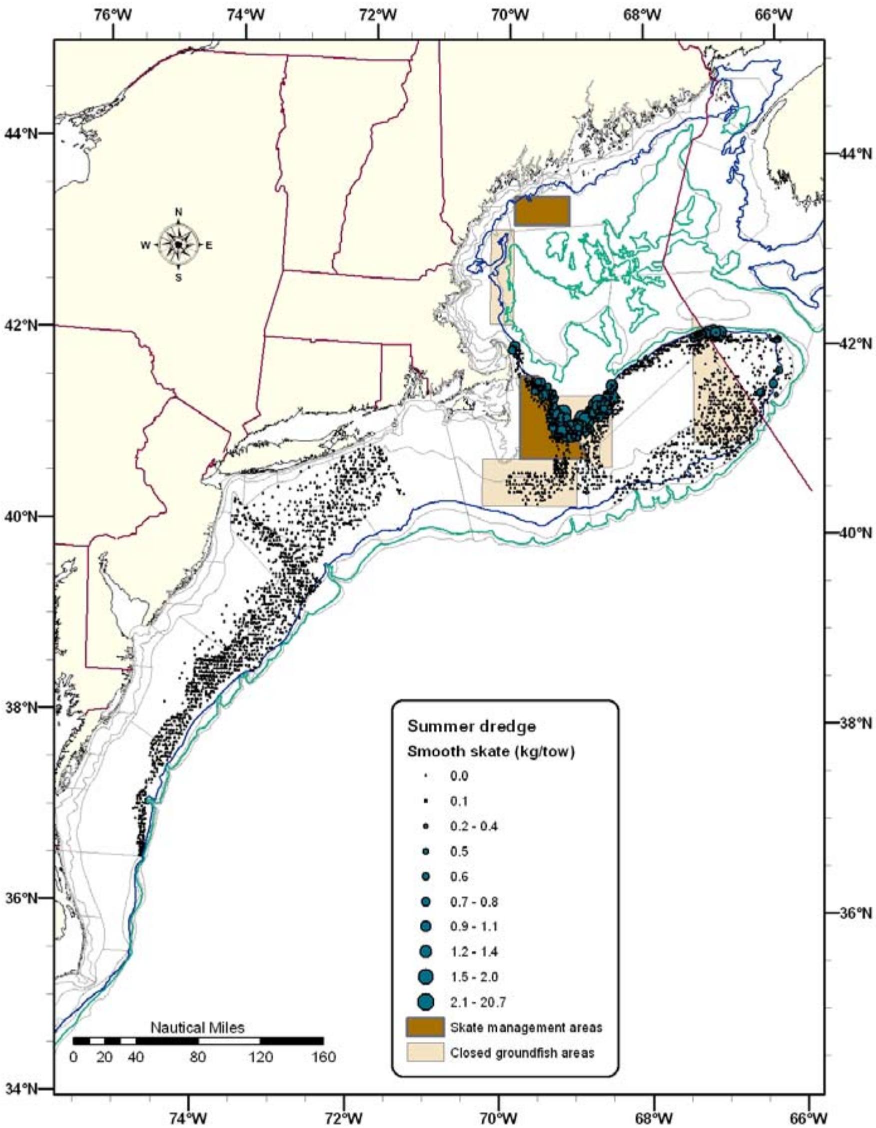
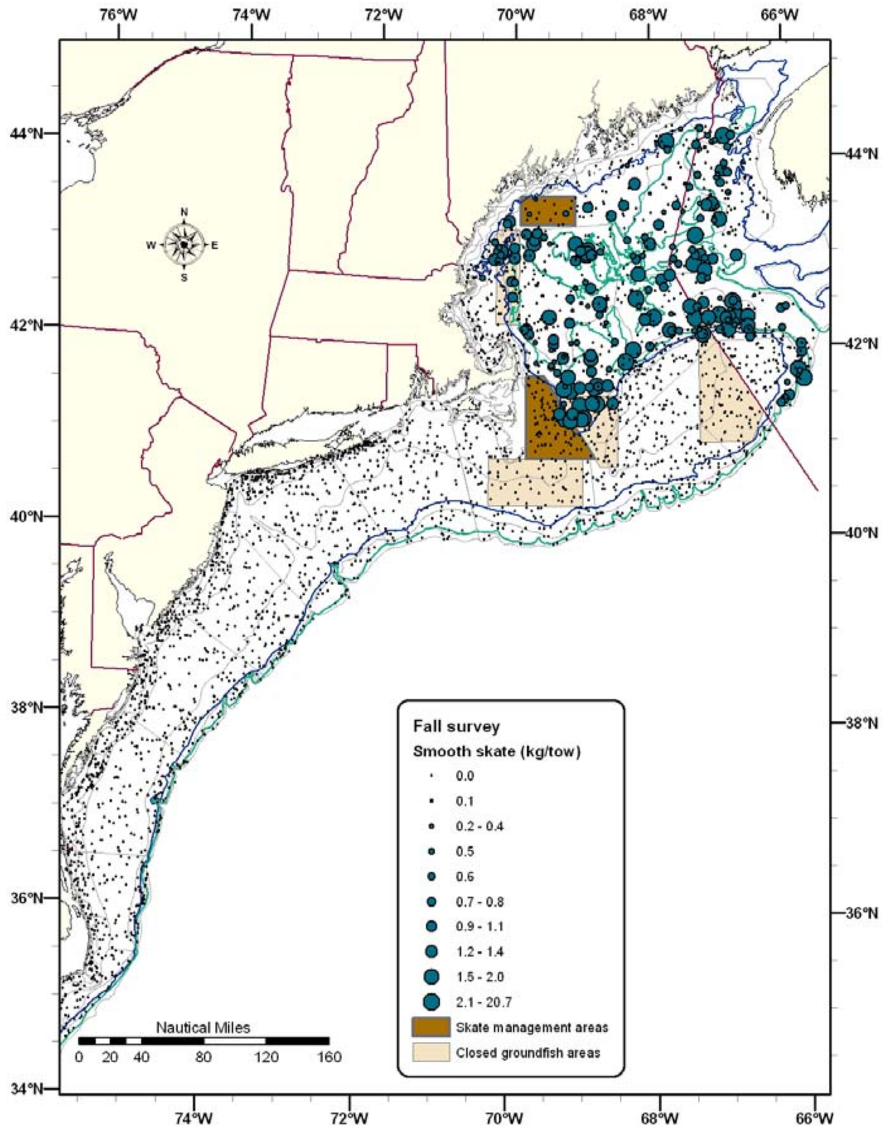
	weight/tow			**number/tow**				**Length (cm TL)**						**nonzero**	
	mean	lower	upper	mean	lower	upper	ind wt	min	5%	50%	mean	95%	max	tows	no fish
2000	0.06	0.025	0.095	0.22	-0.021	0.46	0.272	10	10	27	30.9	59	62	13	30
2001	0.058	0.02	0.096	0.125	0.058	0.192	0.466	19	28	46	44.6	57	60	16	25
2002	0.184	0.096	0.271	0.482	0.297	0.667	0.381	10	13	45	40.4	55	61	26	78
2003	0.224	0.161	0.287	0.642	0.429	0.348	0.348	14	19	40	40.4	55	59	36	95
2004	0.262	0.141	0.383	0.65	0.278	1.022	0.403	12	19	43	42.3	56	60	32	125
2005	0.457	0.125	0.788	1.207	0.288	2.126	0.378	10	27	42	42.4	53	60	22	178
2006	0.203	0.005	0.401	0.531	-0.009	1.072	0.382	19	21	41	41.3	56	62	22	71

Table 15. Abundance and biomass from NEFSC autumn surveys for smooth skate for the Gulf of Maine to Southern New England region (offshore strata 1-30, 33-40). The mean index, 95% confidence intervals, individual fish weight, minimum, mean, and maximum length, 5th, 50th, and 95th percentiles of length, number of nonzero tows, and number of fish caught are presented for 2000-2005.

	weight/tow			**number/tow**				**Length (cm TL)**						**nonzero**	
	mean	lower	upper	mean	lower	upper	ind wt	min	5%	50%	mean	95%	max	tows	no fish
2000	0.154	0.083	0.226	0.318	0.19	0.447	0.485	10	11	45	42.3	59	73	27	55
2001	0.287	0.169	0.405	0.565	0.349	0.781	0.507	17	23	49	46.5	58	62	29	84
2002	0.111	0.067	0.155	0.209	0.14	0.278	0.533	15	24	50	46.2	60	62	25	32
2003	0.19	0.076	0.304	0.646	0.248	1.045	0.294	10	14	39	36.3	52	62	30	84
2004	0.214	0.126	0.303	0.467	0.283	0.652	0.458	18	24	47	45.3	55	59	29	58
2005	0.131	0.039	0.224	0.291	0.143	0.439	0.451	15	17	47	43.1	59	62	18	44

Map 5. Smooth skate biomass distribution in the winter trawl (2000-2007), spring trawl (2000-2008), summer dredge (2000-2007), and autumn trawl (2000-2007) surveys.

Winter (Feb/Mar)	Spring (Apr/May)
	

Summer (Jul/Aug)	Autumn (Sep/Oct)
	

7.3.3.6 Clearnose Skate

NEFSC bottom trawl surveys indicate that clearnose skate are most abundant in the Mid-Atlantic offshore and inshore strata regions, with very few fish caught in Southern New England and no fish caught in other survey regions (Map 5). Since 2000, the total annual catch of clearnose skate in the NEFSC spring surveys has ranged from 126 fish in 2000 to 39 fish in 2006 (Table 16). Since 2000, the total annual catch of clearnose skate in the NEFSC autumn surveys has ranged from 61 fish in 2000 to 71 fish in 2006 (Table 17). Recent NEFSC winter survey (2000-2006) annual catches of clearnose skate have ranged from 1,449 fish in 2000 to 1,916 fish in 2006, equating to a maximum stratified mean catch per tow of 9 fish or 10 kg per tow in 2000 and 11 fish or 12 kg per tow in 2006 (Table 18).

The median length of clearnose skate in the spring survey catch has increased over the time series, from about 50 cm TL during the late 1970s to at about 60 cm TL in recent years (24 in; SAW44 2006). The median length of the autumn survey catch has been stable over the time series, and is also at about 60 cm TL. Length frequency distributions from the NEFSC spring and autumn surveys are presented in the SAW 44 documents and are not reproduced in this SAFE Report. In general, the length frequency distributions show a consistent mode at 60-70 cm TL that may represent the accumulated abundance of several older ages.

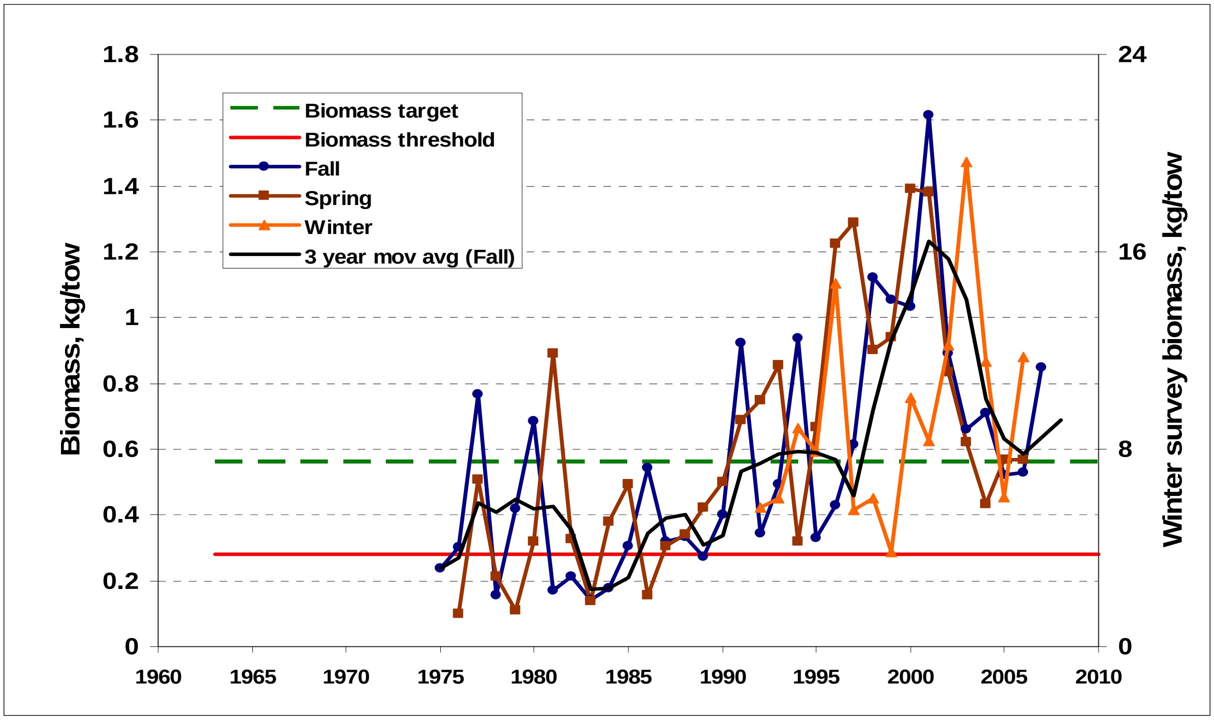
NEFSC spring and autumn survey indices for clearnose skate have increased since the mid-1980s, through 2000 and have since declined to about average values (SAW44 2006). Clearnose skate biomass index is currently above the biomass threshold reference point and the B_{MSY} proxy and is not considered to be overfished (Table 2). Overfishing is not occurring on this species because the consecutive three-year moving average of the biomass indices did not exceed the maximum threshold which according to the FMP defines when overfishing is occurring
.

Indices of abundance for clearnose skate are available from the CTDEP spring and autumn finfish trawl surveys in Long Island Sound for the years 1984-2006 (1992 and later only for biomass). The CTDEP survey has caught very few clearnose skate, with annual catches ranging from 0 to 20 skates through 1998, but the indices have increased in Long Island Sound over the time series.

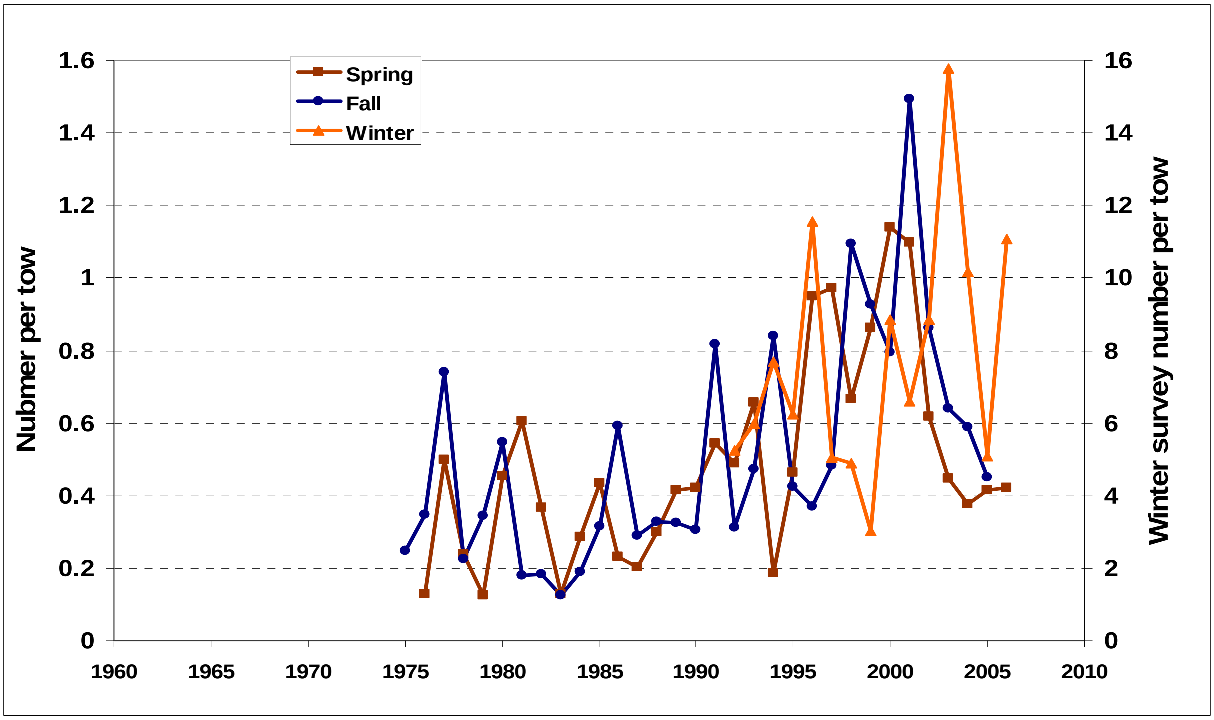
Indices of abundance for clearnose skate are available from the Virginia Institute of Marine Science (VIMS) trawl survey in Chesapeake Bay and its' tributaries for the years 1988-1998. The VIMS trawl survey indices suggest no trend in clearnose skate abundance over this period (SAW44 2006).

Figure 6. Clearnose skate stratified mean weight and number per tow for the winter, spring, and fall NEFSC trawl surveys.

Survey Biomass (kg/tow)



Survey Abundance (#/tow)



.

Table 16. Abundance and biomass from NEFSC spring surveys for clearnose skate for the Mid-Atlantic region (offshore strata 61-76, inshore strata 15-44). The mean index, 95% confidence intervals, individual fish weight, minimum, mean, and maximum length, 5th, 50th, and 95th percentiles of length, number of nonzero tows, and number of fish caught are presented for 2000-2006.

	weight/tow			**number/tow**				**Length (cm TL)**						**nonzero**	
	mean	lower	upper	mean	lower	upper	ind wt	min	5%	50%	mean	95%	max	tows	no fish
2000	1.391	1.046	1.736	1.14	0.789	1.491	1.221	24	40	59	59.4	70	76	31	126
2001	1.38	0.674	2.087	1.097	0.456	1.738	1.258	42	49	62	60.8	68	72	19	74
2002	0.836	0.281	1.392	0.617	0.241	0.993	1.355	29	42	62	60.5	69	74	23	59
2003	0.622	0.366	0.879	0.448	0.265	0.631	1.389	49	49	62	62.7	75	76	16	35
2004	0.433	0.05	0.815	0.376	0.049	0.703	1.151	35	35	59	56.2	70	72	9	23
2005	0.569	0.03	1.109	0.414	0.008	0.82	1.374	42	42	61	61.2	70	73	11	27
2006	0.567	0.189	0.946	0.42	0.179	0.661	1.35	36	41	63	60.7	68	72	18	39

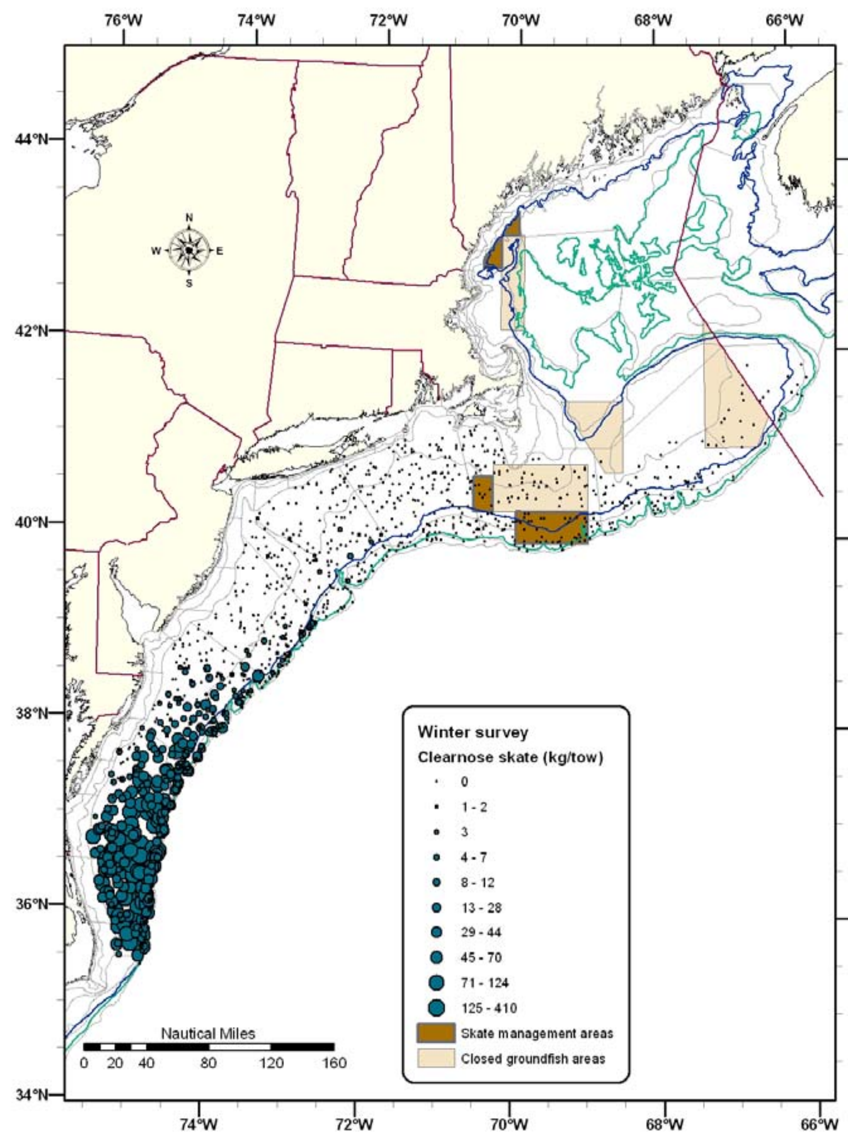
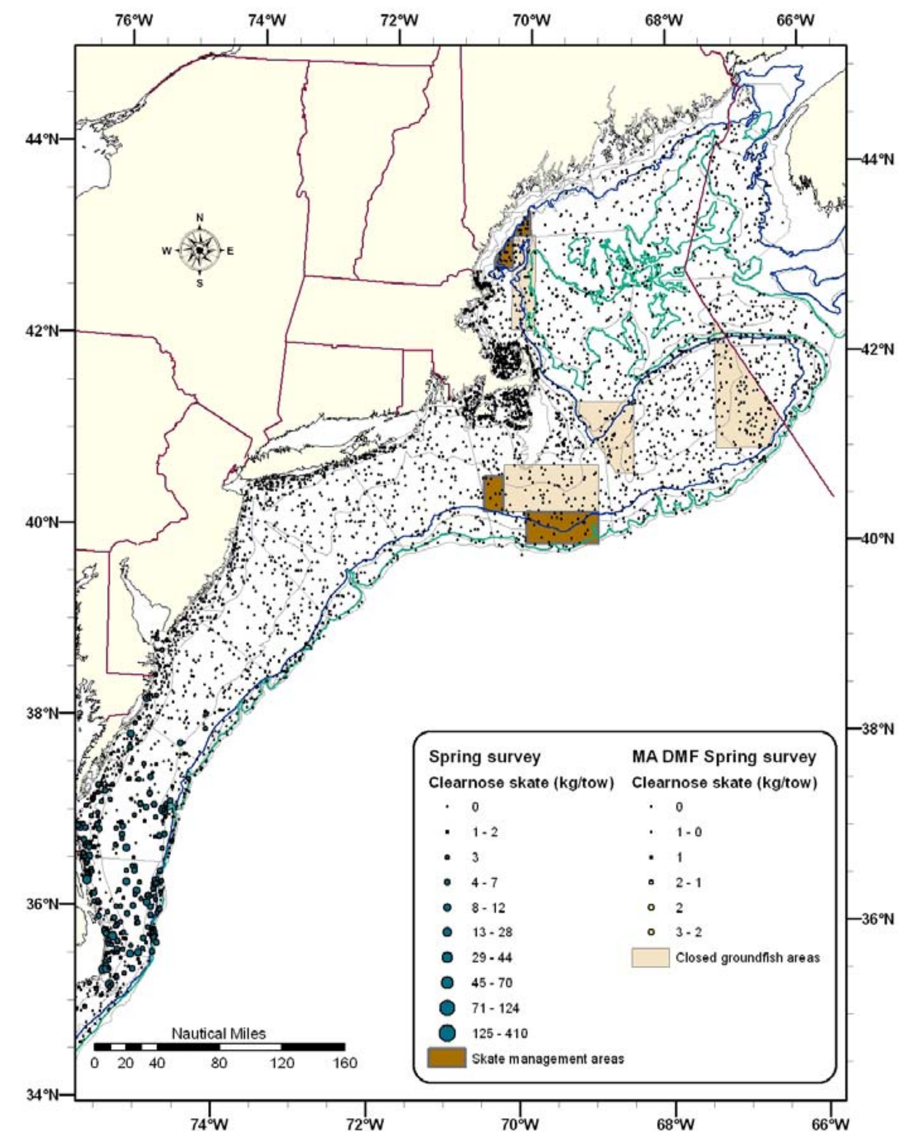
Table 17. Abundance and biomass from NEFSC autumn surveys for clearnose skate for the Mid-Atlantic region (offshore strata 61-76, inshore strata 15-44). The mean index, 95% confidence intervals, individual fish weight, minimum, mean, and maximum length, 5th, 50th, and 95th percentiles of length, number of nonzero tows, and number of fish caught are presented for 2000-2005.

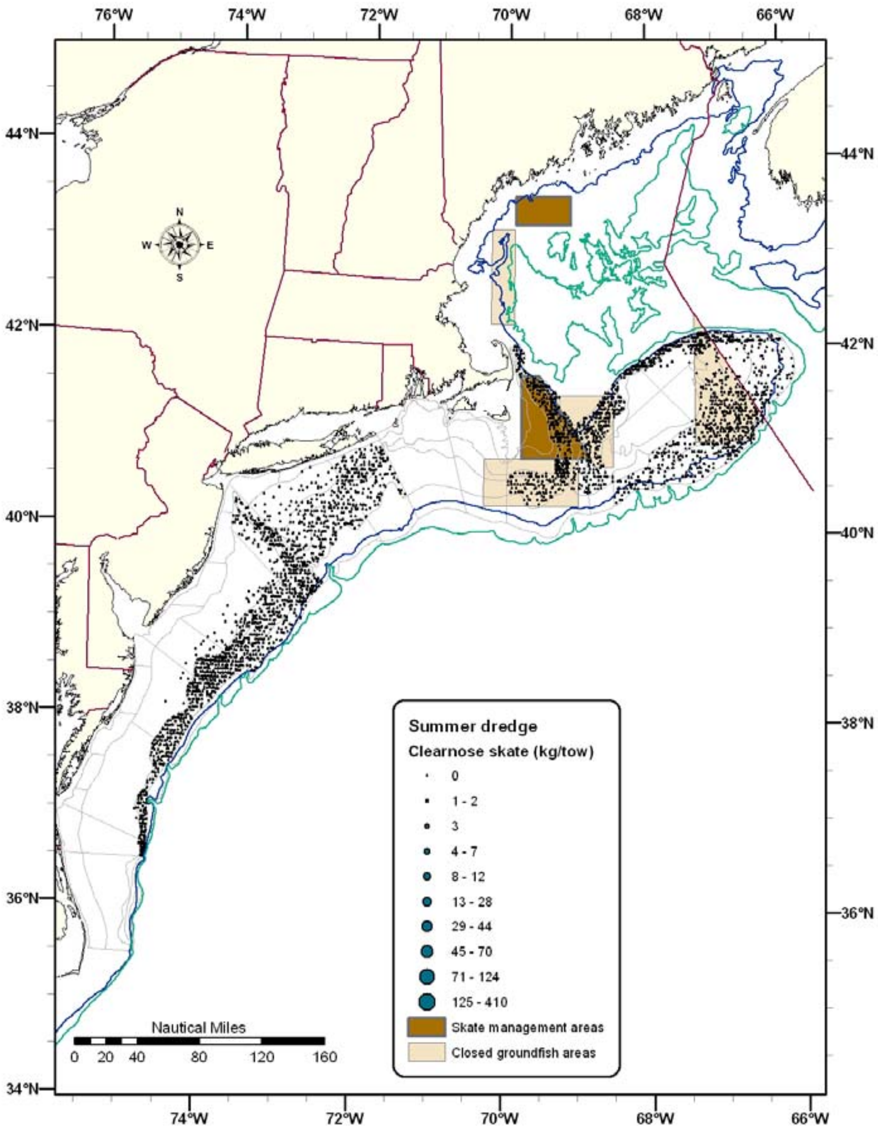
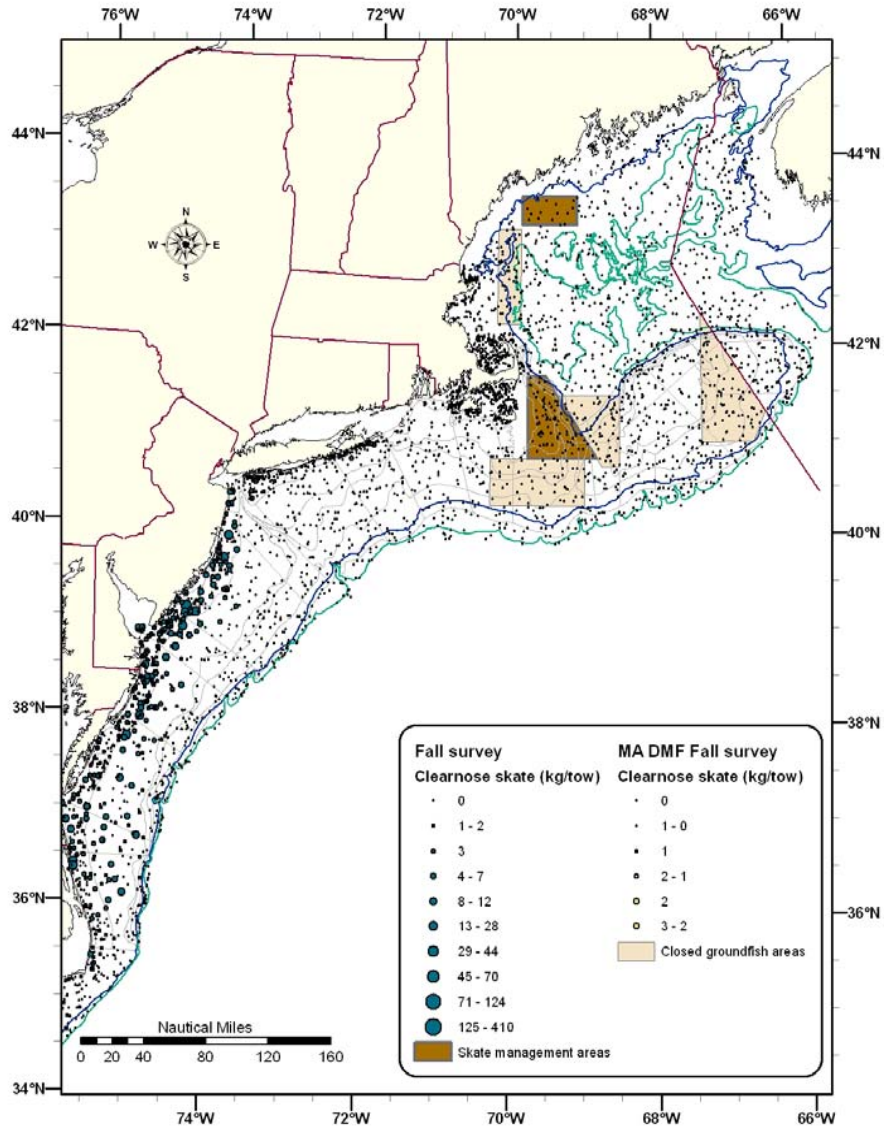
	weight/tow			**number/tow**				**Length (cm TL)**						**nonzero**	
	mean	lower	upper	mean	lower	upper	ind wt	min	5%	50%	mean	95%	max	tows	no fish
2000	1.032	0.422	1.642	0.795	0.353	1.238	1.298	14	47	60	60.5	69	74	29	61
2001	1.614	1.092	2.136	1.494	0.984	2.004	1.081	13	15	59	55.2	68	73	41	221
2002	0.891	0.372	1.411	0.863	0.317	1.409	1.033	14	38	55	56	68	73	27	63
2003	0.661	0.417	0.906	0.64	0.456	0.823	1.034	15	30	54	54.5	71	78	38	81
2004	0.709	0.201	1.217	0.59	0.172	1.008	1.201	37	43	62	60.1	69	75	18	55
2005	0.524	0.192	0.855	0.452	0.207	0.697	1.159	26	37	62	59.6	71	74	30	71

Table 18. Abundance and biomass from NEFSC winter surveys for clearnose skate for the Georges Bank to Mid-Atlantic region (offshore strata 1-3,5-7,9-11,13-14,16,61-63,65-67,69-71,73-75). The mean index, 95% confidence intervals, individual fish weight, minimum, mean, and maximum length, 5th, 50th, and 95th percentiles of length, number of nonzero tows, and number of fish caught are presented for 2000-2006. Stratum 16 not sampled in 1993, 2000, 2002-2006. Strata 13 and 14 not sampled in 2003. Stratum 63 not sampled in 1993. Stratum 14 not sampled in 2005.

	weight/tow			**number/tow**				**Length (cm TL)**						**nonzero**	
	mean	lower	upper	mean	lower	upper	ind wt	min	5%	50%	mean	95%	max	tows	no fish
2000	10.102	5.693	14.51	8.864	4.579	13.15	1.14	25	42	59	58.2	69	93	43	1449
2001	8.316	5.624	11.008	5.499	4.24	8.957	1.26	25	43	61	60.6	69	86	41	1300
2002	12.223	8.343	16.102	8.864	5.886	11.843	1.379	23	39	63	61.6	70	74	51	1704
2003	19.637	13.819	25.455	15.769	10.902	20.635	1.245	23	39	62	59.1	70	81	36	2260
2004	11.566	7.743	15.389	10.462	6.344	13.979	1.138	20	35	60	58.1	70	80	38	1880
2005	6.036	3.837	8.235	5.078	2.425	7.731	1.189	24	44	60	59.1	70	82	26	1047
2006	11.723	4.862	18.585	11.085	4.693	17.477	1.058	23	35	57	56.7	70	77	41	1916

Map 6. Clearnose skate biomass distribution in the winter trawl (2000-2007), spring trawl (2000-2008), summer dredge (2000-2007), and autumn trawl (2000-2007) surveys.

Winter (Feb/Mar)	Spring (Apr/May)
	

Summer (Jul/Aug)	Autumn (Sep/Oct)
	

7.3.3.7 Rosette Skate

NEFSC bottom trawl surveys indicate that rosette skate are most abundant in the Mid-Atlantic offshore strata region, with very few fish caught in Southern New England and Georges Bank and no fish caught in the Gulf of Maine or inshore (Map 6). Since 2000, the total annual catch of rosette skate in the NEFSC spring surveys has ranged from 15 fish in 2000 to 8 fish in 2006 (Table 19). Since 2000, the total annual catch of rosette skate in the NEFSC autumn surveys has ranged from 10 fish in 2000 to 24 fish in 2005 (Table 20). Calculated on a per tow basis, these spring survey catches equate to maximum stratified mean number per tow indices for the Mid-Atlantic offshore strata set of about 0.1 fish, or about 0.03 kg, per tow during 2000 and about 0.05 fish, or about 0.01 kg, per tow during 2006 (Table 19 and Table 20).

Recent NEFSC winter survey (2000-2006) annual catches of rosette skate have ranged from 740 fish in 2000 to 513 fish in 2006, equating to a maximum stratified mean catch per tow of 0.7 fish or 0.3 kg per tow in 2000 and 0.8 fish or 0.4 kg per tow in 2006 (Table 21).

The median length of rosette skate in the survey catch has been stable over the spring and autumn time series at about 36-37 cm TL (14 in; SAW44 2006). Length frequency distributions from the NEFSC spring and autumn surveys are presented in the SAW 30 documents. In general, the length frequency distributions show a consistent mode at 30-40 cm TL.

Indices of rosette skate abundance and biomass from the NEFSC surveys were at a peak during 1975-1980, before declining through 1986. NEFSC survey indices for rosette skate increased since 1986 through 2001, declined slightly and recent indices are near the peak values of the late 1970s (Figure 7). Rosette skate biomass index is currently above the biomass threshold reference point and the B_{MSY} proxy and is not considered to be overfished. Overfishing is not occurring on this species because the consecutive three-year moving average of the biomass indices did not exceed the maximum threshold which according to the FMP defines when overfishing is occurring
.

Figure 7. Rosette skate stratified mean weight and number per tow for the winter, spring, and fall NEFSC trawl surveys.

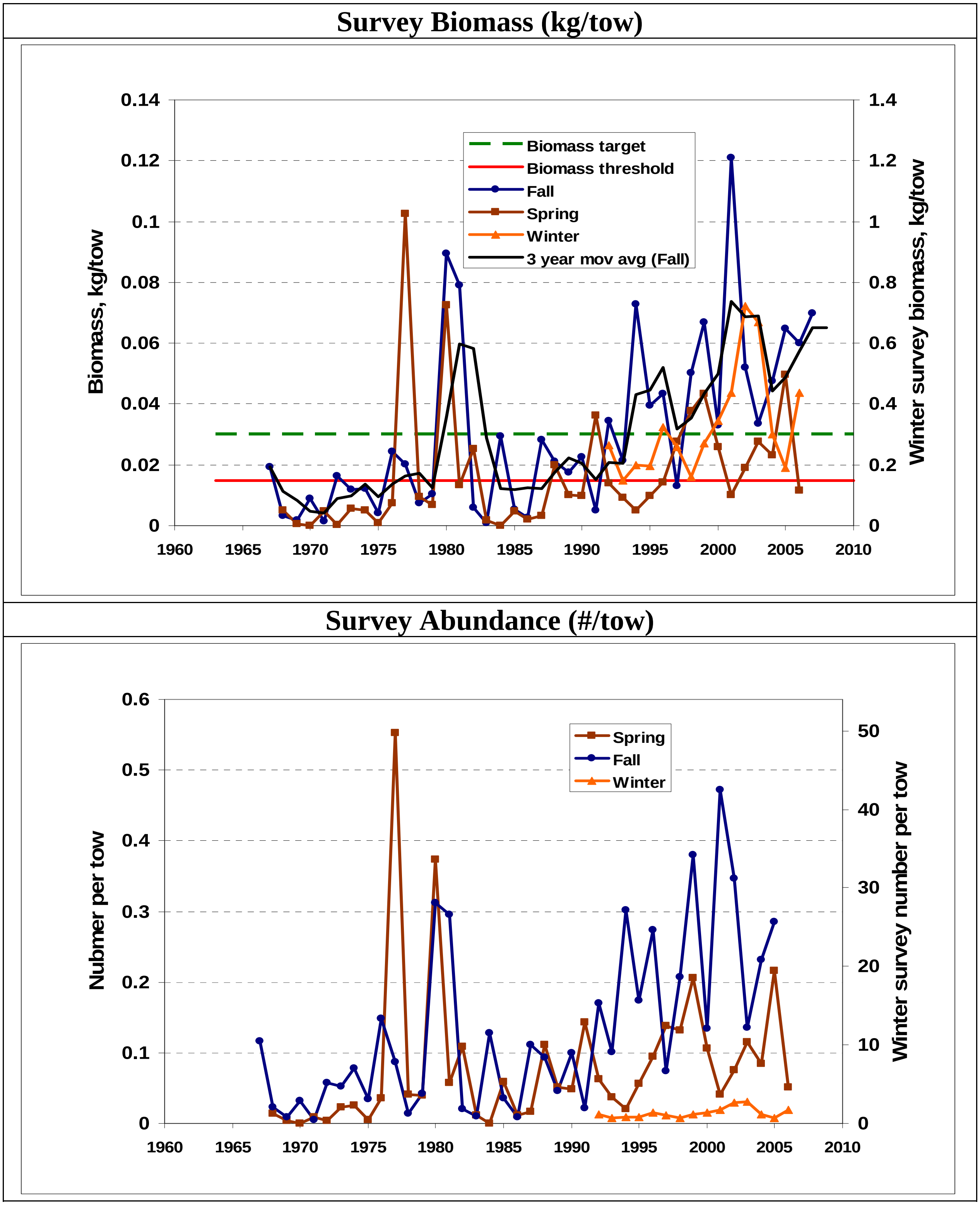


Table 19. Abundance and biomass from NEFSC spring surveys for rosette skate for the Mid-Atlantic region (offshore strata 61-76). The mean index, 95% confidence intervals, individual fish weight, minimum, mean, and maximum length, 5th, 50th, and 95th percentiles of length, number of nonzero tows, and number of fish caught are presented for 2000-2006.

	weight/tow			**number/tow**			**Length (cm TL)**							**nonzero**	
	mean	lower	upper	mean	lower	upper	ind wt	min	5%	50%	mean	95%	max	tows	no fish
2000	0.026	0.009	0.043	0.106	0.04	0.171	0.247	30	32	37	38	41	42	7	15
2001	0.01	-0.005	0.025	0.041	-0.012	0.095	0.244	21	21	40	38.2	40	41	4	4
2002	0.019	-0.007	0.045	0.076	-0.029	0.18	0.252	12	12	38	34.1	39	40	3	5
2003	0.028	-0.002	0.057	0.115	0.003	0.226	0.241	9	24	38	37	39	41	5	17
2004	0.023	-0.009	0.055	0.084	-0.025	0.193	0.276	30	32	39	39.2	40	41	3	7
2005	0.05	-0.029	0.128	0.216	-0.131	0.564	0.229	13	31	37	36.7	40	41	5	21
2006	0.012	0.007	0.016	0.051	0.02	0.081	0.23	25	25	39	35.5	40	41	5	8

Table 20. Abundance and biomass from NEFSC autumn surveys for rosette skate for the Mid-Atlantic region (offshore strata 61-76). The mean index, 95% confidence intervals, individual fish weight, minimum, mean, and maximum length, 5th, 50th, and 95th percentiles of length, number of nonzero tows, and number of fish caught are presented for 2000-2005.

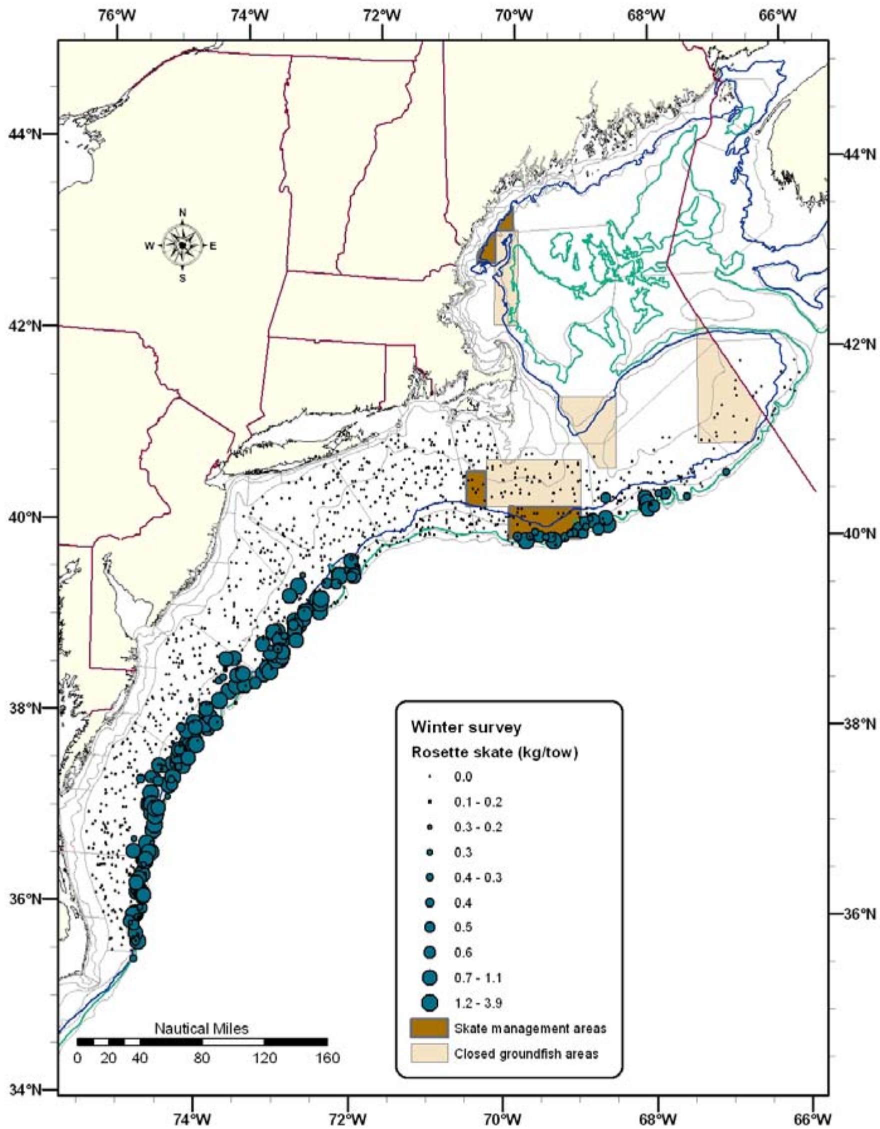
	weight/tow			**number/tow**			**Length (cm TL)**							**nonzero**	
	mean	lower	upper	mean	lower	upper	ind wt	min	5%	50%	mean	95%	max	tows	no fish
2000	0.033	-0.006	0.073	0.134	-0.015	0.283	0.248	26	30	35	36.5	39	40	7	10
2001	0.121	-0.007	0.249	0.472	-0.016	0.961	0.257	11	34	39	38.6	43	44	10	28
2002	0.052	0.009	0.095	0.347	0.045	0.648	0.15	8	8	30	28	40	42	11	29
2003	0.033	0.016	0.051	0.136	0.071	0.2	0.247	33	33	36	37.4	39	41	7	18
2004	0.048	0.003	0.092	0.231	0.03	0.432	0.206	19	29	35	35.5	37	40	8	29
2005	0.065	0.001	0.129	0.286	-0.004	0.575	0.227	30	30	35	36.4	39	40	7	24

Table 21. Abundance and biomass from NEFSC winter surveys for rosette skate for the Georges Bank to Mid-Atlantic region (offshore strata 1-3,5-7,9-11,13-14,16,61-63,65-67,69-71,73-75). The mean index, 95% confidence intervals, individual fish weight, minimum, mean, and maximum length, 5th, 50th, and 95th percentiles of length, number of nonzero tows, and number of fish caught are presented for 2000-2006. Stratum 16 not sampled in 1993, 2000, 2002-2006. Strata 13 and 14 not sampled in 2003. Stratum 63 not sampled in 1993. Stratum 14 not sampled in 2005.

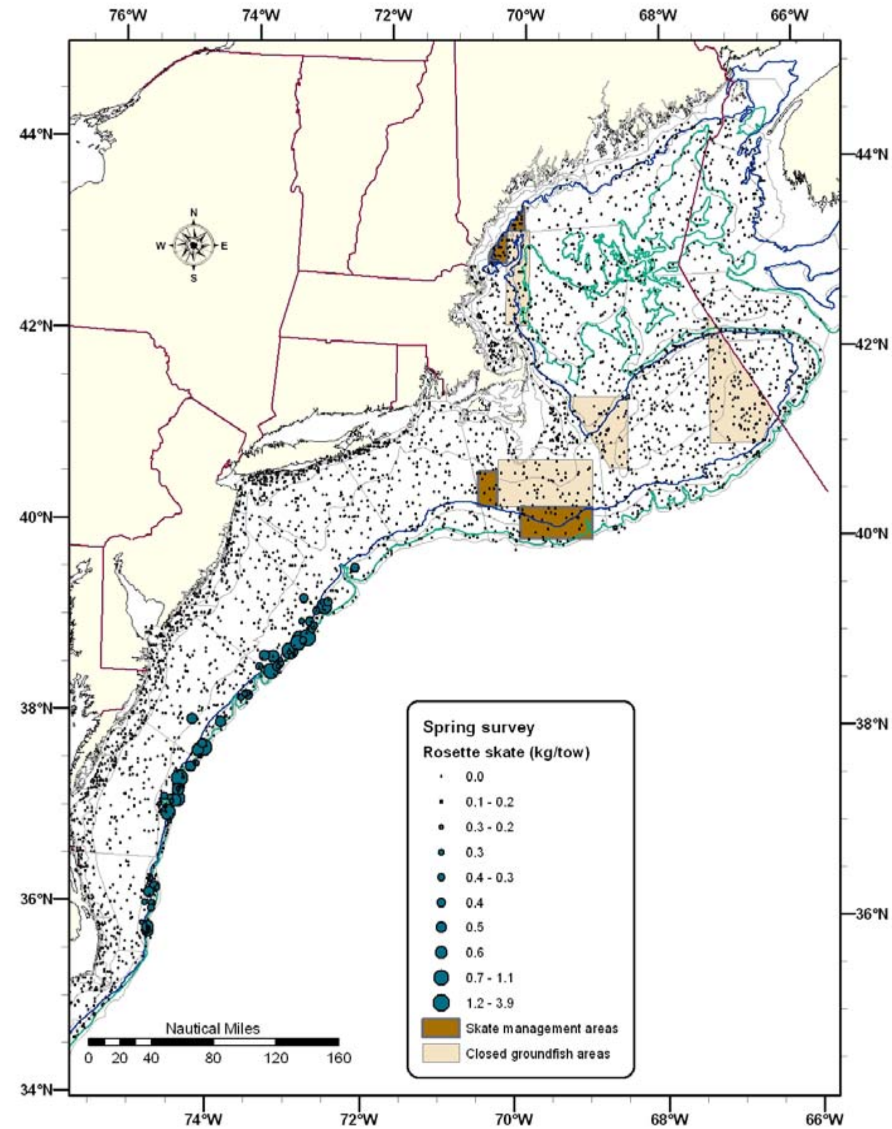
	weight/tow			number/tow				Length (cm TL)						nonzero	
	mean	lower	upper	mean	lower	upper	ind wt	min	5%	50%	mean	95%	max	tows	no fish
2000	0.344	0.198	0.491	1.357	0.725	1.989	0.254	8	28	37	37.5	43	47	34	740
2001	0.437	0.185	0.69	1.718	0.797	2.64	0.254	9	24	38	37.6	41	46	36	790
2002	0.723	0.14	1.307	2.655	0.603	4.708	0.272	8	29	38	38.3	42	47	34	913
2003	0.67	0.195	1.144	2.774	0.802	4.745	0.242	8	26	37	36.9	41	47	28	1029
2004	0.3	0.171	0.429	1.192	0.653	1.73	0.252	16	31	37	37.8	41	46	29	784
2005	0.189	0.09	0.289	0.716	0.357	1.076	0.264	12	30	38	38.2	43	45	19	281
2006	0.437	0.209	0.665	1.738	0.821	2.654	0.251	8	31	37	37.7	42	45	28	513

Map 7. Rosette skate biomass distribution in the winter trawl (2000-2007), spring trawl (2000-2008), summer dredge (2000-2007), and autumn trawl (2000-2007) surveys.

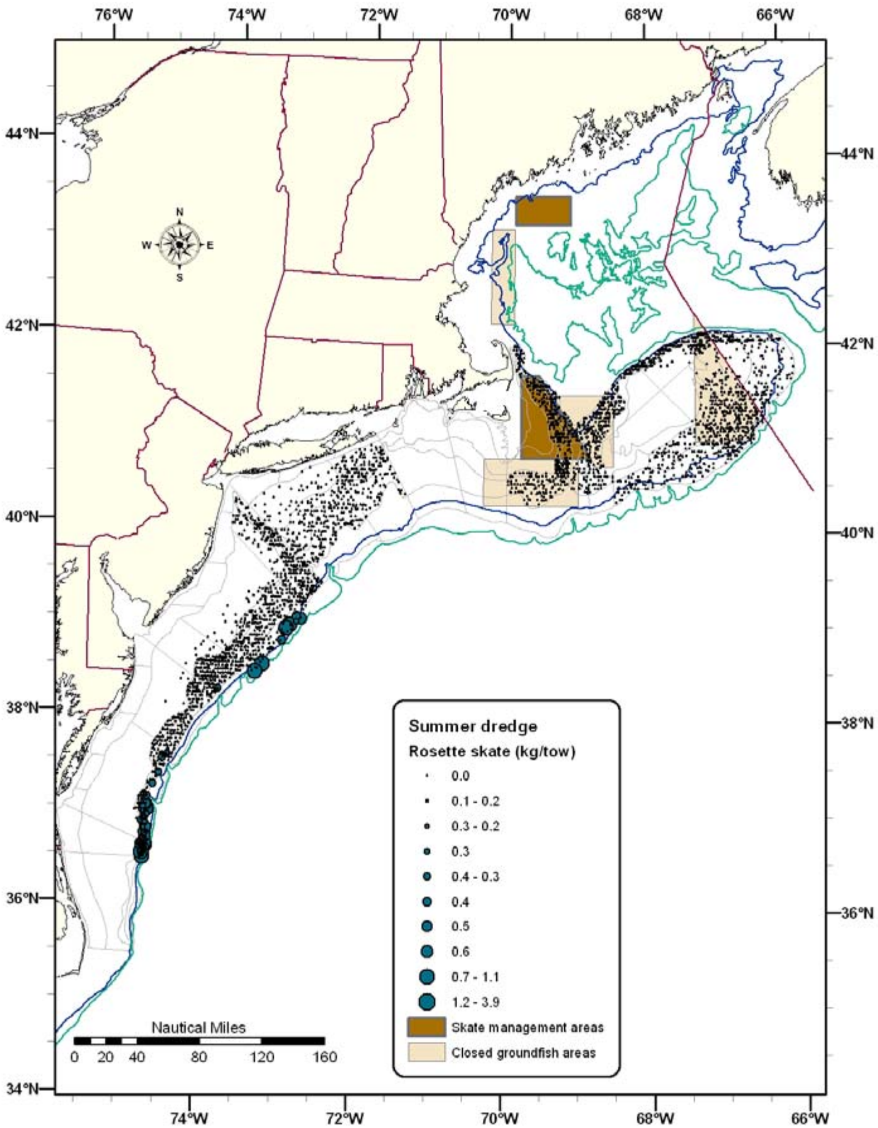
Winter (Feb/Mar)

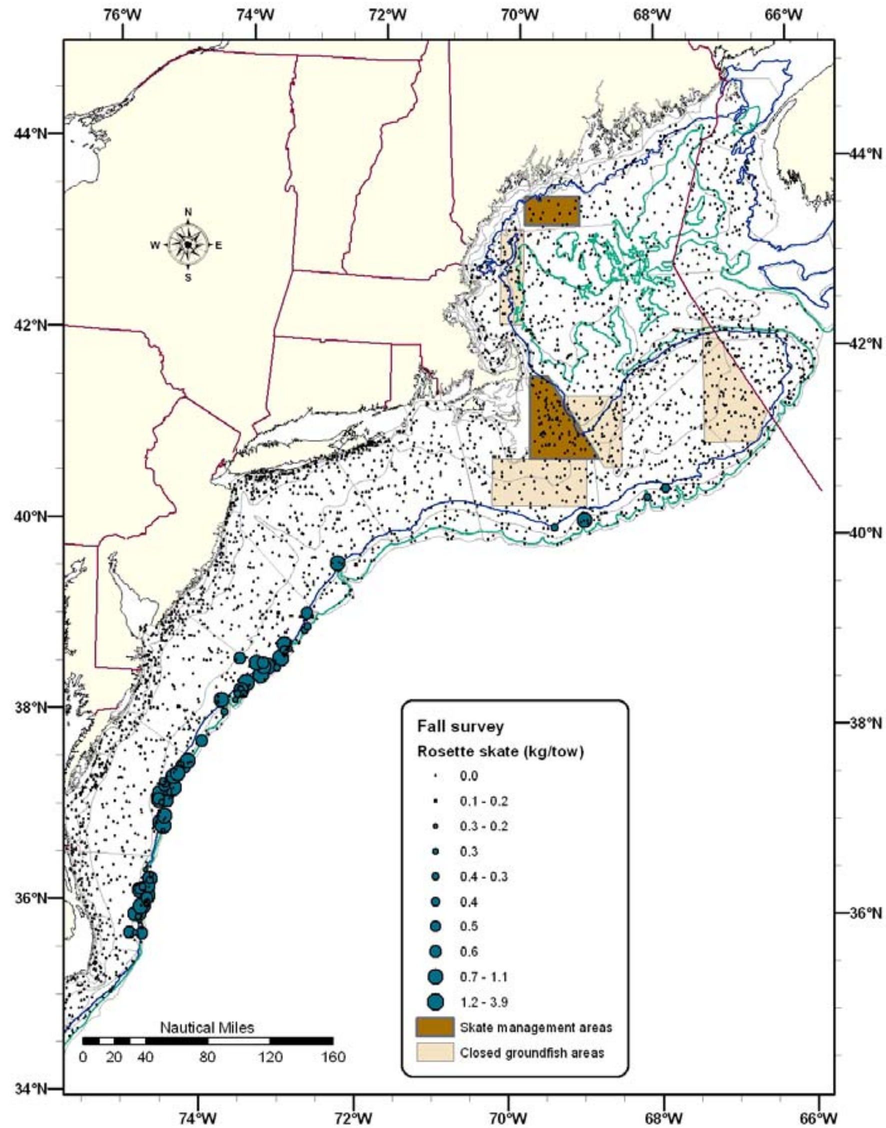


Spring (Apr/May)



Summer (Jul/Aug)	Autumn (Sep/Oct)





7.3.4 Life History Characteristics and Biological Reference Points

The Essential Fish Habitat Source Documents prepared by the Northeast Fisheries Science Center (NEFSC) of the National Marine Fisheries Service for each of the seven skate species provide most available biological and habitat information on skates. Any updated information will be provided below. These technical documents are available at http://www.nefsc.noaa.gov/nefsc/habitat/efh/ and contain the following information for each skate species in the northeast complex:

- Life history, including a description of the eggs and reproductive habits
- Average size, maximum size and size at maturity
- Feeding habits
- Predators and species associations
- Geographical distribution for each life history stage
- Habitat characteristics for each life history stage
- Status of the stock (in general terms, based on the Massachusetts inshore and NEFSC trawl surveys)
- A description of research needs for the stock
- Graphical representations of stock abundance from NEFSC trawl survey and Massachusetts inshore trawl survey data
- Graphical representations of percent occurrence of prey from NEFSC trawl survey data

Please refer to the source documents (http://www.nefsc.noaa.gov/nefsc/habitat/efh/) for more detailed information on the above topics. All additional biological information is presented below.

The seven species of the northeast skate complex follow a similar life history strategy but differ in their biological characteristics. This section describes any information made available after the publication of the EFH documents.

7.3.4.1 Winter Skate

Sulikowski et al. (2003) aged winter skate in western Gulf of Maine and determined the oldest age estimated to be 18 and 19 years for females and males, respectively (corresponding length – 94.0 cm and 93.2 cm). Verification of the periodicity of the vertebral bands was determined to be annual with the opaque band being formed in June - July using marginal increment analysis. Von Bertalanffy Growth parameters for male winter skates were calculated to be $k = 0.074$, $L_\infty = 121.8$ cm TL, $t_o = -1.418$; calculated estimates for female winter skates were: $k = 0.059$, $L_\infty = 137.4$ cm, $t_o = -1.609$ (Sulikowski et al. 2003). Growth curves fit to data from this study were found to overestimate maximum total length compared to observed lengths. This may result from a low representation of maximum sized individuals. The maximum reported length is 150 cm TL. Maximum sizes examined in the Gulf of Maine were 93.2 cm total length and 94.0 cm total length for males and females, respectively (Sulikowski et al. 2003).

Winter skates are capable of reproducing year-round but exhibit one peak in the annual cycle (Sulikowski et al. 2004). Sulikowski et al. (2004) examined hormone concentrations in samples obtained from the Gulf of Maine. Mature spermatocysts were observed in males throughout the year; females were capable of reproducing throughout the year. Peak reproductive activity occurs during June – August.

Size at maturity has been shown to vary with latitude. Sulikowski et al. (2003) examined winter skates in the Gulf of Maine and determined that males attained a maximum TL of 121.8cm and 137.4 cm TL for females. Age at maturity in the Gulf of Maine is estimated to be 11 years for males and 11 – 12 years in females (Sulikowski et al. 2005b). Size at maturity is 76cm for females and 73 cm for males (Sulikowski et al. 2005b).

Sosebee (2005) used body morphometry to determine size at maturity to be approximately 65 - 73 cm TL for females and 49 - 60 cm TL for males on samples obtained from the NEFSC trawl survey ranging from Gulf of Maine to Cape Hatteras.

Following its listing as overfished, it was necessary to estimate the required reduction in fishing pressure to rebuild this stock. A Leslie matrix demographic model was used for this purpose. This analysis uses life history parameters (e.g. age-at-maturity, longevity, fecundity) to estimate the exponential growth or decline of the population. These estimates are specific to a particular set of life history parameters and population size. In its simplest form, this model is density independent. It is plausible some of these life history parameters may vary with population size, i.e. they are density dependent; incorporating density dependence is difficult to achieve even in a data rich population. For the purposes of this analysis the population was considered to be in a depleted state with a current growth rate of zero, as estimated from the stable trend in survey data in recent years. Further studies on the fecundity and egg survival of this species would aid in reducing the uncertainty in these input parameters.

For winter skate, the model was constructed using recent estimates of available life history parameters described above. The model was tested to determine feasibility of estimates by comparison of estimated growth rates to known growth rates. NEFSC trawl data was used to estimate the current population growth (or decline) rate. Fishing pressure was then incorporated into the model. For a detailed description of the model construction, please refer to Documents 6 and 7 in Appendix I. Natural mortality was found to range between 0.09 yr^{-1} and 0.17 yr^{-1}. It was not possible to construct age-specific natural mortality rate so this range was assumed to apply to all ages. The base case scenario based solely on available life history parameters resulted in an $r_{predicted}$ of 0.19 yr^{-1}. A sensitivity analysis resulted in a range of $r_{predicted}$ of 0.15 to 0.25 yr^{-1}. Owing to the high level of uncertainty in the input parameters, the model was further tested with a range of scenarios of varying productivities. The size at vulnerability to the NEFSC trawl gear was determined from cumulative size frequency plots. Age at vulnerability was calculated using the size at vulnerability and von Bertalanffy growth parameters. This estimate has a level of uncertainty as the vulnerability of skates to commercial gear may differ to that of the research gear. Examination of the NEFSC trawl survey data provided estimates of population growth and decline throughout the survey. Between 1975 and 1987 the population growth rate was 0.17 yr^{-1} (the maximum observed), while the maximum decline was observed between 1987 and 1993 (-0.14 yr^{-1}). Using the above information the necessary percent reduction in fishing mortality was calculated as 31% for winter skates.

7.3.4.2 Little Skate

Previous age and growth studies conducted on little skate have observed similar size at ages through the northwestern Atlantic (Richards et al. 1963; Johnson, 1979; Waring, 1984; Bigelow and Schroeder, 1953). These studies utilized length frequency plots and rings counted in the vertebral centra to estimate the ages of little skate. For more details on these studies refer to the EFH document (Packer et al. 2003c). Johnson (1979) found a maximum length (L_{max}) of 60 cm (males) and 62 cm (females) cm, A_{max} of 4 years for both sexes, L_{mat} of about 45 cm for both sexes, fecundity of 30 egg cases per year, and maximum age of 8 years. Using Frisk's predictive equations and the NEFSC survey maximum observed length of 62 cm provides estimates of L_{mat} of 50 cm and A_{mat} of 4 years; using Waring's (1984) L_{∞} value of about 53 cm provides an estimate of L_{mat} of 43 cm. This differs to age and size at maturity estimates for the Gulf of Maine and northern Massachusetts waters. Ciccia et al. (in review) found 50% maturity occurs at 9.5 years and 48 cm TL for females and 7.7 years and 46 cm TL for males. Natanson (1993) performed age and growth experiments on captive little skate from Narragansett Bay, Rhode Island that were injected with the antibiotic oxytetracycline. This methodology can be used to validate the ageing protocol for a species. Frisk and Miller (2006) examined vertebral samples of little skate to identify any latitudinal patterns in the northwestern Atlantic. Maximum observed age was 12.5 years. The oldest aged little skate from the mid-Atlantic was 11 years. The oldest individuals from the Gulf of Maine and Southern New England – Georges Bank were 11 years or older. Von Bertalanffy curves were fit for the northwestern Atlantic ($k = 0.19$, $L_\infty = 56.1$ cm TL, $t_o = -1.77$, $p < 0.0001$, $n = 236$) and for individual regions (GOM: $k = 0.18$, $L_\infty = 59.31$ cm TL, $t_o = -1.15$, $p < 0.0001$; SNE-GB: $k = 0.20$, $L_\infty = 54.34$ cm TL, $t_o = -1.22$, $p < 0.0001$; mid-Atlantic: $k = 0.22$, $L_\infty = 53.26$ cm, $t_o = -1.04$, $p < 0.0001$).

Sosebee (2005) used body morphometry to determine size at maturity (male – 39 cm TL; females – 40 – 48 cm TL) on samples obtained from the NEFSC trawl survey ranging from Gulf of Maine to Cape Hatteras. Fecundity was estimated to be 30 eggs per year (Packer et al. 2003 c).

7.3.4.3 Barndoor Skate

Barndoor skates have been reported to reach a maximum size of 152 cm and 20 kb weight (Bigelow & Schroeder, 1953). The maximum observed length in the NEFSC trawl survey was 136 cm total length. In a study conducted in Georges Bank Closed Area II the largest individual observed was 133.5 cm, with total lengths ranging from 20.0 to 133.5 cm. Previous discussions of barndoor skate life history have been limited owing to a lack of appropriate data. To compensate for this, Casey and Myers (1998) used a related species, the common skate (*Dipturus batis*), as a proxy for biological characteristics. This approach is less desirable compared to directed studies on the species in question. Gedamke et al. (2005) examined barndoor skates in the southern section of Georges Bank Closed Area II. Length at 50% maturity was 116.3 cm TL and 107.9 cm TL for females and males, respectively. The oldest age observed was 11 years. Age at maturity was estimated to be 6.5 years and 5.8 years for females and males, respectively. The von Bertalanffy parameters were also determined: $L_\infty = 166.3$ cm TL; $k = 0.1414$ yr^{-1}; $t_o = -1.2912$ yr. Based on the predictive equations from Frisk *et al.* (2001) and the Northeast Fisheries Science Center (NEFSC) survey maximum observed length of 136 cm TL, L_{mat} is estimated at 102 cm TL and A_{mat} is estimated at 8 years (Northeast Fisheries Science Center 2000). In another study, clasper length measurements on males from Georges Bank show that male sexual maturity occurs at approximately 100 cm TL.

Sosebee (2005) used body morphometry to determine the size of maturity (females: 96 to 105 cm TL; males: 100 cm TL) on samples obtained from the NEFSC trawl survey ranging from Gulf of Maine to Cape Hatteras. Egg production is estimated to range between 69 – 85 eggs/female/year (Parent et al. 2008). As part of a captive breeding program, the egg incubation was determined to range from 342 – 494 days. As part of the same study, successful hatch rate was 73% (Parent et al. 2008). Previous fecundity estimates were 47 eggs per year (Packer et al. 2003a). Hatchlings range in size from 193 mm TL, 128 mm disk width and 32 g body mass.

Historical Canadian survey data (e.g., as presented in Casey and Myers (1998) from St. Pierre Bank to Brown's Bank) suggest that a substantial decline in barndoor skate biomass in the northern part of the species' range had occurred by the time that standardized NEFSC surveys began in U.S. waters in 1963. If the barndoor skate in U.S. waters are a part of the same unit stock as that in Canadian waters, then the high indices in the NEFSC surveys during the early 1960s likely indicate a biomass well below B_{MSY}. The linkage between barndoor skates in U.S. and Canadian waters, however, is unknown. The occurrence of barndoor skate in the autumn survey has been increasing steadily since the 1990s and is approaching levels observed in the 1960s.

7.3.4.4 Thorny Skate

Sulikowski et al (2005a) aged thorny skate in western Gulf of Maine and found oldest age estimated to be 16 years for both females and males (corresponding length – 105 cm and 103 cm). Verification of the periodicity of the vertebral bands was determined to be annual with the opaque band being formed in August or September using marginal increment analysis. However, marginal increment analysis was only suitable for use on juvenile thorny skates (≤ 80 cm TL). Von Bertalanffy Growth parameters for male thorny skates were calculated to be k = 0.11, L_∞ = 127 cm TL, t_o = -0.37; calculated estimates for female thorny skates were: k = 0.13, L_∞ = 120 cm TL, t_o = -0.4 (Sulikowski et al. 2005a). Growth curves fit to data from this study were found to overestimate maximum total length compared to observed lengths. This may result from a low representation of maximum sized individuals. The maximum observed length from the NEFSC trawl survey is 111cm TL. Maximum sizes examined in the Gulf of Maine were 103 cm TL and 105 cm TL for males and females, respectively (Sulikowski et al. 2005a).

Sulikowski et al. (2006) used morphological and hormonal criteria to determine the age and size at sexual maturity in the western Gulf of Maine. For females, 50% maturity occurred at approximately 11 years and 875 mm TL; while for males approximately 10.90 years and 865 mm TL. This species is capable of reproducing year round (Sulikowski et al. 2005a) based on morphological characteristics.

Sosebee (2005) used body morphometry to determine size at maturity to be approximately 36 - 38 cm TL for females and 49 cm TL for males on samples obtained from the NEFSC trawl survey ranging from Gulf of Maine to Cape Hatteras.

Parent et al. (2008) estimated mean annual fecundity to be 40.5 eggs per year based on 2 captive females producing 81 eggs in 1 year. The observed hatching success is 37.5% (Parent et al. 2008).

Following its listing as overfished, it was necessary to estimate the required reduction in fishing pressure to rebuild this stock. A Leslie matrix demographic model was used for this purpose. This analysis uses life history parameters (e.g. age-at-maturity, longevity, fecundity) to estimate the exponential growth or decline of the population. These estimates are specific to a particular set of life history parameters and population size. In its simplest form, this model is density independent. It is plausible some of these life history parameters may vary with population size, i.e. they are density dependent; incorporating density dependence is difficult to achieve even in a data rich population. For the purposes of this analysis the population was considered to be in a depleted state with a current growth rate of zero, as estimated from the stable trend in survey data in recent years. Further studies on the fecundity and egg survival of this species would aid in reducing the uncertainty in these input parameters.

For thorny skate, the model was constructed using recent estimates of available life history parameters described above. The model was tested to determine feasibility of estimates by comparison of estimated growth rates to known growth rates. NEFSC trawl data was used to estimate the current population growth (or decline) rate. Fishing pressure was then incorporated into the model. For a detailed description of the model construction, please refer to Documents 6 and 7 in Appendix I. Natural mortality was found to range between 0.15 yr^{-1} and 0.2 yr^{-1}. It was not possible to construct age-specific natural mortality rate so this range was assumed to apply to all ages. The base case scenario based solely on available life history parameters resulted in an $r_{predicted}$ of 0.14 yr^{-1}. A sensitivity analysis resulted in a range of $r_{predicted}$ of 0.1 to 0.22 yr^{-1}. Owing to the high level of uncertainty in the input parameters, the model was further tested with a range of scenarios of varying productivities. The size at vulnerability to the NEFSC trawl gear was determined from cumulative size frequency plots. Age at vulnerability was calculated using the size at vulnerability and von Bertalanffy growth parameters. This estimate has a level of uncertainty as the vulnerability of skates to commercial gear may differ to that of the research gear. Examination of the NEFSC trawl survey data provided limited information on population growth owing to the lack of obvious trends throughout the time series. Between 1963 and 1994 the population declined at a lower rate of -0.026 yr^{-1}, which increased to -0.23 yr^{-1} between 1993 and 1998 Using the above information the necessary percent reduction in fishing mortality was calculated as 34% for thorny skates.

7.3.4.5 Smooth Skate

Natanson et al. (2007) aged smooth skate from New Hampshire and Massachusetts waters. Maximum ages were estimated to be 14 and 15 years for females and males respectively. Longevity was estimated to be 23 years for females and 24 years for males. Male and females exhibited significantly different growth rates. Accordingly different growth models were required to fit the male and female growth data. Parameters for the von Bertalanffy equation for the males were determined to be k = 0.12, L_∞ = 75.4 cm TL, with L_o required to be set at 11 cm TL (Natanson et al. 2007). Growth models applied to females overestimated the size at birth thus requiring the use of back-calculated data resulting in von Bertalanffy parameters of: k = 0.12, L_∞ = 69.6 cm TL, L_o = 10 TL (Natanson et al. 2007). Sulikowski et al. (2007) determined, in a study conducted in the Gulf of Maine that in their sample mature females ranged in size from 508 to 630 mm TL and for males 550 to 660 mm TL. Based on morphological characteristics in females (ovary weight, shell gland weight, diameter of largest follicles, and pattern of ovarian follicle development) and histological analysis of males (mature spermatocysts in testes) Sulikowski et al. (2007) determined that in the Gulf of Maine smooth skate are capable of reproducing year round. The reproductive cycles of the two sexes are thought to be synchronous (Sulikowski et al. 2007). Kneebone et al. (2007) examined hormonal concentrations of male and female smooth skate in the Gulf of Maine further confirming the ability of this species to reproduce throughout the year. Information is needed on the fecundity and egg survival of this species.

Sosebee (2005) used body morphometry to determine size at maturity to be approximately 33 – 49 cm TL for females and 49 cm TL for males on samples obtained from the NEFSC trawl survey ranging from Gulf of Maine to Cape Hatteras.

Following the methodology used for determining the necessary fishing mortality reduction for winter and thorny skates, construction of a Leslie matrix demographic model was attempted for smooth skate after its recent listing as being overfished. However, some of the required life history parameters are unavailable for smooth skate, e.g. fecundity, first year survival and egg survival. It was necessary to estimate the required reduction in fishing pressure to rebuild this stock. In order to construct a Leslie Matrix for this species, it was necessary to utilize data available for other species in the skate complex (as described in Gedamke 2008; Document 6 in Appendix I). Available data on age-at-maturity, longevity and von Bertalanffy growth parameters were used to estimate natural mortality (0.17 to 0.2 yr^{-1}). It was not possible to construct age-specific natural mortality rate so this range was assumed to apply to all ages. No clear trend is apparent from the NEFSC trawl survey, limiting its use in determining growth rates. The base case scenario based solely on available life history parameters resulted in an $r_{predicted}$ of 0.20 yr^{-1}. A sensitivity analysis resulted in a range of $r_{predicted}$ of 0.12 to 0.35 yr^{-1}. These estimates carry a high level of uncertainty owing to the limited input parameters. Based on examination of the spring survey data, the population was declining until the early 1990s; since 1994 there has been an apparent increase at a rate of 0.12 yr^{-1}. A decline is not apparent in the autumn survey since the 1990s; the population appears to exhibit some stability in the autumn survey during that time period. Existing fishing restrictions may be sufficient to allow this stock to rebuild.

7.3.4.6 Clearnose Skate

Gelsleichter (1998) examined the vertebral centra of clearnose skates that were collected from Chesapeake Bay and the northwest Atlantic Ocean. The oldest male was aged at 5+ years, with the oldest female being 7+ years. This study suggests that clearnose skate experience rapid growth over during a relatively short life span.

Sosebee (2005) used body morphometry to determine size at maturity (females: 59 to 65 cm TL; males: 56 cm TL) on samples obtained from the NEFSC trawl survey ranging from Gulf of Maine to Cape Hatteras. Fecundity was estimated to be 35 eggs/year (Packer et al. 2003b). Information is needed on the fecundity and egg survival of this species.

7.3.4.7 Rosette Skate

Sosebee (2005) used body morphometry to determine size at maturity (males = 33 cm TL; females = 33 – 35 cm TL) on samples obtained from the NEFSC trawl survey ranging from Gulf of Maine to Cape Hatteras. Age and growth data are currently unavailable for rosette skate. Information is needed on the fecundity and egg survival of this species.

7.3.5 Feeding habits

Link and Sosebee (2008) investigated the impact of the consumption by the northeast skate complex on the ecosystem using stomach samples obtained from the NEFSC trawl. Overall the skate complex consumes a small proportion of the biomass contained in the system but they have the potential to have a large impact on some prey species. This impact can be at the same level or even exceed that removed by the fishery for a particular prey species. This study was also described in detail in the SAW 44 documents. The percentage composition of each prey type by maturity stage and species is listed in Table 22. For more complete data regarding the feeding habits and prey composition by species please refer to the SAW 44 documents.

Table 22. Relative means stomach weight on average for the size class and time period available expressed as a percentage of total stomach content weight throughout the time series.

Species	Winter Skate		Little Skate		Barndoor Skate		Thorny Skate		
	Immature	Medium	Immature	Mature	Immature	Mature	Small	Medium	Large
Ammodytes spp	27.489	8.781							
Amphipods	1.379	29.183	53.97	25.16	2.059	0	21.181	3.698	0.055
Annelids	13.826	20.415							
Animal Remains	2.805485766	6.41147378	13.5919	9.32877355	6.58838867	1.08627204	17.53218	8.76334299	3.3145161
Ocean Quahog	0.005	0.233							
Bivalves	16.027	6.956	0.214	8.259					
Cancer Crabs	1.061	3.195	0.737	12.502	26.666	8.732			
Cephalopods	3.511	0.534			1.847	0.071	1.53	7.547	8.533
CITARC	0.008	0.018							
Herrings	3.534	0.307			0	18.226	0	0.555	11.02
CRAFAM	0.449	6.048							
Crustaceans	0.496	3.058	5.241	3.826			5.336	9.313	3.462
Decapods	0.013	0.1	0.006	0.429			0.272	0.244	0.06
Other Crabs	1.309	2.381			12.684	15.73	1.36	3.844	3.239
GADFAM	0.042	0.089					0	0.004	0.769
GADMOR	0	0.015							
ISOPOD	1.836	5.614	2.797	2.452			4.133	1.264	0.129
MELAEG	0.076	0							
Silver Hake	1.579	0.333			4.82	3.89	0	0.733	2.726
Mollusk	2.116	0.887	0.121	1.756					
OPHFA2	5.3644	0.205							
Other Fish	12.704	3.326	0.200	3.183	3.756	28.046	1.129	3.479	29.502
PAGFAM	0.116	0.942					0.066	0.128	0.437
Pandalid shrimp	0.616	0.646			16.757	7.726			
Parden	0.51	0							

Species	Winter Skate		Little Skate		Barndoor Skate		Thorny Skate		
PecFa1	0.509	0.27							
PenFam	0.032	0.009							
SCOFam	1.361	0							
Red hake	1.11	0.043			0.347	0			
Polychaetes			7.226	13.91	0.484	0	35.677	42.381	16.941
Crangon Spp			11.593	7.644	4.769	0.062			
CUMACE			1.378	0.124					
DECCRA			1.865	10.807					
EUPFam			1.058	0.617					
Gulf Stream Fi					0.526	0.141			
Sculpins					0.144	6.002			
Misc Crustaceans				16.78	0.56				
Other Decapods					0.488	0			
Other Shrimp					0.181	0.141			
Other Gadids					0	0.4			
Haddock					1.104	0.891			
4-Spot Flounder					0	8.298			
CANFAM							0.041	0.603	2.682
COTFAM							0	0.409	1.249
DECSHR							0.114	3.550	1.162
Euphausiids							9.963	7.915	3.923
MYXFAM							0	0.371	5.434
PANFAM							1.634	4.691	3.847
Eelpouts							0.03	0.505	1.515
MERBIL									
Mysida									
SERFA2									
SOLFAM									
Total Prey	93.183	96.182	98.011	89.097	98.515	98.298	94.777	95.752	91.042

Species	Smooth Skate		Clearnose Skate		Rosette Skate	
	Immature	Mature	Immature	Mature	Immature	Mature
Ammodytes spp			0.378	1.242		
Amphipods	14.009	1.087			24.843	6.922
Annelids	0.978	2.702	3.056	0.299		
Animal Remains	23.201013	8.94110746	2.507139471	0.29680721	22.005541	20.5159093
Ocean Quahog						
Bivalves			2.775	3.401		
Cancer Crabs	0	1.521	23.979	17.282	2.462	5.674
Cephalopods			7.72	10.537	7.159	3.927
CITARC						
Herrings						
CRAFAM						
Crustaceans					0	2.832
Decapods			0.505	0	0	0.380
Other Crabs	0.37	2.726	28.317	11.9		
GADFAM	8.165	0.132				
GADMOR						
ISOPOD					1.34	3.304
MELAEG						
Silver Hake						
Mollusk						
OPHFA2			9.249	5.826	0	3.819
Other Fish	0	6.14	11.917	47.717	1.839	2.477
PAGFAM						
Pandalid shrimp	2.169	28.885			0	4.269
Parden						
PecFa1						
PenFam						

Species	Smooth Skate		Clearnose Skate		Rosette Skate	
SCOFam						
Red hake						
Polychaetes					17.558	13.088
Crangon Spp	1.024	3.636			8.091	9.487
CUMACE						
DECCRA					1.341	18.036
EUPFam					3.179	4.435
Gulf Stream Fi						
Sculpins						
Misc Crustaceans	11.382	11.539	8.108	0.873		
Other Decapods	3.489	2.908				
Other Shrimp						
Other Gadids						
Haddock						
4-Spot Flounder						
CANFAM						
COTFAM						
DECSHR	1.109	4.958				
Euphausiids	30.913	18.012				
MYXFAM						
PANFAM						
Eelpouts						
MERBIL	0	6.668				
Mysida	3.193	0.144			10.184	0.836
SERFA2			1.488	0.271		
SOLFAM			0	0.358		
Total Prey	98.823	94.893	85.048	92.529	98.352	97.79

7.3.5.1 Winter Skate

Winter skates were divided into three size groups: small (<30 cm TL) medium (45 cm TL) and large (80 cm TL). Owing to the difficulties in distinguishing between immature little and winter skates, the small size category was included in the analysis of immature little skates. The amount of food consumed was related to the size of the skate. Medium sized skates consumed approximately 2 kg per year of prey items, while large skates consumed approximately 9 kg per year. The total consumptive demand for this species is estimated to range between 20,000 and 180,000 mt per year. Winter skates are benthivorous and their piscivorous nature was clearly shown by the large portion of the diet formed by forage fishes. Overall, the diet of winter skates was dominated by forage fish, squid and benthic macrofauna. Up to 80,000 mt of a particular prey item can be removed by this skate in any given year.

7.3.5.2 Little Skate

Little skates were divided into two size groups: immature (20 cm TL) mature (45 cm TL). Owing to the difficulties in distinguishing between immature little and winter skates, the small size category for winter skate was included in the analysis of immature little skates. The amount of food consumed was related to the size of the skate. Immature skates consumed approximately 500 g per year of prey items, while mature skates consumed approximately 2.5 kg per year. The total consumptive demand for this species is estimated to range between 100,000 and 350,000 mt per year, with total consumption dominated by mature skates. Little skates are benthivorous which was reflected by the large portion of the diet that benthic macrofauna (polychaetes and amphipods) and benthic megafauna (crabs and bivalves) comprised. Overall, the diet of little skates was dominated by benthic invertebrates. Up to 8,000 mt of a particular prey item can be removed by this skate in any given year.

7.3.5.3 Barndoor Skate

Barndoor skates were divided into two size groups: immature (<60 cm TL) mature (>100 cm TL). The amount of food consumed was related to the size of the skate. Immature skates consumed approximately 5 kg per year of prey items, while mature skates consumed approximately 10 to 20 kg per year. The total consumptive demand for this species is estimated to range between 4,000 and 16,000 mt per year, with total consumption dominated by mature skates. Barndoor skates are benthivorous and their piscivorous nature was clearly shown by the large portion of the diet formed by forage fishes. Overall, the diet of barndoor skates was dominated by herrings Pandalid shrimps and *Cancer* crabs. Up to 8,000 mt of a particular prey item can be removed by this skate in any given year.

7.3.5.4 Thorny Skate

Thorny skates were divided into three size groups: small (20 cm TL) medium (45 cm TL) and large (80 cm TL). Owing to the difficulties in distinguishing between immature little and winter skates, the small size category was included in the analysis of immature little skates. The amount of food consumed was related to the size of the skate. Small sized skates consumed approximately 500 g per year of prey items, while medium and large skates consumed approximately 1.5 kg and 12 kg per year, respectively. The total consumptive demand for this species is estimated to range between 10,000 and 40,000 mt per year. Thorny skates are benthivorous and their piscivorous nature was clearly shown by the large portion of the diet formed by forage fishes. Overall, the diet of thorny skates was dominated by herrings, squid, polychaetes, silver hake and other fish. Up to 80,000 mt of a particular prey item can be removed by this skate in any given year.

7.3.5.5 Smooth Skate

Smooth skates were divided into two size groups: immature (20-25 cm TL) mature (50 cm TL). The amount of food consumed was related to the size of the skate. Immature skates consumed approximately 0.5 - 1 kg per year of prey items, while mature skates consumed approximately 2 - 3 kg per year. The total consumptive demand for this species is estimated to range between 1,000 and 5,000 mt per year, with total consumption dominated by mature skates. Smooth skates are benthivorous which was reflected by the large portion of the diet that benthic megafauna (pandalids and euphausiids) comprised. Overall, the diet of smooth skates was dominated by pandalid shrimp and euphausiids. Up to 2,000 mt of a particular prey item can be removed by this skate in any given year, but values are typically on the order of 500 to 1,000 mt.

7.3.5.6 Clearnose Skate

Clearnose skates were divided into two size groups: immature (45 - 50 cm TL) mature (60 - 65 cm TL). The amount of food consumed was related to the size of the skate. Immature skates consumed approximately 1 - 2 kg per year of prey items, while mature skates consumed approximately 5 kg per year. The total consumptive demand for this species is estimated to range between 2,000 and 18,000 mt per year, with total consumption dominated by mature skates. Clearnose skates are benthivorous which was reflected by the large portion of the diet that benthic megafauna (crabs and miscellaneous crustaceans) comprised. Overall, the diet of clearnose skates was dominated by other crabs, *Cancer* crabs and squids. Up to 8,000 – 10,000 mt of a particular prey item can be removed by this skate in any given year, but values are typically on the order of 2,000 to 4,000 mt.

7.3.5.7 Rosette Skate

Rosette skates were divided into two size groups: immature (22 cm TL) mature (38 cm TL). The amount of food consumed was related to the size of the skate. Immature skates consumed approximately 200 g per year of prey items, while mature skates consumed approximately 800 g per year. The total consumptive demand for this species is estimated to range between 50 and 500 mt per year, with total consumption dominated by mature skates. Rosette skates are benthivorous which was reflected by the large portion of the diet that benthic macrofauna (amphipods and polychaetes) and benthic megafauna (crabs and shrimps) comprised. Overall, the diet of rosette skates was dominated by benthic macrofauna and to a lesser extent pandalid shrimps, squids and *Cancer* crabs. Up to 70 mt of a particular prey item can be removed by this skate in any given year, but more typically 10 – 30 mt.

7.3.6 Evaluation of Fishing Mortality and Stock Abundance

The length-based mortality estimators of Beverton and Holt (1956) and Hoenig (1987) were considered for the estimation of fishing mortality rates for winter, little, barndoor, thorny and clearnose skates from length frequency distribution sampled by the NEFSC spring and autumn. At the time of the 44th Stock Assessment Workshop (NEFSC 2007), age and growth data were only available for the 5 species listed above. Recently, age and growth estimates have become available for smooth skates (Natanson et al. 2007) but age information remains unavailable for rosette skates.

SARC 30 (NEFSC 2000) concluded that the Hoenig (1987) estimates are more reliable, and those are the fishing mortality rates (F) referenced below. Estimates were calculated for five year moving groups, or windows of years to smooth the variation in the mortality estimates caused by variations in recruitment over time. Natural mortality for all species was assumed to be equal to the k parameter in the von

Bertalanffy equation based on Frisk et al. (2001) which suggests that the M/k ratio for skates is about 1.0. Various values for L' were used to determine the effect of that parameter.

Gedamke et al. (2007; Document 6 in Appendix I) describe the use of Leslie matrices and life tables in evaluating an elasmobranch species ability to withstand fishing pressure. Demographic analysis such as this, tracks the change over time of the number of individuals in each specified class. In an age-based analysis, the data on age-at-maturity, longevity, fecundity and survivorship are required. These data are not always readily available for the skate species. However, as shown in Gedamke et al. (2007) this method can be used in conjunction with the NEFSC survey data to "solve" for the missing parameter, as exampled by barndoor skate. The Leslie Matrix was used to calculate an $r_{conditional}$ of 0.41/year for barndoor skate in the absence of fishing pressure. This methodology was applied to the skate species from the northeast skate complex currently listed as overfished.

The following subsections describe estimates of mortality for winter, little, barndoor, thorny and clearnose skates. At the time of analysis, no age and growth parameters were available for smooth and rosette skates, so no mortality estimates have been made.

7.3.6.1 Winter Skate

The latest assessment report (SAW 44; NEFSC 2007) described the patterns in mortality estimates for winter skate finding that they are consistent across alternative values of L' in both surveys with high values found in the mid-1970s dropping to low values in the 1980s (NEFSC, 2007). Increases occurred with the onset of the directed fishery through the mid-1990s followed by a decline. There is a lag associated with the moving window estimator, so any increase or decrease will be delayed. The values for F from the autumn survey where L' is 50 cm are 0.17 in the early part of the time series, drop to a low of 0.02 in 1985, increase to 0.2 in 1997 and have declined to 0.11 in recent years.

For winter skate, the SAW concluded that there are insufficient data on species specific historical landings to determine F or propose F_{MSY} or proxy reference points. New techniques of estimating fishing mortality were rejected by the SAW. The SAW approved the continued use of the 75th percentile value of the NEFSC autumn biomass indices for the Gulf of Maine (GOM) to Mid Atlantic (MA) offshore region during 1967-1998 as a proxy for the B_{MSY} for winter skate (6.46 kg/tow), and one-half of that value as the threshold biomass reference point for winter skate (3.23 kg/tow).

Benoit (2006) estimated the acute discard mortality rate of winter skate on Canadian research vessels. Mortality was determined from visible respiratory movements, i.e., spiracle movement. After 1-2 hours out of water, 50% of individuals no longer showed respiratory movements. Acute discard mortality for this species was estimated to be at least 50%. This estimate is based solely on time on deck and may vary accordingly with sorting time. This study did not address long-term mortality; effects of injuries sustained in the net remain unknown.

For winter skate, the 2005-2007 NEFSC autumn survey biomass index average of 2.93 kg/tow is less than the biomass threshold reference point of 3.23 kg/tow and thus species remains overfished. The 2005 – 2007 average index is less than the 2004 – 2006 index by 4%, but overfishing is not occurring because the percent decline in the consecutive three year moving averages does not exceed the maximum threshold which according to the FMP defines when overfishing is occurring.

7.3.6.2 Little Skate

The latest assessment report (SAW 44; NEFSC 2007) described the patterns in mortality estimates for little skate finding that they are less consistent across alternative values of L' and surveys. The lower values of L' indicate that the force of mortality being exerted at these sizes is almost entirely natural mortality. The trend in mortality estimates for L' = 45 cm TL suggests an increases over the time series at relatively high values between 0.2 and 0.4.

The use of length-based yield per recruit reference points for little skate in the northeast region is considered to be unreliable by the SAW, due to the uncertainty of cohort slicing for age groups. A threshold F reference is therefore proposed for little skate based on the estimate of the natural mortality rate (M). The SARC approved the continued use of the 75th percentile value of the NEFSC spring survey biomass indices for the GOM-MA inshore and offshore regions during 1982-1999 as a proxy for B_{MSY} for little skate (6.54 kg/tow), and one-half of that value as the threshold biomass reference point for little skate (3.27 kg/tow).

For little skate, the 2005-2007 NEFSC spring survey biomass index average of 3.67 kg/tow is greater than the biomass threshold reference point of 3.27 kg/tow. Therefore, little skate is not overfished. The 2005 – 2007 average index is less than the 2004 – 2006 index by 20%, but overfishing is not occurring, because the percent decline does not exceed the maximum threshold which according to the FMP defines when overfishing is occurring.

7.3.6.3 Barndoor Skate

The latest assessment report (SAW 44; NEFSC 2007) described the patterns in mortality estimates for barndoor skate finding that they are very consistent across alternative values of L' and seasons. The trend is low F until 1975 when estimates become more imprecise because of few sampled fish. Estimates then decline to low values through 2006. The time lag in this estimate of fishing mortality is evident in the delay in the increase in F in the early part of the time series.

For barndoor skate, the SAW concluded that there are insufficient data on species specific historical landings to determine F or propose F_{MSY} or proxy reference points. New techniques of estimating fishing mortality were rejected by the SAW. The SAW approved the continued use of the mean value of the NEFSC autumn survey biomass indices for the GOM-SNE offshore region during 1963-1966 as a proxy for B_{MSY} for barndoor skate (1.62 kg/tow), and one-half of that value as the threshold biomass reference point for barndoor skate (0.81 kg/tow).

For barndoor skate, the 2005-2007 NEFSC autumn survey biomass index average of 1.00 kg/tow is greater than the biomass threshold reference point of 0.81 kg/tow. Therefore, barndoor skate is not overfished. The 2005 – 2007 average index is less than the 2004 – 2006 index by 14%, but overfishing is not occurring, because the percent decline does not exceed the maximum threshold which according to the FMP defines when overfishing is occurring.

7.3.6.4 Thorny Skate

Fishing mortality patterns, as described in the latest assessment report (SAW 44; NEFSC 2007), for thorny skate are also consistent across seasons and alternative values of L' (NEFSC, 2007). There has been a general increase in F estimates over the entire time series. For L' = 50 cm TL, the values in the early part of the time series were less than 0.1, increased to 0.15 in the 1980s and have since increased to around 0.2 in recent years.

For thorny skate, the SAW concluded that there are insufficient data on species specific historical landings to determine F rates or propose F_{MSY} or proxy reference points. New techniques of estimating fishing mortality were rejected by the SARC. The SAW approved the continued use of the 75th percentile value of the NEFSC autumn biomass indices for the GOM-SNE offshore region during 1963-1998 as a proxy for the B_{MSY} for thorny skate (4.41 kg/tow), and one-half of that value as the threshold biomass reference point for thorny skate (2.20 kg/tow).

For thorny skate, the 2005-2007 NEFSC autumn survey biomass index average of 0.42 kg/tow is less than the biomass threshold reference point of 2.20 kg/tow. Therefore, thorny skate is overfished. The 2005 – 2007 index is lower than the 2004 – 2006 index by 24%, therefore overfishing is occurring.

7.3.6.5 Smooth Skate

At time of SAW 44 (NEFSC 2007), age and growth data were unavailable to determine fishing mortality rates. There are insufficient data on species specific historical landings to determine fishing mortality rates or propose F_{MSY} reference points. New techniques of estimating F were rejected by the SARC. The SAW approved the continued use of the 75th percentile value of the NEFSC autumn biomass indices for the GOM-SNE offshore region during 1963-1998 as a proxy for the B_{MSY} for smooth skate (0.31 kg/tow), and one-half of that value as the threshold biomass reference point for smooth skate (0.16 kg/tow).

For smooth skate, the 2005 – 2007 NEFSC autumn survey biomass index average of 0.14 kg/tow is less than the biomass threshold reference point of 0.16 kg/tow. Unlike its previous status, smooth skate is now overfished. The 2005-2007 index is less than the 2004 – 2006 index by 22%, so overfishing is not occurring because the percent decline does not exceed the maximum threshold which according to the FMP defines when overfishing is occurring.

7.3.6.6 Clearnose Skate

Fishing mortality patterns, as described by SAW 44 (NEFSC 2007), for clearnose skate are less consistent between surveys and alternative values of L'. However, there has been a general decreasing trend in F estimates over the time series. The values for L' = 50 cm TL have ranged from 0.3 in the early part of the time series and slowly deceased to 0.2 in recent years.

The SAW concluded that there are insufficient data on species specific historical landings for clearnose skate to determine fishing mortality rates or propose F_{MSY} reference points. New techniques of estimating F were rejected by the SARC review panel. The SAW approved the continued use of the mean value of the NEFSC autumn survey biomass indices for the GOM-SNE offshore region during 1975-1998 as a proxy for the B_{MSY} for clearnose skate (0.56 kg/tow), and one-half of that value as the threshold biomass reference point for clearnose skate (0.28 kg/tow).

For clearnose skate, the 2005-2007 NEFSC autumn survey biomass index average of 0.64 kg/tow is greater than the B_{MSY} proxy and the threshold reference points of 0.56 kg/tow and 0.28 kg/tow. Clearnose skate is not overfished. The 2003 – 2005 average of 0.63 kg/tow was less than 30% below the 2002-2004 average of 0.75 kg/tow, therefore overfishing is not occurring for clearnose skate, because this percent decline does not exceed the maximum threshold which according to the FMP defines when overfishing is occurring.

7.3.6.7 Rosette Skate

Frisk's (1999) predictive equations and the NEFSC survey L_{max} of 57 cm provide estimates of L_{mat} of 46 cm and A_{mat} of four years. There are insufficient data on the age and growth of rosette skate to determine F or propose F_{MSY} reference points. The SAW report (NEFSC 2007) approved the continued use of the 75th percentile value of the NEFSC autumn survey biomass indices for the Mid-Atlantic offshore region during 1967-1998 as a proxy for B_{MSY} for rosette skate (0.029 kg/tow), and one-half of that value as the threshold biomass reference point for rosette skate (0.015 kg/tow).

For rosette skate, there are insufficient data on age and growth to determine F. The 2005 – 2007 NEFSC autumn survey biomass index average of 0.06 kg/tow is above the B_{MSY} proxy and threshold reference points of 0.029 kg/tow and 0.015 kg/tow. Rosette skate is not overfished. The 2005-2007 index is above the 2004 – 2006 index, and therefore overfishing is not occurring, because the percent decline does not exceed the maximum threshold which according to the FMP defines when overfishing is occurring.

7.3.6.8 SARC Comments

NEFSC survey data were the primary source of information used to derive indices of biomass for the skate species and reference points. The trend of indices of winter skate abundance and biomass from the NEFSC autumn surveys has varied throughout the time serious, with a peak occurring in the mid 1980s. Current NEFSC indices of winter skate abundance are below the time series mean, and are about 20% of the peak observed during the mid 1980s. Indices of little skate abundance and biomass from the NEFSC spring survey have also varied, with increases beginning in the 1980s, reaching a peak in 1999. This peak has been followed by a steady decline. After a long period of absence from the survey, the presence of barndoor skates in the survey has been steadily increasing since 1990. NEFSC autumn survey indices for thorny skate have declined continuously over the last 40 years, reaching a historically low value in 2005 is less than10% of the peak observed in the 1970s. Indices of smooth skate abundance and biomass from the NEFSC autumn survey have not shown an increase since the observed peak in the late 1970s. Recently smooth skate was listed as being overfished. NEFSC spring and autumn survey indices for clearnose skate increased from the mid-1980s through 2000 and have since declined to about average values. Recent indices of rosette skate abundance and biomass from the NEFSC surveys have increased approaching the peak values of the late 1970s.

Assessment data for the northeast skate complex is considered to be poor . Difficulties with species identification have hindered the collection of high quality species specific catch data. This in turn has reduced the number of appropriate models available for the stock assessment of these species. The SARC proposed alternative model-based fishing mortality estimates and new biological reference points. The proposed biological reference points were based on stock-recruit or yield-per-recruit analysis. These were not accepted by the review panel due to a lack of species-specific catch data. Further study is required to determine the reliability of these proposed models to ensure their suitability.

The SARC discussed two methods for estimating fishing mortality rates; models developed by Hoenig (1987) and Gedamke and Hoenig (2006). There was concern about whether the assumptions of both methods were met sufficiently. It was suggested that the reliability of the two methods be tested using simulation methods.

The use of observer data to disaggregate historical landings and discard data was discussed. The observer data contain some errors related to species identification that complicates the disaggregation of historical catch and discards into individual species.

7.3.7 Marine Mammals and Protected Species

The following protected species are found in the environment utilized by the skate fishery. A number of them are listed under the Endangered Species Act of 1973 (ESA) as "endangered" or "threatened", while others are identified as protected under the Marine Mammal Protection Act of 1972 (MMPA). Actions taken to minimize the interaction of the fishery with protected species are described in Section 4.1.1 of Skate Amendment 3. Monthly reports of observed incidental takes are available on the NEFSC website at http://www.nefsc.noaa.gov/femad/fishsamp/fsb/.

Cetaceans	***Status***
Northern right whale (*Eubalaena glacialis*)	Endangered
Humpback whale (*Megaptera novaeangliae*)	Endangered
Fin whale (*Balaenoptera physalus*)	Endangered
Blue whale (*Balaenoptera musculus*)	Endangered
Sei whale (*Balaenoptera borealis*)	Endangered
Sperm whale (*Physeter macrocephalus*)	Endangered
Minke whale (*Balaenoptera acutorostrata*)	Protected
Pilot whale (*Globicephala* spp.)	Protected
Spotted dolphin (*Stenella frontalis*)	Protected
Risso's dolphin (*Grampus griseus*)	Protected
White-sided dolphin (*Lagenorhynchus acutus*)	Protected
Common dolphin (*Delphinus delphis*)	Protected
Bottlenose dolphin: coastal stocks (*Tursiops truncatus*)	Protected
Harbor porpoise (*Phocoena phocoena*)	Protected
Seals	
Harbor seal (*Phoca vitulina*)	Protected
Gray seal (*Halichoerus grypus*)	Protected
Harp seal (*Phoca groenlandica*)	Protected
Hooded seal (*Crystophora cristata*)	Protected
Sea Turtles	
Leatherback sea turtle (*Dermochelys coriacea*)	Endangered
Kemp's ridley sea turtle (*Lepidochelys kempii*)	Endangered
Green sea turtle (*Chelonia mydas*)	Endangered*
Loggerhead sea turtle (*Caretta caretta*)	Threatened
Fish	
Shortnose sturgeon (*Acipenser brevirostrum*)	Endangered
Atlantic salmon (*Salmo salar*)	Endangered

**Green turtles in U.S. waters are listed as threatened except for the Florida breeding population which is listed as endangered.*

Although salmon belonging to the Gulf of Maine distinct population segment (DPS) of Atlantic salmon occur within the general geographical area covered by the Northeast Multispecies FMP, they are unlikely to occur in the area where the fishery is prosecuted given their numbers and distribution. Therefore, the DPS is not likely to be affected by the skate fishery.

It is expected that all of the remaining species identified have the potential to be affected by the operation of the skate fishery. However, given differences in abundance, distribution and migratory patterns, it is likely that any effects that may occur, as well as the magnitude of effects when they do occur, will vary among the species. Summary information is provided here that describes the general distribution of cetaceans, pinnipeds, and sea turtles within the management area for the Skate FMP as well as the known interactions of gear used in the skate fishery with these protected species. Additional background information on the range-wide status of marine mammal and sea turtle species that occur in the area can be found in a number of published documents. These include sea turtle status reviews and biological reports (NMFS and USFWS 2007; Hirth 1997; USFWS 1997; Marine Turtle Expert Working Group (TEWG) 1998 & 2000), recovery plans for Endangered Species Act-listed sea turtles and marine mammals (NMFS 1991; NMFS and USFWS 1991a; NMFS and USFWS 1991b; NMFS and USFWS 1992; NMFS 1998; USFWS and NMFS 1992; NMFS 2005), the marine mammal stock assessment reports (*e.g.*, Waring *et al*. 2006,2007 and 2008), and other publications (*e.g.*, Clapham *et al.* 1999; Perry *et al.* 1999; Wynne and Schwartz 1999; Best *et al.* 2001; Perrin *et al*. 2002). Additionally, the Center for Biological Diversity and the Turtle Island Restoration Network has recently filed a petition to reclassify loggerhead turtles in the North Pacific Ocean as a distinct population segment (DPS) with endangered status and designate critical habitat under the ESA (72 *Federal Register* 64585; November 16, 2007). While this petition is geared toward the North Pacific, the possibility exists that it could affect status in other areas. NMFS has found that the petition presents substantial scientific information that the petition action may be warranted, and has published a notice and request for comments, available at: http://www.nmfs.noaa.gov/pr/pdfs/fr/fr72-64585.pdf.

7.3.7.1 Sea Turtles

Loggerhead, leatherback, Kemp's ridley, and green sea turtles occur seasonally in southern New England and Mid-Atlantic continental shelf waters north of Cape Hatteras. In general, turtles move up the coast from southern wintering areas as water temperatures warm in the spring (James *et al*. 2005; Morreale and Standora 2005; Braun-McNeill and Epperly 2004; Morreale and Standora 1998; Musick and Limpus 1997; Shoop and Kenney 1992; Keinath *et al.* 1987). The trend is reversed in the fall as water temperatures cool. By December, turtles have passed Cape Hatteras, returning to more southern waters for the winter (James *et al*. 2005; Morreale and Standora 2005; Braun-McNeill and Epperly 2004; Morreale and Standora 1998; Musick and Limpus 1997; Shoop and Kenney 1992; Keinath *et al.* 1987). Hard-shelled species are typically observed as far north as Cape Cod whereas the more cold-tolerant leatherbacks are observed in more northern Gulf of Maine waters in the summer and fall (Shoop and Kenney 1992; STSSN database).

Sea turtles are known to be captured in gillnet and trawl gear; gear types that are used in the skate fishery. According to the monthly reports on the NEFSC website for March 2006 – February 2008, one loggerhead turtle was taken in observed groundfish trips by a bottom trawl, and none were observed in sink gillnets.

7.3.7.2 Large Cetaceans (Baleen Whales and Sperm Whale)

The western North Atlantic baleen whale species (Northern right, humpback, fin, sei, and minke) follow a general annual pattern of migration from high latitude summer foraging grounds, including the Gulf of Maine and Georges Bank, and low latitude winter calving grounds (Perry *et al.* 1999; Kenney 2002). However, this is an oversimplification of species movements, and the complete winter distribution of most species is unclear (Perry et al. 1999; Waring et al. *2008*). Studies of some of the large baleen whales (right, humpback, and fin) have demonstrated the presence of each species in higher latitude waters even in the winter (Swingle *et al*. 1993; Wiley *et al*. 1995; Perry *et al*. 1999; Brown *et al*. 2002).

In comparison to the baleen whales, sperm whale distribution occurs more on the continental shelf edge, over the continental slope, and into mid-ocean regions (Waring *et al*. 2005). However, sperm whales distribution in U.S. EEZ waters also occurs in a distinct seasonal cycle (Waring *et al*. *2008*). Typically, sperm whale distribution is concentrated east-northeast of Cape Hatteras in winter and shifts northward in spring when whales are found throughout the Mid-Atlantic Bight (Waring *et al*. 2005). Distribution extends further northward to areas north of Georges Bank and the Northeast Channel region in summer and then south of New England in fall, back to the Mid-Atlantic Bight (Waring *et al.* 1999).

Right whales and sei whales feed on copepods (Horwood 2002; Kenney 2002). The groundfish fishery will not affect the availability of copepods for foraging right and sei whales because copepods are very small organisms that will pass through skate fishing gear rather than being captured in it. Blue whales feed on euphausiids (krill) (Sears 2002) which, likewise, are too small to be captured in skate fishing gear. Humpback whales and fin whales also feed on krill as well as small schooling fish (e.g., sand lance, herring, mackerel) (Aguilar 2002; Clapham 2002). Fish species caught in skate gear are species that live in benthic habitat (on or very near the bottom) such as flounders versus schooling fish such as herring and mackerel that occur within the water column. Sperm whales feed on larger organisms that inhabit the deeper ocean regions (Whitehead 2002). The skate fishery does not operate in these deep water areas.

The skate fishery does not operate in low latitude waters where calving and nursing occurs for these large cetacean species (Aguilar 2002; Clapham 2002; Horwood 2002; Kenney 2002; Sears 2002; Whitehead 2002).

Gillnet gear is known to pose a risk of entanglement causing injury and death to large cetaceans. Right whale, humpback whale, and minke whale entanglements in gillnet gear have been documented (Johnson *et al*. 2005; Waring *et al*. *2008*). However, it is often not possible to attribute the gear to a specific fishery. For the period March 2006 – February 2008, five incidents of whale takes were observed on trips targeting groundfish, all of which were taken in bottom trawl trips. Of those five takes, four were of whales that were in various states of decomposition, while one pilot whale was deemed “fresh”. No takes were observed in groundfish sink gillnets.

7.3.7.3 Small Cetaceans (Dolphins, Harbor Porpoise and Pilot Whale)

Numerous small cetacean species (dolphins, pilot whales, harbor porpoise) occur within the area from Cape Hatteras through the Gulf of Maine. Seasonal abundance and distribution of each species in Mid-Atlantic, Georges Bank, and/or Gulf of Maine waters varies with respect to life history characteristics. Some species primarily occupy continental shelf waters (e.g., white sided dolphins, harbor porpoise), while others are found primarily in continental shelf edge and slope waters (e.g., Risso’s dolphin), and still others occupy all three habitats (e.g., common dolphin, spotted dolphins). Information on the western North Atlantic stocks of each species is summarized in Waring *et al*. (*2008*). Small cetaceans are known be captured in gillnet and trawl gear, although the rate of bycatch of harbor porpoise in trawl gear is so low as to be considered 0 (Waring *et al*. *2008*).

With respect to harbor porpoise specifically, the most recent Stock Assessment Reports show that the estimated number of harbor porpoise takes is increasing, moving closer to the Potential Biological Removal level calculated for this species rather than declining toward the long-term Zero Mortality Rate Goal (ZMRG), which is 10 percent of PBR (approximately 75 animals). The most recent stock assessment report states that the average annual estimated harbor porpoise mortality and serious injury in the Northeast sink gillnet fishery during 1994-1998, before the Harbor Porpoise Take Reduction Plan (HPTRP), was 1,163, and from 2000 to 2005 was 480 (Waring *et al.*, 2008). The assessment also states that the total annual estimated average human-caused mortality is 734 harbor porpoises per year, including 77 from Canadian fisheries and 5 from unknown fisheries using strandings data. This is an increase from 575 in the previous assessment. The Harbor Porpoise Take Reduction Team is currently developing options to reduce takes.

7.3.7.4 Pinnipeds

Of the four species of seals expected to occur in the area, harbor seals have the most extensive distribution with sightings occurring as far south as 30° N (Katona *et al.* 1993). Grey seals are the second most common seal species in U.S. EEZ waters, occurring primarily in New England (Katona *et al.* 1993; Waring *et al. 2008*). Pupping colonies for both species are also present in New England, although the majority of pupping occurs in Canada. Harp and hooded seals are less commonly observed in U.S. EEZ waters. Both species form aggregations for pupping and breeding off of eastern Canada in the late winter/early spring, and then travel to more northern latitudes for molting and summer feeding (Waring *et al. 2008*). However, individuals of both species are also known to travel south into U.S. EEZ waters and sightings as well as strandings of each species have been recorded for both New England and Mid-Atlantic waters (Waring *et al. 2008*). All four species of seals are known to be captured in gillnet and/or trawl gear (Waring *et al. 2008*).
Of the four species of seals expected to occur in the area, harbor seals have the most extensive distribution with sightings occurring as far south as 30° N (Katona *et al.* 1993). Grey seals are the second most common seal species in U.S. EEZ waters, occurring primarily in New England (Katona *et al.* 1993; Waring *et al.* 2007). Pupping colonies for both species are also present in New England, although the majority of pupping occurs in Canada. Harp and hooded seals are less commonly observed in U.S. EEZ waters. Both species form aggregations for pupping and breeding off of eastern Canada in the late winter/early spring, and then travel to more northern latitudes for molting and summer feeding (Waring *et al.* 2007). However, individuals of both species are also known to travel south into U.S. EEZ waters and sightings as well as strandings of each species have been recorded for both New England and Mid-Atlantic waters (Waring *et al.* 2007). All four species of seals are known to be captured in gillnet and/or trawl gear (Waring *et al.* 2007).

PHYSICAL ENVIRONMENT

The Northeast U.S. Shelf Ecosystem (Map 8) has been described as including the area from the Gulf of Maine south to Cape Hatteras, extending from the coast seaward to the edge of the continental shelf, including the slope sea offshore to the Gulf Stream (Sherman *et al.* 1996). The continental slope includes the area east of the shelf, out to a depth of 2000 m. Four distinct sub-regions comprise the NOAA Fisheries Northeast Region: the Gulf of Maine, Georges Bank, the Mid-Atlantic Bight, and the continental slope. Occasionally another sub-region, Southern New England, is described; however, we incorporated discussions of any distinctive features of this area into the sections describing Georges Bank and the Mid-Atlantic Bight.

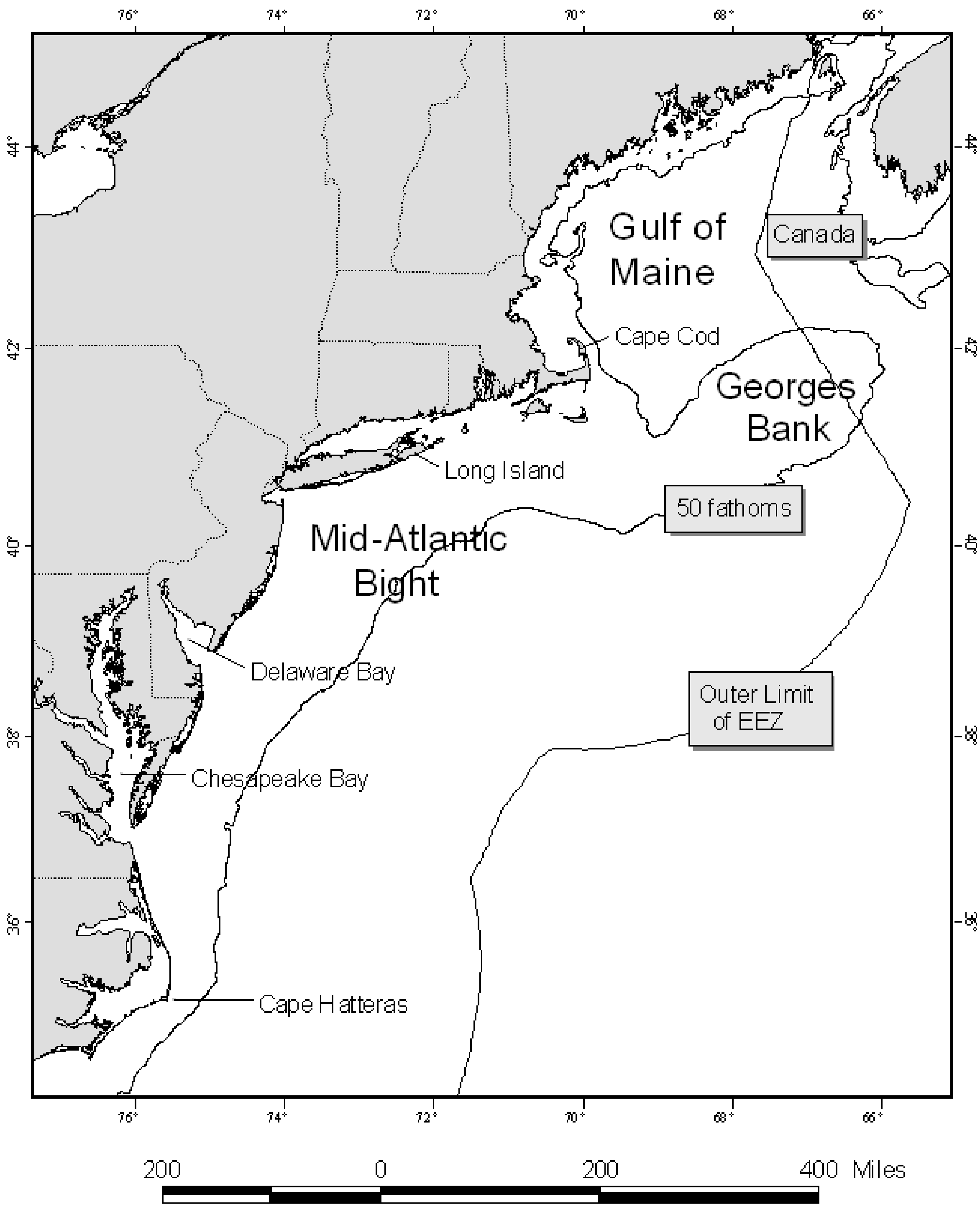
The Gulf of Maine is an enclosed coastal sea, characterized by relatively cold waters and deep basins, with a patchwork of various sediment types. Georges Bank is a relatively shallow coastal plateau that slopes gently from north to south and has steep submarine canyons on its eastern and southeastern edge. It is characterized by highly productive, well-mixed waters and strong currents. The Mid-Atlantic Bight is comprised of the sandy, relatively flat, gently sloping continental shelf from southern New England to Cape Hatteras, NC. The continental slope begins at the continental shelf break and continues eastward with increasing depth until it becomes the continental rise. It is fairly homogenous, with exceptions at the shelf break, some of the canyons, the Hudson Shelf Valley, and in areas of glacially rafted hard bottom.

Pertinent physical and biological characteristics of each of these sub-regions are described in this section, along with a short description of the physical features of coastal environments. Inshore, offshore, and continental slope lobster habitats are described in Section 3.2.6. Information on the affected physical and biological environments included in this amendment was extracted from Stevenson et al. (2004). The primary source references used by Stevenson et al. are not cited in the text of Section 3.1. They are: Backus 1987; Schmitz *et al*. 1987; Tucholke 1987; Wiebe *et al*. 1987; Cook 1988; Reid and Steimle 1988; Stumpf and Biggs 1988; Abernathy 1989; Townsend 1992; Mountain 1994; Beardsley *et al*. 1996; Brooks 1996; Sherman *et al*. 1996; Dorsey 1998; Kelley 1998; NEFMC 1998; Steimle *et al*. 1999. References used to describe the biological features of the affected environment and to describe lobster habitats are cited in the text.

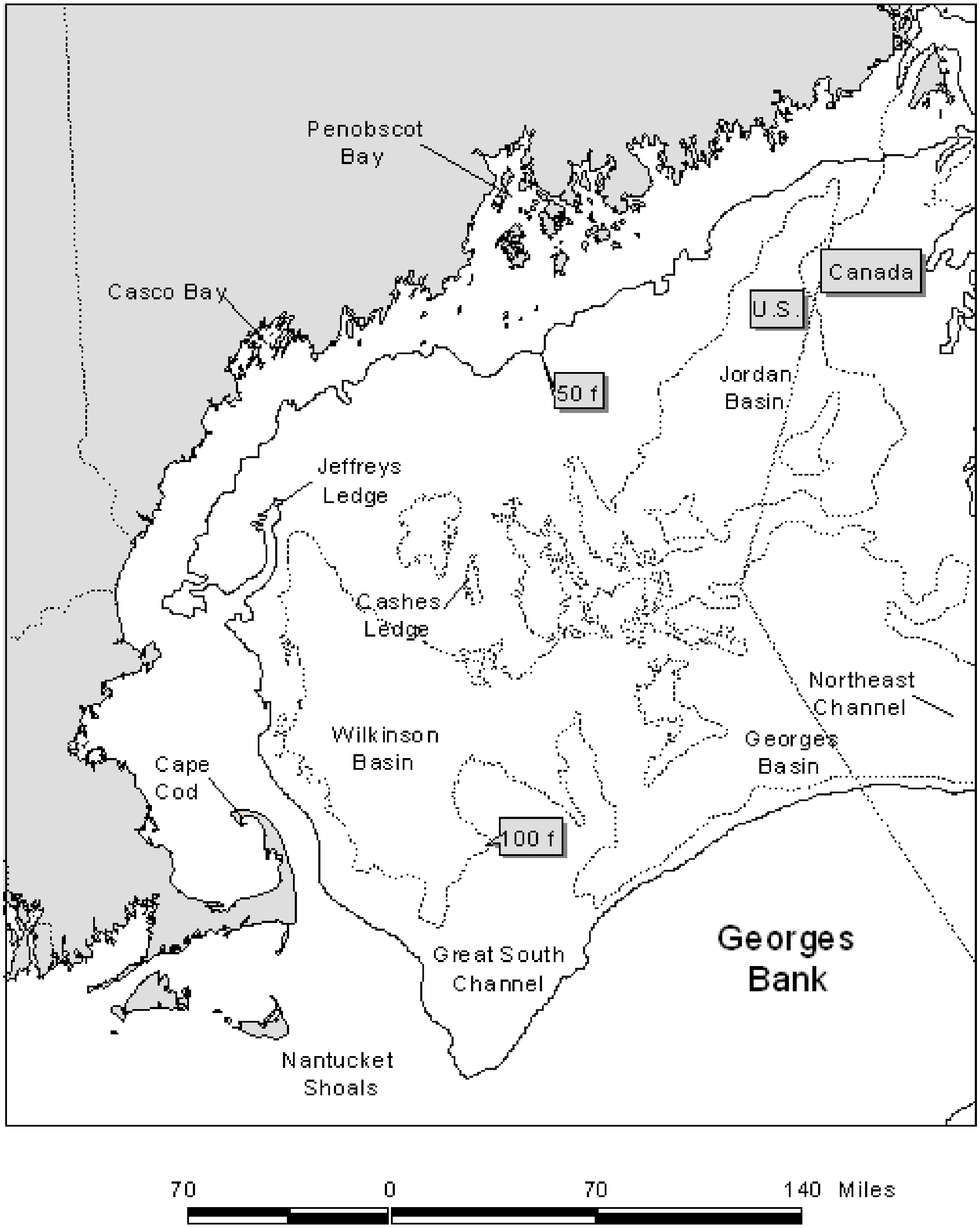
Gulf of Maine

Physical Environment

Although not obvious in appearance, the Gulf of Maine (GOM) is actually an enclosed coastal sea, bounded on the east by Browns Bank, on the north by the Nova Scotian (Scotian) Shelf, on the west by the New England states, and on the south by Cape Cod and Georges Bank (Map 9). The GOM was glacially derived, and is characterized by a system of deep basins, moraines and rocky protrusions with limited access to the open ocean. This geomorphology influences complex oceanographic processes that result in a rich biological community.



Map 8. Northeast U.S Shelf Ecosystem.



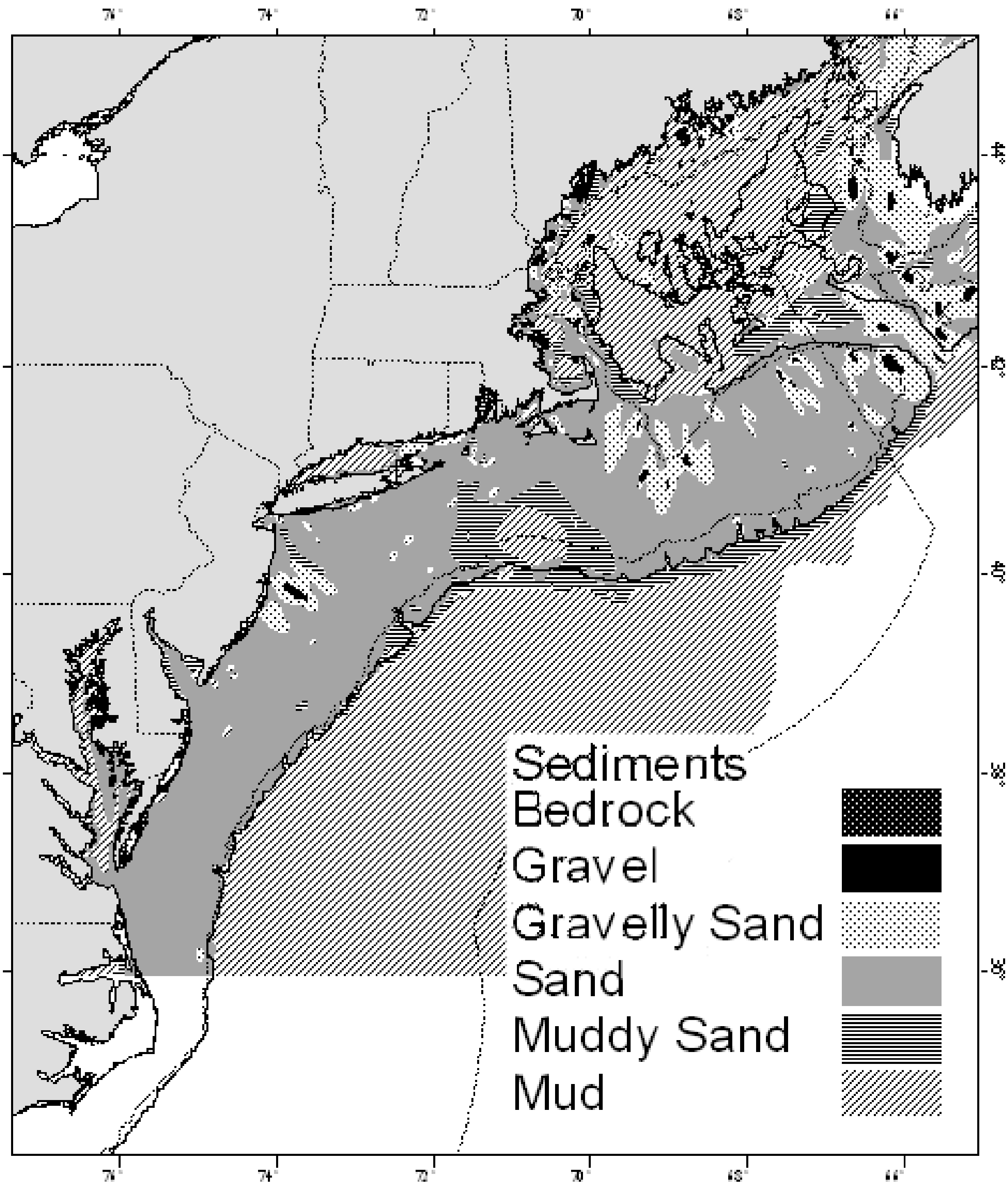
Map 9. Gulf of Maine.

The GOM is topographically unlike any other part of the continental border along the U.S. Atlantic coast. The GOM's geologic features, when coupled with the vertical variation in water properties, result in a great diversity of habitat types. It contains twenty-one distinct basins separated by ridges, banks, and swells. The three largest basins are Wilkinson, Georges, and Jordan (Map 9). Depths in the basins exceed 250 m, with a maximum depth of 350 m in Georges Basin, just north of Georges Bank. The Northeast Channel between Georges Bank and Browns Bank leads into Georges Basin, and is one of the primary avenues for exchange of water between the GOM and the North Atlantic Ocean.

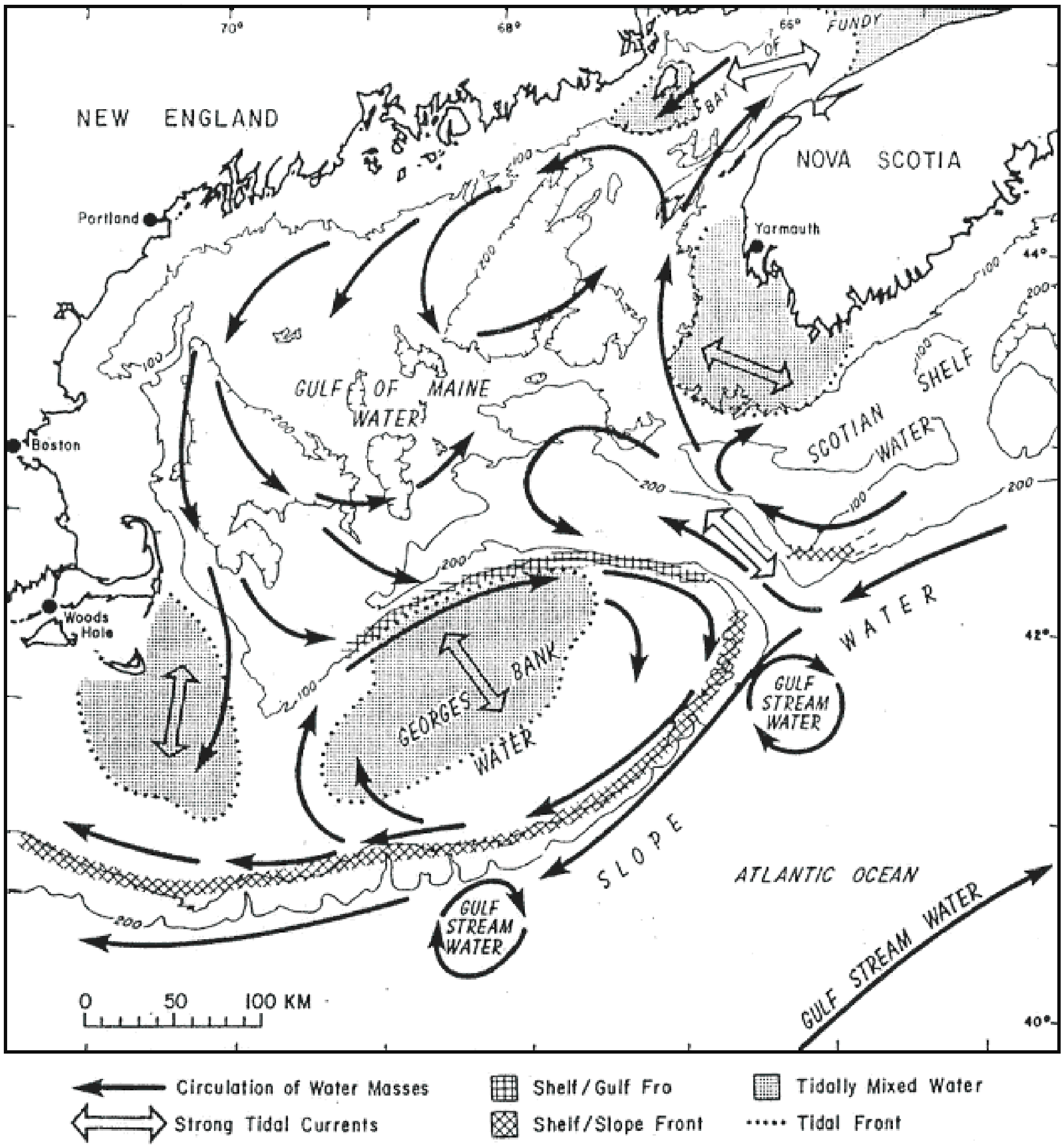
High points within the Gulf include irregular ridges, such as Cashes Ledge, which peaks at 9 m below the surface, as well as lower flat topped banks and gentle swells. Some of these rises are remnants of the sedimentary shelf that was left after most of it was removed by the glaciers. Others are glacial moraines and a few, like Cashes Ledge, are outcroppings of bedrock. Very fine sediment particles created and eroded by the glaciers have collected in thick deposits over much of the GOM, particularly in its deep basins (Map 9). These mud deposits blanket and obscure the irregularities of the underlying bedrock, forming topographically smooth terrains. Some shallower basins are covered with mud as well, including some in coastal waters. In the rises between the basins, other materials are usually at the surface. Unsorted glacial till covers some morainal areas, as on Sewell Ridge to the north of Georges Basin and on Truxton Swell to the south of Jordan Basin. Sand predominates on some high areas and gravel, sometimes with boulders, predominates on others.

Coastal sediments exhibit a high degree of small-scale variability. Bedrock is the predominant substrate along the western edge of the GOM north of Cape Cod in a narrow band out to a depth of about 60 m. Rocky areas become less common with increasing depth, but some rock outcrops poke through the mud covering the deeper sea floor. Mud is the second most common substrate on the inner continental shelf. Mud predominates in coastal valleys and basins that often abruptly border rocky substrates. Many of these basins extend without interruption into deeper water. Gravel, often mixed with shell, is common adjacent to bedrock outcrops and in fractures in the rock. Large expanses of gravel are not common, but do occur near reworked glacial moraines and in areas where the seabed has been scoured by bottom currents. Gravel is most abundant at depths of 20 - 40 m, except in eastern Maine where a gravel-covered plain exists to depths of at least 100 m. Bottom currents are stronger in eastern Maine where the mean tidal range exceeds 5 m. Sandy areas are relatively rare along the inner shelf of the western GOM, but are more common south of Casco Bay, especially offshore of sandy beaches.

An intense seasonal cycle of winter cooling and turnover, springtime freshwater runoff, and summer warming influences oceanographic and biologic processes in the GOM. The Gulf has a general counterclockwise nontidal surface current that flows around its coastal margin (Map 11). It is primarily driven by fresh, cold Scotian Shelf water that enters over the Scotian Shelf and through the Northeast Channel, and freshwater river runoff, which is particularly important in the spring. Dense relatively warm and saline slope water entering through the bottom of the Northeast Channel from the continental slope also influences gyre



Map 10. Northeast region sediments, modified from Poppe *et al*. (1989a and b).



Map 11. Water mass circulation patterns in the Georges Bank - Gulf of Maine region.

formation. Counterclockwise gyres generally form in Jordan, Wilkinson, and Georges Basins and the Northeast Channel as well. These surface gyres are more pronounced in spring and summer; with winter, they weaken and become more influenced by the wind.

Stratification of surface waters during spring and summer seals off a mid-depth layer of water that preserves winter salinity and temperatures. This cold layer of water is called “Maine intermediate water” (MIW) and is located between more saline Maine bottom water and the warmer, stratified Maine surface water. The stratified surface layer is most pronounced in the deep portions of the western GOM. Tidal mixing of shallow areas prevents thermal stratification and results in thermal fronts between the stratified areas and cooler mixed areas. Typically, mixed areas include Georges Bank, the southwest Scotian Shelf, eastern Maine coastal waters, and the narrow coastal band surrounding the remainder of the Gulf.

The Northeast Channel provides an exit for cold MIW and outgoing surface water while it allows warmer more saline slope water to move in along the bottom and spill into the deeper basins. The influx of water occurs in pulses, and appears to be seasonal, with lower flow in late winter and a maximum in early summer.

GOM circulation and water properties can vary significantly from year to year. Notable episodic events include shelf-slope interactions such as the entrainment of shelf water by Gulf Stream rings (see the “Gulf Stream and Associated Features” section, below), and strong winds that can create currents as high as 1.1 m/s over Georges Bank. Warm core Gulf Stream rings can also influence upwelling and nutrient exchange on the Scotian shelf, and affect the water masses entering the GOM. Annual and seasonal inflow variations also affect water circulation.
Internal waves are episodic and can greatly affect the biological properties of certain habitats. Internal waves can shift water layers vertically, so that habitats normally surrounded by cold MIW are temporarily bathed in warm, organic rich surface water. On Cashes Ledge, it is thought that deeper nutrient rich water is driven into the photic zone, providing for increased productivity. Localized areas of upwelling interaction occur in numerous places throughout the Gulf.

Benthic Invertebrates

Based on 303 benthic grab samples collected in the GOM during 1956-1965, Theroux and Wigley (1998) reported that, in terms of numbers, the most common groups of benthic invertebrates in the GOM were annelid worms (35%), bivalve mollusks (33%), and amphipod crustaceans (14%). Biomass was dominated by bivalves (24%), sea cucumbers (22%), sand dollars (18%), annelids (12%), and sea anemones (9%). Watling (1998) used numerical classification techniques to separate benthic invertebrate samples into seven bottom assemblages. These assemblages are identified in Table 1 and their distribution is indicated in Map 12. This classification system considers predominant taxa, substrate types, and seawater properties.

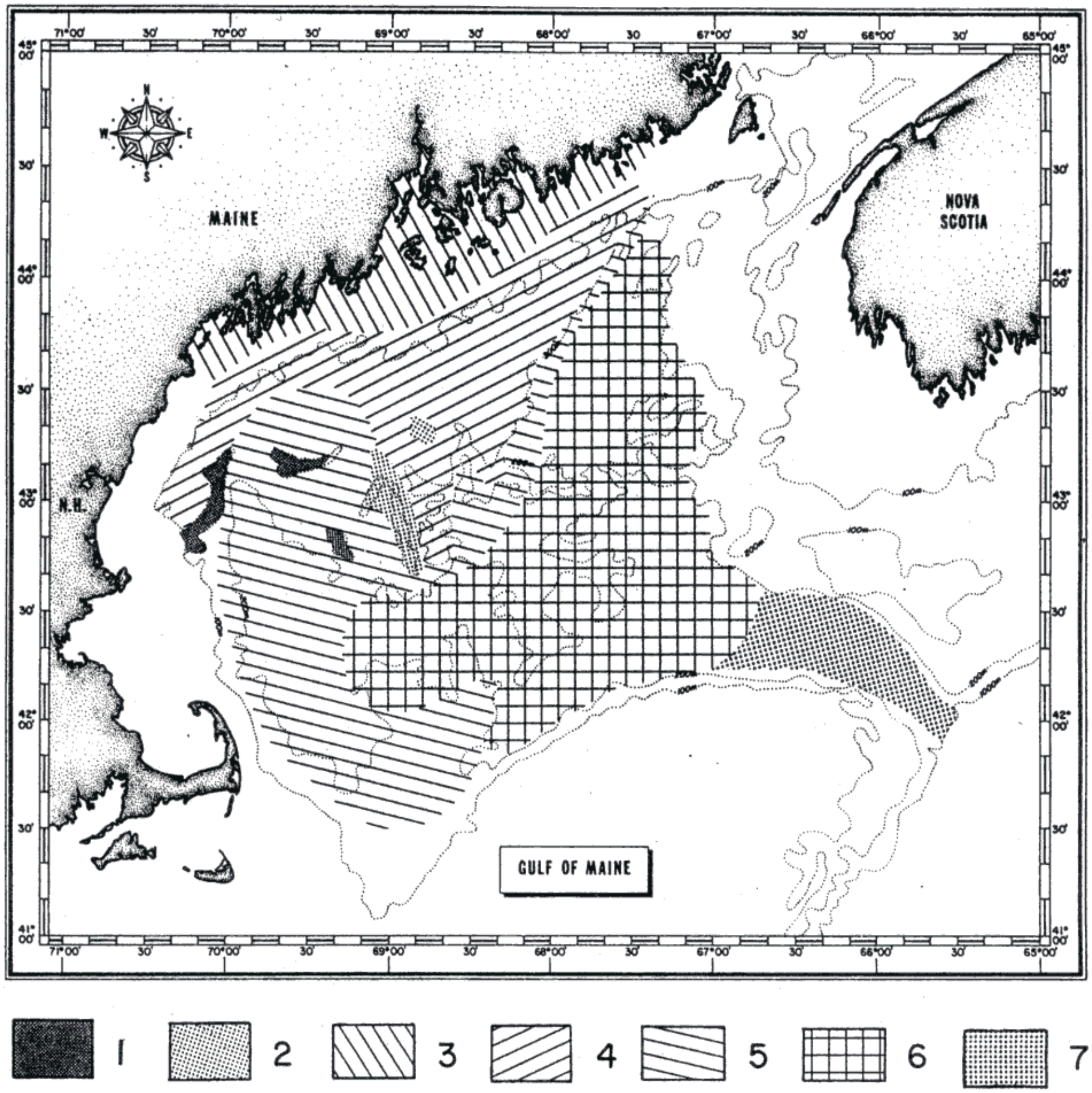
Demersal Fish

Demersal fish assemblages for the GOM and Georges Bank were part of broad scale geographic investigations conducted by Gabriel (1992) and Mahon *et al.* (1998). Both these studies and a more limited study by Overholtz and Tyler (1985) found assemblages that were consistent over space and time in this region. In her analysis, Gabriel (1992) found that the most persistent feature over time in assemblage structure from Nova Scotia to Cape Hatteras was the boundary separating assemblages between the GOM and Georges Bank, which occurred at approximately the 100 m isobath on northern Georges Bank. Overholtz and Tyler (1985) identified five assemblages for this region. The Gulf of Maine-deep assemblage included a number of species found in other assemblages, with the exception of American plaice and witch flounder, which was unique to this assemblage. Gabriel's approach did not allow species to co-occur in assemblages, and classified these two species as unique to the deepwater Gulf of Maine-Georges Bank assemblage. Results of these two studies are compared in Table 2.

Table 1. Gulf of Maine benthic assemblages as identified by Watling (1998).

Benthic Assemblage	Benthic Community Description
1	Comprises all sandy offshore banks, most prominently Jeffreys Ledge, Fippennies Ledge, and Platts Bank; depth on top of banks about 70 m; substrate usually coarse sand with some gravel; fauna characteristically sand dwellers with an abundant interstitial component.
2	Comprises the rocky offshore ledges, such as Cashes Ledge, Sigsbee Ridge and Three Dory Ridge; substrate either rock ridge outcrop or very large boulders, often with a covering of very fine sediment; fauna predominantly sponges, tunicates, bryozoans, hydroids, and other hard bottom dwellers; overlying water usually cold Gulf of Maine Intermediate Water.
3	Probably extends all along the coast of the Gulf of Maine in water depths less than 60 m; bottom waters warm in summer and cold in winter; fauna rich and diverse, primarily polychaetes and crustaceans, probably consists of several (sub-) assemblages due to heterogeneity of substrate and water conditions near shore and at mouths of bays.
4	Extends over the soft bottom at depths of 60 - 140 m, well within the cold Gulf of Maine Intermediate Water; bottom sediments primarily fine muds; fauna dominated by polychaetes, shrimp, and cerianthid anemones.
5	A mixed assemblage comprising elements from the cold water fauna as well as a few deeper water species with broader temperature tolerances; overlying water often a mixture of Intermediate Water and Bottom Water, but generally colder than 7°C most of the year; fauna sparse, diversity low, dominated by a few polychaetes, with brittle stars, sea pens, shrimp, and cerianthids also present.
6	Comprises the fauna of the deep basins; bottom sediments generally very fine muds, but may have a gravel component in the offshore morainal regions; overlying water usually 7 - 8°C, with little variation; fauna shows some bathyal affinities but densities are not high, dominated by brittle stars and sea pens, and sporadically by a tube-making amphipod.
7	The true upper slope fauna that extends into the Northeast Channel; water temperatures are always above 8°C and salinities are at least 35 ppt; sediments may be either fine muds or a mixture of mud and gravel.

Geographical distribution of assemblages is shown in Map 12.



Map 12. Distribution of the seven major benthic assemblages in the Gulf of Maine. Distribution determined from both soft bottom quantitative sampling and qualitative hard bottom sampling. The assemblages are characterized as follows: 1. Sandy offshore banks; 2. Rocky offshore ledges; 3. Shallow (< 50 m) temperate bottoms with mixed substrate; 4. Boreal muddy bottom, overlain by Maine Intermediate Water, 50 - 160 m (approximate); 5. Cold deep water, species with broad tolerances, muddy bottom; 6. Deep basin warm water, muddy bottom; 7. Upper slope water, mixed sediment. Source: Watling (1998).

Table 2. Comparison of demersal fish assemblages of Georges Bank and the Gulf of Maine.

Overholtz and Tyler (1985)		**Gabriel (1992)**	
Assemblage	**Species**	**Species**	**Assemblage**
Slope and Canyon	offshore hake blackbelly rosefish Gulf stream flounder fourspot flounder, goosefish, silver hake, white hake, red hake	offshore hake blackbelly rosefish Gulf stream flounder fawn cusk-eel, longfin hake, armored sea robin	Deepwater
Intermediate	silver hake red hake goosefish Atlantic cod, haddock, ocean pout, yellowtail flounder, winter skate, little skate, sea raven, longhorn sculpin	silver hake red hake goosefish northern shortfin squid, spiny dogfish, cusk	Combination of Deepwater Gulf of Maine/Georges Bank and Gulf of Maine-Georges Bank Transition
Shallow	Atlantic cod haddock pollock silver hake white hake red hake goosefish ocean pout yellowtail flounder windowpane winter flounder winter skate little skate longhorn sculpin summer flounder sea raven, sand lance	Atlantic cod haddock pollock yellowtail flounder windowpane winter flounder winter skate little skate longhorn sculpin	Gulf of Maine-Georges Bank Transition Zone (*see below also*) Shallow Water Georges Bank-Southern New England
Gulf of Maine-Deep	white hake American plaice witch flounder thorny skate silver hake, Atlantic cod, haddock, cusk, Atlantic wolffish	white hake American plaice witch flounder thorny skate redfish	Deepwater Gulf of Maine-Georges Bank
Northeast Peak	Atlantic cod haddock pollock ocean pout, winter flounder, white hake, thorny skate, longhorn sculpin	Atlantic cod haddock pollock	Gulf of Maine-Georges Bank Transition Zone (*see above also*)

Georges Bank

Physical Environment

Georges Bank is a shallow (3 - 150 m depth), elongate (161 km wide by 322 km long) extension of the continental shelf that was formed by the Wisconsinian glacial episode. It is characterized by a steep slope on its northern edge and a broad, flat, gently sloping southern flank. The Great South Channel lies to the west. Natural processes continue to erode and rework the sediments on Georges Bank. It is anticipated that erosion and reworking of sediments will reduce the amount of sand available to the sand sheets, and cause an overall coarsening of the bottom sediments (Valentine *et al.* 1993).

Glacial retreat during the late Pleistocene deposited the bottom sediments currently observed on the eastern section of Georges Bank, and the sediments have been continuously reworked and redistributed by the action of rising sea level, and by tidal, storm and other currents. The strong, erosive currents affect the character of the biological community. Bottom topography on eastern Georges Bank is characterized by linear ridges in the western shoal areas; a relatively smooth, gently dipping sea floor on the deeper, easternmost part; a highly energetic peak in the north with sand ridges up to 30 m high and extensive gravel pavement; and steeper and smoother topography incised by submarine canyons on the southeastern margin (see the "Continental Slope" section, below, for more on canyons). The interaction of several environmental factors, including availability and type of sediment, current speed and direction, and bottom topography, has formed seven sedimentary provinces on eastern Georges Bank (Valentine and Lough 1991), which are described in Table 3 and depicted in Map 13. The gravel-sand mixture is usually a transition zone between coarse gravel and finer sediments.

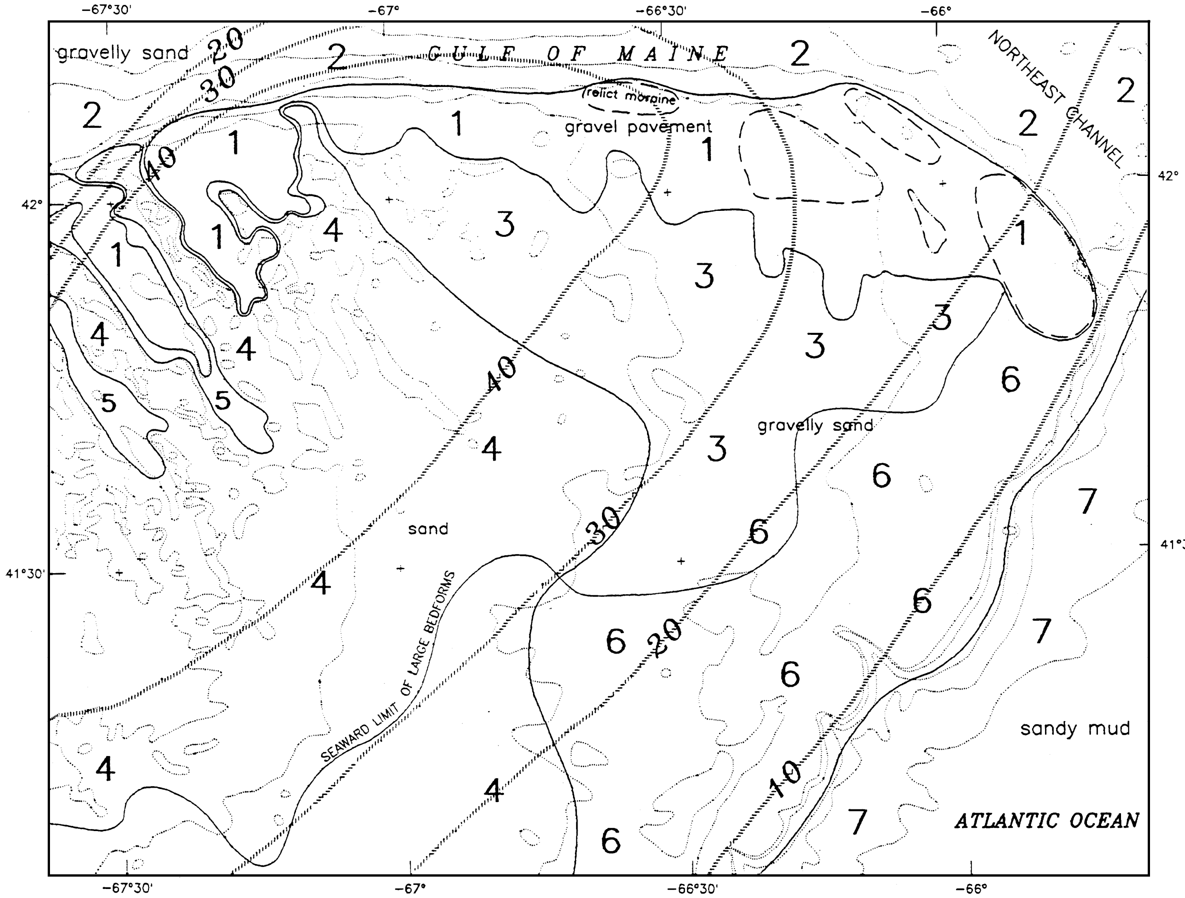
The central region of the Bank is shallow, and the bottom is characterized by shoals and troughs, with sand dunes superimposed upon them. The two most prominent elevations on the ridge and trough area are Cultivator and Georges Shoals. This shoal and trough area is a region of strong currents, with average flood and ebb tidal currents greater than 4 km/h, and as high as 7 km/h. The dunes migrate at variable rates, and the ridges may also move. In an area that lies between the central part and Northeast Peak, Almeida *et al.* (2000) identified high-energy areas as between 35 - 65 m deep, where sand is transported on a daily basis by tidal currents, and a low-energy area at depths > 65 m that is affected only by storm currents.

The area west of the Great South Channel, known as Nantucket Shoals (Map 9), is similar in nature to the central region of the Bank. Currents in these areas are strongest where water depth is shallower than 50 m. This type of travelling dune and swale morphology is also found in the Mid-Atlantic Bight, and further described in that section of the document. The Great South Channel separates the main part of Georges Bank from Nantucket Shoals. Sediments in this region include gravel pavement and mounds, some scattered boulders, sand with storm generated ripples, and scattered shell and mussel beds. Tidal and storm currents range from moderate to strong, depending upon location and storm activity (Valentine, pers. comm.).

Table 3. Sedimentary provinces and associated benthic landscapes of Georges Bank.

Sedimentary Province	**Depth (m)**	**Description**	**Benthic Assemblage**
Northern Edge / Northeast Peak (1)	40 - 200	Dominated by gravel with portions of sand, common boulder areas, and tightly packed pebbles. Representative epifauna (bryozoa, hydrozoa, anemones, and calcareous worm tubes) are abundant in areas of boulders. Strong tidal and storm currents.	Northeast Peak
Northern Slope and Northeast Channel (2)	200 - 240	Variable sediment type (gravel, gravel-sand, and sand) scattered bedforms. This is a transition zone between the northern edge and southern slope. Strong tidal and storm currents.	Northeast Peak
North /Central Shelf (3)	60 - 120	Highly variable sediment type (ranging from gravel to sand) with rippled sand, large bedforms, and patchy gravel lag deposits. Minimal epifauna on gravel due to sand movement. Representative epifauna in sand areas includes amphipods, sand dollars, and burrowing anemones.	Central Georges
Central and Southwestern Shelf - shoal ridges (4)	10 - 80	Dominated by sand (fine and medium grain) with large sand ridges, dunes, waves, and ripples. Small bedforms in southern part. Minimal epifauna on gravel due to sand movement. Representative epifauna in sand areas includes amphipods, sand dollars, and burrowing anemones.	Central Georges
Central and Southwestern Shelf - shoal troughs (5)	40 - 60	Gravel (including gravel lag) and gravel-sand between large sand ridges. Patchy large bedforms. Strong currents. (Few samples – submersible observation noted presence of gravel lag, rippled gravel-sand, and large bedforms.) Minimal epifauna on gravel due to sand movement. Representative epifauna in sand areas includes amphipods, sand dollars, and burrowing anemones.	Central Georges
Southeastern Shelf (6)	80 - 200	Rippled gravel-sand (medium and fine grained sand) with patchy large bedforms and gravel lag. Weaker currents; ripples are formed by intermittent storm currents. Representative epifauna includes sponges attached to shell fragments and amphipods.	Southern Georges
Southeastern Slope (7)	400 - 2000	Dominated by silt and clay with portions of sand (medium and fine) with rippled sand on shallow slope and smooth silt-sand deeper.	none

Sediment provinces as defined by Valentine *et al.* (1993) and Valentine and Lough (1991), with additional comments by Valentine (pers. comm.) and benthic assemblages assigned by Theroux and Grosslein (1987). See text for further discussion on benthic assemblages.



Map 13. Sedimentary provinces of eastern Georges Bank.
Based on criteria of sea floor morphology, texture, sediment movement and bedforms, and mean tidal bottom current speed (cm/s). Relict moraines (bouldery seafloor) are enclosed by dashed lines. See Table 3 for descriptions of provinces. Source: Valentine and Lough (1991).

Oceanographic frontal systems separate water masses of the GOM and Georges Bank from oceanic waters south of the Bank. These water masses differ in temperature, salinity, nutrient concentration, and planktonic communities, which influence productivity and may influence fish abundance and distribution. Currents on Georges Bank include a weak, persistent clockwise gyre around the Bank, a strong semidiurnal tidal flow predominantly northwest and southeast, and very strong, intermittent storm induced currents, which all can occur simultaneously (Map 11). Tidal currents over the shallow top of Georges Bank can be very strong, and keep the waters over the Bank well mixed vertically. This results in a tidal front that separates the cool waters of the well mixed shallows of the central Bank from the warmer, seasonally stratified shelf waters on the seaward and shoreward sides of the Bank. The clockwise gyre is instrumental in distribution of plankton, including fish eggs and larvae.

Invertebrates

Amphipod crustaceans (49%) and annelid worms (28%) numerically dominated the contents of 211 samples collected on Georges Bank during 1956-1965 (Theroux and Wigley 1998). Biomass was dominated by sand dollars (50%) and bivalves (33%). Theroux and Grosslein (1987) utilized the same database to identify four macrobenthic invertebrate assemblages. They noted that the boundaries between assemblages were not well defined because there is considerable intergrading between adjacent assemblages. Their assemblages are associated with those identified by Valentine and Lough (1991) in Table 3.

The Western Basin assemblage is found in the upper Great South Channel region at the northwestern corner of the Bank, in comparatively deepwater (150 - 200 m) with relatively slow currents and fine bottom sediments of silt, clay and muddy sand. Fauna are comprised mainly of small burrowing detritivores and deposit feeders, and carnivorous scavengers. Valentine and Lough (1991) did not identify a comparable assemblage; however, this assemblage is geographically located adjacent to Assemblage 5 as described by Watling (1998) (Table 1, Map 12).

The Northeast Peak assemblage is found along the Northern Edge and Northeast Peak, which varies in depth and current strength and includes coarse sediments, consisting mainly of gravel and coarse sand with interspersed boulders, cobbles, and pebbles. Fauna tend to be sessile (coelenterates, brachiopods, barnacles, and tubiferous annelids) or free-living (brittle stars, crustaceans, and polychaetes), with a characteristic absence of burrowing forms.

The Central Georges Bank assemblage occupies the greatest area, including the central and northern portions of the Bank in depths less than 100 m. Medium grained shifting sands predominate this dynamic area of strong currents. Organisms tend to be small to moderately large with burrowing or motile habits.

The Southern Georges Bank assemblage is found on the southern and southwestern flanks at depths from 80 - 200 m, where fine grained sands and moderate currents predominate. Many southern species exist here at the northern limits of their range.

Demersal Fish

Along with high levels of primary productivity, Georges Bank has been historically characterized by high levels of fish production. Several studies have attempted to identify demersal fish assemblages over large spatial scales. Overholtz and Tyler (1985) found five depth related groundfish assemblages for Georges Bank and the GOM that were persistent temporally and spatially. Depth and salinity were identified as major physical influences explaining assemblage structure. Gabriel (1992) identified six assemblages, which are compared with the results of Overholtz and Tyler (1985) in Table 2. Mahon *et al.* (1998) found similar results.

Mid-Atlantic Bight

Physical Environment

The Mid-Atlantic Bight includes the shelf and slope waters from Georges Bank south to Cape Hatteras, and east to the Gulf Stream (Map 8). Like the rest of the continental shelf, the topography of the Mid-Atlantic Bight was shaped largely by sea level fluctuations caused by past ice ages. The shelf's basic morphology and sediments derive from the retreat of the last ice sheet, and the subsequent rise in sea level. Since that time, currents and waves have modified this basic structure.

Shelf and slope waters of the Mid-Atlantic Bight have a slow southwestward flow that is occasionally interrupted by warm core rings or meanders from the Gulf Stream. On average, shelf water moves parallel to bathymetry isobars at speeds of 5 - 10 cm/s at the surface and 2 cm/s or less at the bottom. Storm events can cause much more energetic variations in flow. Tidal currents on the inner shelf have a higher flow rate of 20 cm/s that increases to 100 cm/s near inlets.

Slope water tends to be warmer than shelf water because of its proximity to the Gulf Stream, and tends to be more saline. The abrupt gradient where these two water masses meet is called the shelf-slope front. This front is usually located at the edge of the shelf and touches bottom at about 75 - 100 m depth of water, and then slopes up to the east toward the surface. It reaches surface waters approximately 25 - 55 km further offshore. The position of the front is highly variable, and can be influenced by many physical factors. Vertical structure of temperature and salinity within the front can develop complex patterns because of the interleaving of shelf and slope waters; *e.g.*, cold shelf waters can protrude offshore, or warmer slope water can intrude up onto the shelf.

The seasonal effects of warming and cooling increase in shallower, nearshore waters. Stratification of the water column occurs over the shelf and the top layer of slope water during the spring-summer and is usually established by early June. Fall mixing results in homogenous shelf and upper slope waters by October in most years. A permanent thermocline exists in slope waters from 200 - 600 m deep. Temperatures decrease at the rate of about 0.02ºC per meter and remain relatively constant except for occasional incursions of Gulf stream eddies or meanders. Below 600 m, temperature declines, and usually averages about 2.2ºC at 4000 m. A warm, mixed layer approximately 40 m thick resides above the permanent thermocline.

The "cold pool" is an annual phenomenon particularly important to the Mid-Atlantic Bight. It stretches from the Gulf of Maine along the outer edge of Georges Bank and then southwest to Cape Hatteras. It becomes identifiable with the onset of thermal stratification in the spring and lasts into early fall until normal seasonal mixing occurs. It usually exists along the bottom between the 40 and 100 m isobaths and extends up into the water column for about 35 m, to the bottom of the seasonal thermocline. The cold pool usually represents about 30% of the volume of shelf water. Minimum temperatures for the cold pool occur in early spring and summer, and range from 1.1 - 4.7ºC.

The shelf slopes gently from shore out to between 100 and 200 km offshore where it transforms to the slope (100 - 200 m water depth) at the shelf break. In both the Mid-Atlantic and on Georges Bank, numerous canyons incise the slope, and some cut up onto the shelf itself (see the “Continental Slope” section, below). The primary morphological features of the shelf include shelf valleys and channels, shoal massifs, scarps, and sand ridges and swales (Map 14 and Map 15).

Most of these structures are relic except for some sand ridges and smaller sand-formed features. Shelf valleys and slope canyons were formed by rivers of glacier outwash that deposited sediments on the outer shelf edge as they entered the ocean. Most valleys cut about 10 m into the shelf, with the exception of the Hudson Shelf Valley that is about 35 m deep. The valleys were partially filled as the glacier melted and retreated across the shelf. The glacier also left behind a lengthy scarp near the shelf break from Chesapeake Bay north to the eastern end of Long Island (Map 14 and Map 15). Shoal retreat massifs were produced by extensive deposition at a cape or estuary mouth. Massifs were also formed as estuaries retreated across the shelf.

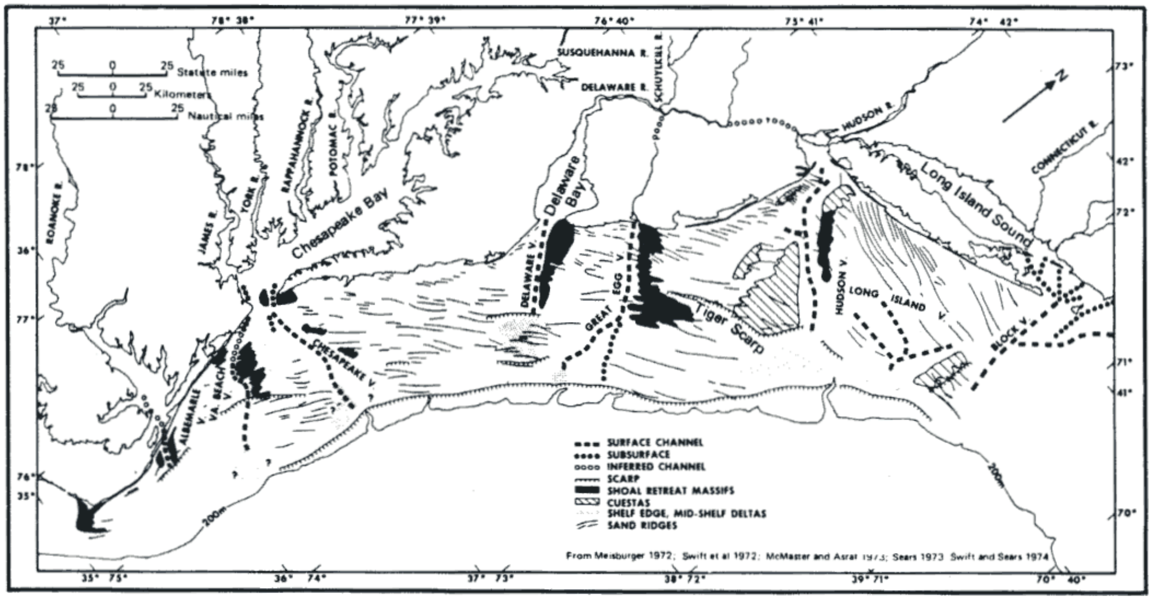
The sediment type covering most of the shelf in the Mid-Atlantic Bight is sand, with some relatively small, localized areas of sand-shell and sand-gravel. On the slope, silty sand, silt, and clay predominate.

Some sand ridges (Map 14) are more modern in origin than the shelf’s glaciated morphology. Their formation is not well understood; however, they appear to develop from the sediments that erode from the shore face. They maintain their shape, so it is assumed that they are in equilibrium with modern current and storm regimes. They are usually grouped, with heights of about 10 m, lengths of 10 - 50 km and spacing of 2 km. Ridges are usually oriented at a slight angle towards shore, running in length from northeast to southwest. The seaward face usually has the steepest slope. Sand ridges are often covered with smaller similar forms such as sand waves, megaripples, and ripples. Swales occur between sand ridges. Since ridges are higher than the adjacent swales, they are exposed to more energy from water currents, and experience more sediment mobility than swales. Ridges tend to contain less fine sand, silt and clay while relatively sheltered swales contain more of the finer particles. Swales have greater benthic macrofaunal density, species richness and biomass, due in part to the increased abundance of detrital food and the physically less rigorous conditions.

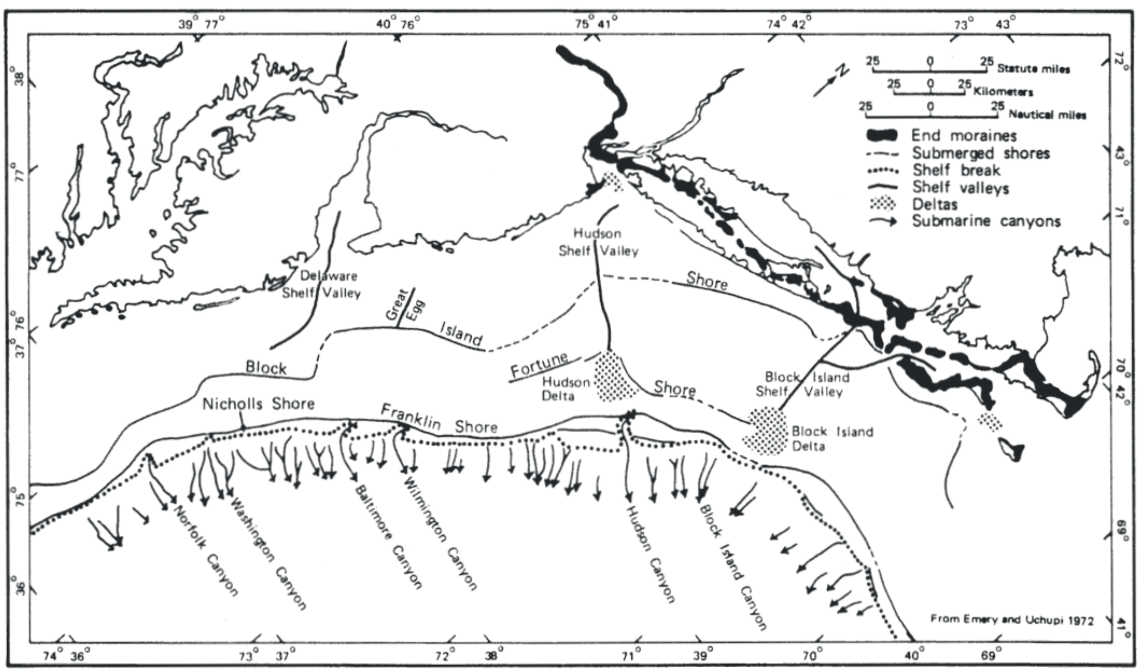
Sand waves are usually found in patches of 5 - 10 with heights of about 2 m, lengths of 50 - 100 m and 1 - 2 km between patches. Sand waves are primarily found on the inner shelf, and often observed on sides of sand ridges. They may remain intact over several seasons. Megaripples occur on sand waves or separately on the inner or central shelf. During the winter storm season, they may cover as much as 15% of the inner shelf. They tend to form in large patches and usually have lengths of 3 - 5 m with heights of 0.5 - 1 m. Megaripples tend to survive for less than a season. They can form during a storm and reshape the upper 50 - 100 cm of the sediments within a few hours. Ripples are also found everywhere on the shelf, and appear or disappear within hours or days, depending upon storms and currents. Ripples usually have lengths of about 1 - 150 cm and heights of a few centimeters.

Sediments are uniformly distributed over the shelf in this region (see Map 10). A sheet of sand and gravel varying in thickness from 0 - 10 m covers most of the shelf. The mean bottom flow from the constant southwesterly current is not fast enough to move sand, so sediment transport must be episodic. Net sediment movement is in the same southwesterly direction as the current. The sands are mostly medium to coarse grains, with finer sand in the Hudson Shelf Valley and on the outer shelf. Mud is rare over most of the shelf, but is common in the Hudson Shelf Valley. Occasionally relic estuarine mud deposits are re-exposed in the swales between sand ridges. Fine sediment content increases rapidly at the shelf break, which is sometimes called the “mud line,” and sediments are 70 - 100% fines on the slope.

The northern portion of the Mid-Atlantic Bight is sometimes referred to as southern New England. Most of this area was discussed under Georges Bank; however, one other formation of this region deserves note. The mud patch is located just southwest of Nantucket Shoals and southeast of Long Island and Rhode Island (Map 10). Tidal currents in this area slow significantly, which allows silts and clays to settle out. The mud is mixed with sand, and is occasionally re-suspended by large storms. This habitat is an anomaly of the outer continental shelf.



Map 14. Mid-Atlantic Bight submarine morphology.
Source: Stumpf and Biggs (1988).



Map 15. Major features of the mid-Atlantic and southern New England continental shelf.
Source: Stumpf and Biggs (1988).

Artificial reefs are another significant Mid-Atlantic habitat, formed much more recently on the geologic time scale than other regional habitat types. These localized areas of hard structure have been formed by shipwrecks, lost cargoes, disposed solid materials, shoreline jetties and groins, submerged pipelines, cables, and other materials (Steimle and Zetlin 2000). While some of materials have been deposited specifically for use as fish habitat, most have an alternative primary purpose; however, they have all become an integral part of the coastal and shelf ecosystem. It is expected that the increase in these materials has had an impact on living marine resources and fisheries, but these effects are not well known. In general, reefs are important for attachment sites, shelter, and food for many species, and fish predators such as tunas may be attracted by prey aggregations, or may be behaviorally attracted to the reef structure. The overview by Steimle and Zetlin (2000) used NOAA hydrographic surveys to plot rocks, wrecks, obstructions, and artificial reefs, which together were considered a fairly complete list of non-biogenic reef habitat in the Mid-Atlantic estuarine and coastal areas (Map 16).

Invertebrates

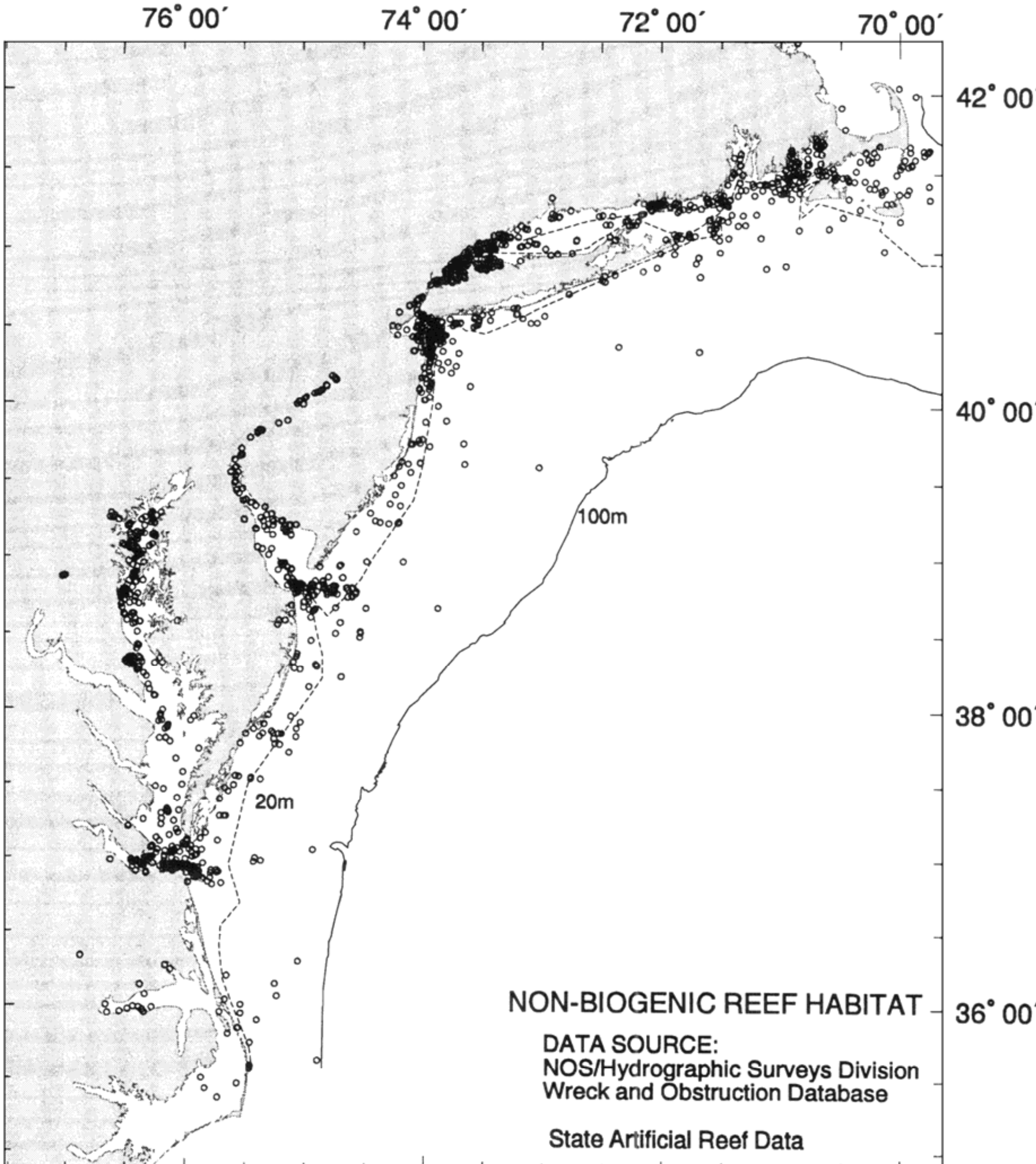
Wigley and Theroux (1981) reported on the faunal composition of 563 bottom grab samples collected in the Mid-Atlantic Bight during 1956-1965. Amphipod crustaceans and bivalve mollusks accounted for most of the individuals (41% and 22%, respectively), whereas mollusks dominated the biomass (70%). Three broad faunal zones related to water depth and sediment type were identified by Pratt (1973). The "sand fauna" zone was defined for sandy sediments (1% or less silt) that are at least occasionally disturbed by waves, from shore out to 50 m (Map 17). The "silty sand fauna" zone occurred immediately offshore from the sand fauna zone, in stable sands containing a small amount of silt and organic material. Silts and clays become predominant at the shelf break and line the Hudson Shelf Valley, and support the "silt-clay fauna."

Building on Pratt's work, the Mid-Atlantic shelf was further divided by Boesch (1979) into seven bathymetric/morphologic subdivisions based on faunal assemblages (Table 4). Sediments in the region studied (Hudson Shelf Valley south to Chesapeake Bay) were dominated by sand with little finer materials. Ridges and swales are important morphological features in this area. Sediments are coarser on the ridges, and the swales have greater benthic macrofaunal density, species richness, and biomass. Faunal species composition differed between these features, and Boesch (1979) incorporated this variation in his subdivisions. Much overlap of species distributions was found between depth zones, so the faunal assemblages represented more of a continuum than distinct zones.

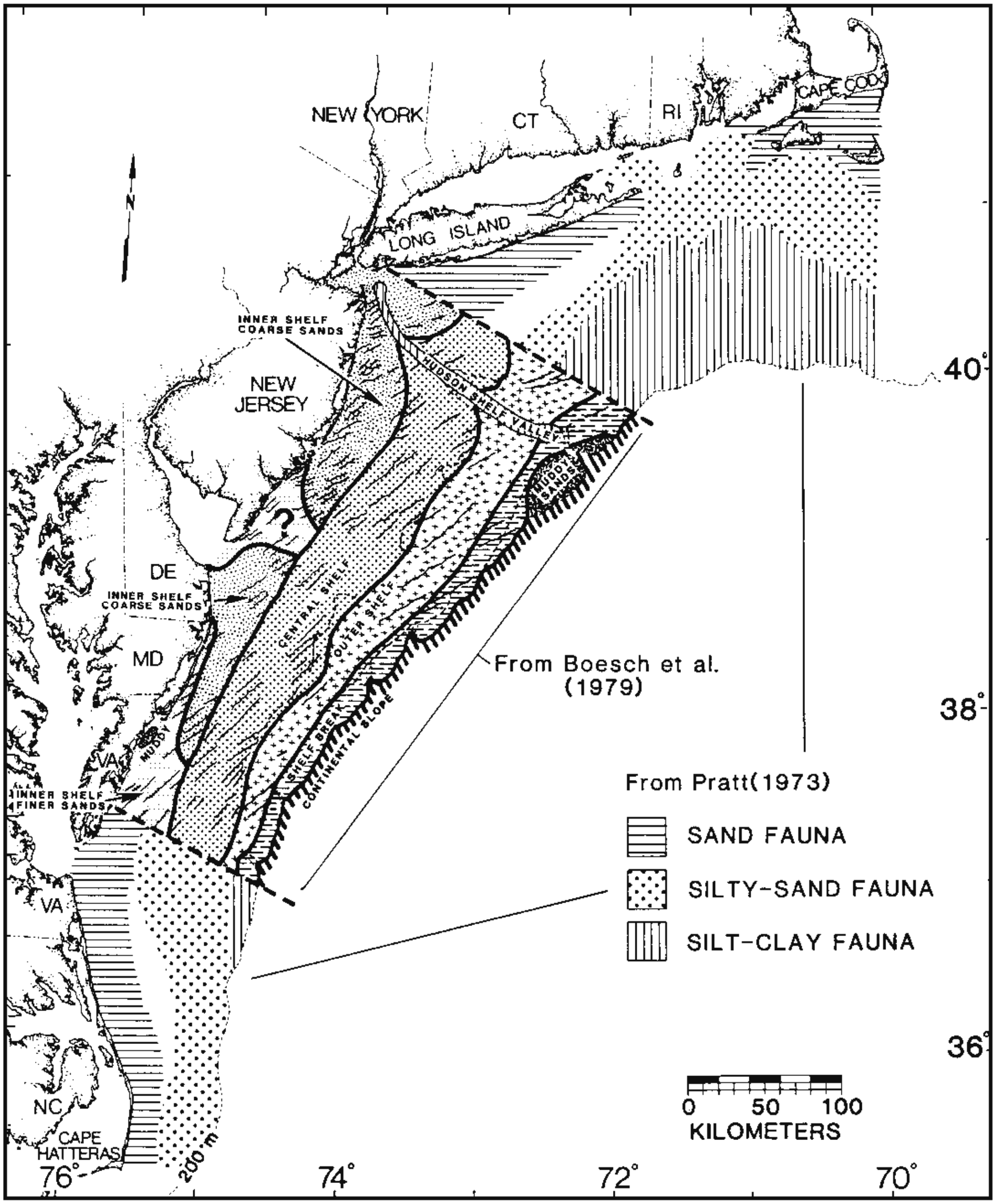
Demersal Fish

Demersal fish assemblages were described at a broad geographic scale for the continental shelf and slope from Cape Chidley, Labrador to Cape Hatteras, North Carolina (Mahon *et al.* 1998) and from Nova Scotia to Cape Hatteras (Gabriel 1992). Factors influencing species distribution included latitude and depth. Results of these studies were similar to an earlier study confined to the Mid-Atlantic Bight continental shelf (Colvocoresses and Musick 1984). In this study, there were clear variations in species abundances, yet they demonstrated consistent patterns of community composition and distribution among demersal fishes of the Mid-Atlantic shelf. This is especially true for five strongly recurring species associations that varied slightly by season (Table 4). The boundaries between fish assemblages generally followed isotherms and isobaths. The assemblages were largely similar between the spring and fall collections, with the most notable change being a northward and shoreward shift in the temperate group in the spring.

Steimle and Zetlin (2000) described representative epibenthic/epibiotic, motile epibenthic, and fish species associated with sparsely scattered reef habitats that consist mainly of manmade structures (Table 5)



Map 16. Summary of all reef habitats (except biogenic, such as mussel or oyster beds) in the Mid-Atlantic Bight.
Source: Steimle and Zetlin (2000).



Map 17. Schematic representation of major macrofaunal zones on the mid-Atlantic shelf. Approximate location of ridge fields indicated. Source: Reid and Steimle (1988).

Table 4. Mid-Atlantic habitat types.

Habitat Type [after Boesch (1979)]	**Description**		
	Depth (m)	**Characterization [Pratt (1973) faunal zone]**	**Characteristic Benthic Macrofauna**
Inner shelf	0 - 30	characterized by coarse sands with finer sands off MD and VA (sand zone)	Polychaetes: *Polygordius, Goniadella, Spiophanes*
Central shelf	30 - 50	(sand zone)	Polychaetes: *Spiophanes, Goniadella* Amphipod: *Pseudunciola*
Central and inner shelf swales	0 - 50	occurs in swales between sand ridges (sand zone)	*Polychaetes: Spiophanes, Lumbrineris, Polygordius*
Outer shelf	50 - 100	(silty sand zone)	Amphipods: *Ampelisca vadorum, Erichthonius* Polychaetes: *Spiophanes*
Outer shelf swales	50 - 100	occurs in swales between sand ridges (silty sand zone)	Amphipods: *Ampelisca agassizi, Unciola, Erichthonius*
Shelf break	100 - 200	(silt-clay zone)	not given
Continental slope	> 200	(none)	not given

As described by Pratt (1973) and Boesch (1979) with characteristic macrofauna as identified in Boesch (1979).

Table 5. Major recurrent demersal finfish assemblages of the Mid-Atlantic Bight during spring and fall.

Season	Species Assemblage				
	Boreal	**Warm temperate**	**Inner shelf**	**Outer shelf**	Slope
Spring	Atlantic cod little skate sea raven goosefish winter flounder longhorn sculpin ocean pout silver hake red hake white hake spiny dogfish	black sea bass summer flounder butterfish scup spotted hake northern searobin	windowpane	fourspot flounder	shortnose greeneye offshore hake blackbelly rosefish white hake
Fall	white hake silver hake red hake goosefish longhorn sculpin winter flounder yellowtail flounder witch flounder little skate spiny dogfish	black sea bass summer flounder butterfish scup spotted hake northern searobin smooth dogfish	windowpane	fourspot flounder fawn cusk eel gulf stream flounder	shortnose greeneye offshore hake blackbelly rosefish white hake witch flounder

As determined by Colvocoresses and Musick (1984).

Table 5. Mid-Atlantic reef types, location, and representative flora and fauna.

Location (Type)	Representative Flora and Fauna		
	Epibenthic/Epibiotic	**Motile Epibenthic Invertebrates**	**Fish**
Estuarine (oyster reefs, blue mussel beds, other hard surfaces, semi-hard clay and *Spartina* peat reefs)	Oyster, barnacles, ribbed mussel, blue mussel, algae, sponges, tube worms, anemones, hydroids, bryozoans, slipper shell, jingle shell, northern stone coral, sea whips, tunicates, caprellid amphipods, wood borers	Xanthid crabs, blue crab, rock crabs, spider crab, juvenile American lobsters, sea stars	Gobies, spot, striped bass, black sea bass, white perch, toadfish, scup, drum, croaker, spot, sheepshead porgy, pinfish, juvenile and adult tautog, pinfish, northern puffer, cunner, sculpins, juvenile and adult Atlantic cod, rock gunnel, conger eel, American eel, red hake, ocean pout, white hake, juvenile pollock
Coastal (exposed rock/soft marl, harder rock, wrecks and artificial reefs, kelp, other materials)	Boring mollusks (piddocks), red algae, sponges, anemones, hydroids, northern stone coral, soft coral, sea whips, barnacles, blue mussel, horse mussel, bryozoans, skeleton and tubiculous amphipods, polychaetes, jingle shell, sea stars	American lobster, Jonah crab, rock crabs, spider crab, sea stars, urchins, squid egg clusters	Black sea bass, pinfish, scup, cunner, red hake, gray triggerfish, black grouper, smooth dogfish, summer flounder, scad, bluefish, amberjack, Atlantic cod, tautog, ocean pout, conger eel, sea raven, rock gunnel, radiated shanny
Shelf (rocks and boulders, wrecks and artificial reefs, other solid substrates)	Boring mollusks (piddocks) red algae, sponges, anemones, hydroids, stone coral, soft coral, sea whips, barnacles, blue mussels, horse mussels, bryozoans, amphipods, polychaetes	American lobster, Jonah crabs, rock crabs, spider crabs, sea stars, urchins, squid egg clusters (with addition of some deepwater taxa at shelf edge)	Black sea bass, scup, tautog, cunner, gag, sheepshead, porgy, round herring, sardines, amberjack, spadefish, gray triggerfish, mackerels, small tunas, spottail pinfish, tautog, Atlantic cod, ocean pout, red hake, conger eel, cunner, sea raven, rock gunnel, pollock, white hake
Outer shelf (reefs and clay burrows including “pueblo village community”)			Tilefish, white hake, conger eel

As described in Steimle and Zetlin (2000).

Continental Slope

Physical Environment

The continental slope extends from the continental shelf break, at depths between 60 - 200 m, eastward to a depth of 2000 m. The width of the slope varies from 10 - 50 km, with an average gradient of 3 - 6°; however, local gradients can be nearly vertical. The base of the slope is defined by a marked decrease in seafloor gradient where the continental rise begins.

The morphology of the present continental slope appears largely to be a result of sedimentary processes that occurred during the Pleistocene, including, 1) slope upbuilding and progradation by deltaic sedimentation principally during sea-level low stands; 2) canyon cutting by sediment mass movements during and following sea-level low stands; and 3) sediment slumping.

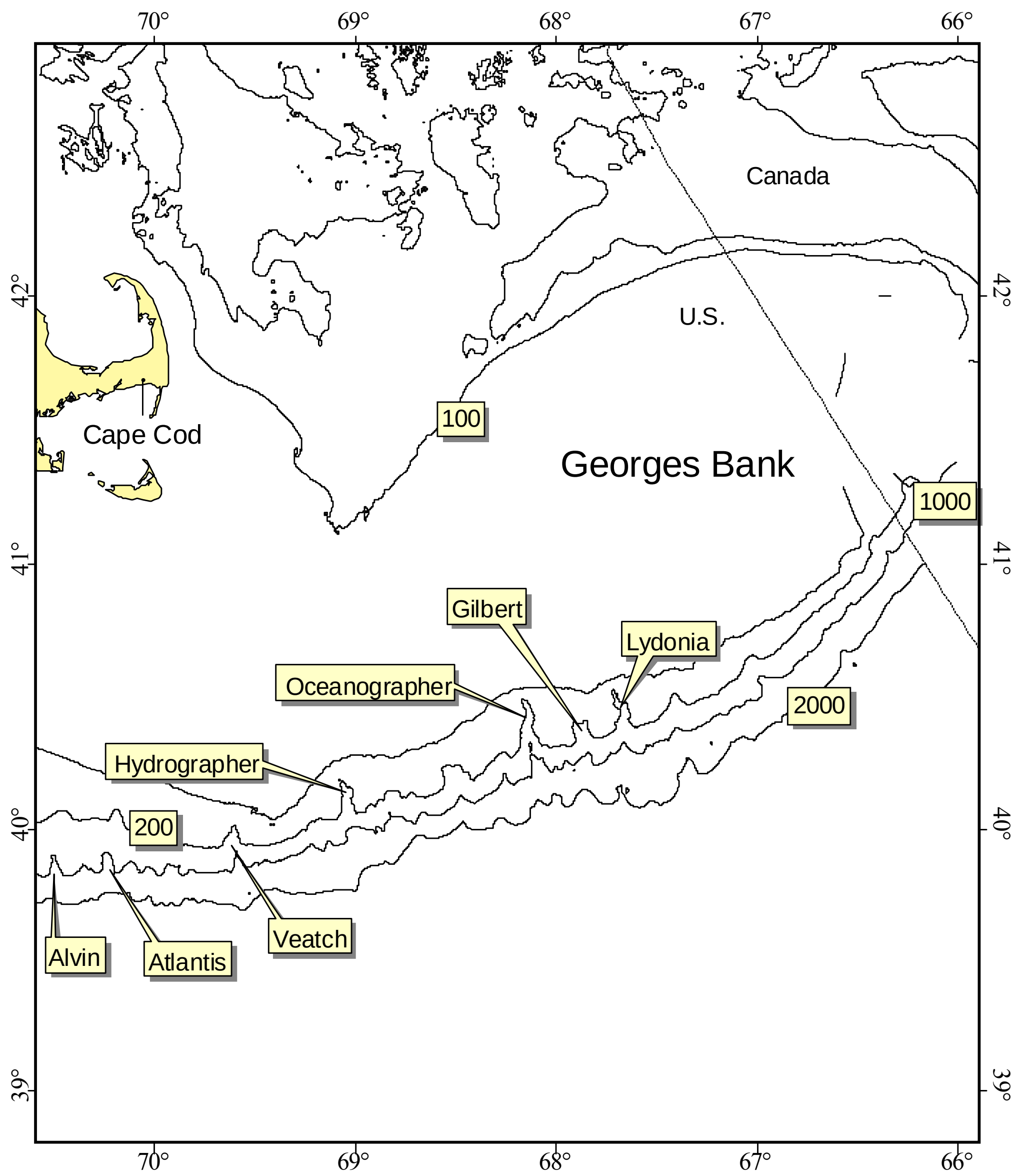
The slope is cut by at least 70 large canyons between Georges Bank and Cape Hatteras (Map 18 and Map 19) and numerous smaller canyons and gullies, many of which may feed into the larger canyon systems. The New England Seamount Chain including Bear, Mytilus, and Balanus Seamounts occurs on the slope southwest of Georges Bank. A smaller chain (Caryn, Knauss, etc.) occurs in the vicinity in deeper water.

A "mud line" occurs on the slope at a depth of 250 - 300 m, below which fine silt and clay-size particles predominate (Map 10). Localized coarse sediments and rock outcrops are found in and near canyon walls, and occasional boulders occur on the slope because of glacial rafting. Sand pockets may also be formed because of downslope movements.

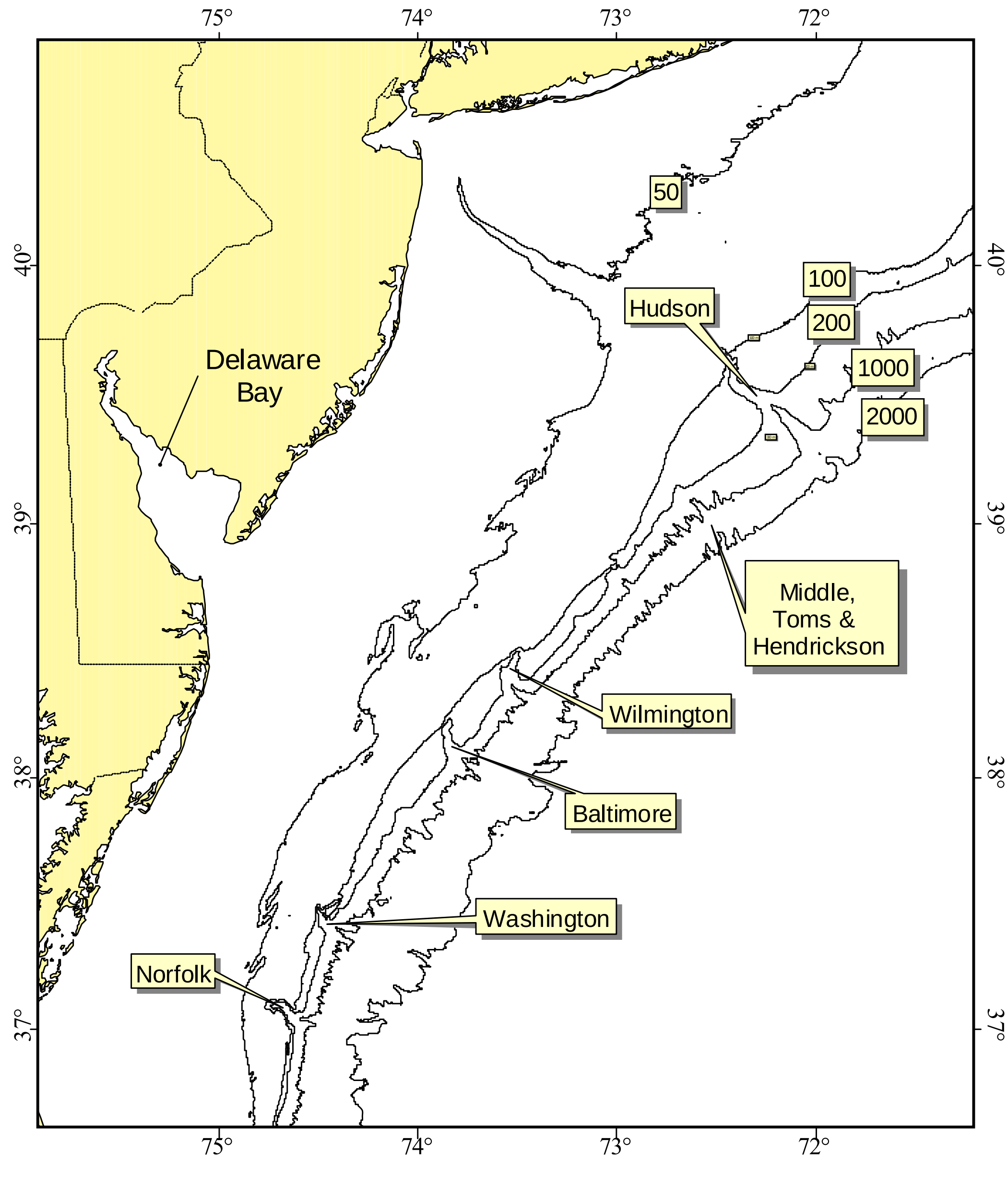
Gravity induced downslope movement is the dominant sedimentary process on the slope, and includes slumps, slides, debris flows, and turbidity currents, in order from thick cohesive movement to relatively nonviscous flow. Slumps may involve localized, short, down-slope movements by blocks of sediment. However, turbidity currents can transport sediments thousands of kilometers.

Submarine canyons are not spaced evenly along the slope, but tend to decrease in areas of increasing slope gradient. Canyons are typically "v" shaped in cross section and often have steep walls and outcroppings of bedrock and clay. The canyons are continuous from the canyon heads to the base of the continental slope. Some canyons end at the base of the slope, but others continue as channels onto the continental rise. Larger and more deeply incised canyons are generally significantly older than smaller ones, and there is evidence that some older canyons have experienced several episodes of filling and re-excavation. Many, if not all, submarine canyons may first form by mass-wasting processes on the continental slope, although there is evidence that some canyons were formed because of fluvial drainage (*e.g.*, Hudson Canyon).

Canyons can alter the physical processes in the surrounding slope waters. Fluctuations in the velocities of the surface and internal tides can be large near the heads of the canyons, leading to enhanced mixing and sediment transport in the area. Shepard *et al.* (1979) concluded that the strong turbidity currents initiated in study canyons were responsible for enough sediment erosion



Map 18. Principal submarine canyons on southern flank of Georges Bank. Depths in meters.



Map 19. Principal submarine canyons in Mid-Atlantic Bight. Depths in meters.

and transport to maintain and modify those canyons. Since surface and internal tides are ubiquitous over the continental shelf and slope, it can be anticipated that these fluctuations are important for sedimentation processes in other canyons as well. In Lydonia Canyon, Butman *et al.* (1982) found that the dominant source of low frequency current variability was related to passage of warm core Gulf Stream rings rather than the atmospheric events that predominate on the shelf.

The water masses of the Atlantic continental slope and rise are essentially the same as those of the North American Basin [defined in Wright and Worthington (1970)]. Worthington (1976) divided the water column of the slope into three vertical layers: deepwater (colder than 4°C), the thermocline (4 - 17°C), and surface water (warmer than 17°C). In the North American Basin, deepwater accounts for two-thirds of all the water, the thermocline for about one-quarter, and surface water the remainder. In the slope water north of Cape Hatteras, the only warm water occurs in the Gulf Stream and in seasonally influenced summer waters.

The principal cold water mass in the region is the North Atlantic Deep Water. North Atlantic Deep Water is comprised of a mixture of five sources: Antarctic Bottom Water, Labrador Sea Water, Mediterranean Water, Denmark Strait Overflow Water, and Iceland-Scotland Overflow Water. The thermocline represents a straightforward water mass compared with either the deepwater or the surface water. Nearly 90% of all thermocline water comes from the water mass called the Western North Atlantic Water. This water mass is slightly less saline northeast of Cape Hatteras due to the influx of southward flowing Labrador Coastal Water. Seasonal variability in slope waters penetrates only the upper 200 m of the water column.

In the winter months, cold temperatures and storm activity create a well mixed layer down to about 100 - 150 m, but summer warming creates a seasonal thermocline overlain by a surface layer of low density water. The seasonal thermocline, in combination with reduced storm activity in the summer, inhibits vertical mixing and reduces the upward transfer of nutrients into the photic zone.

Two currents found on the slope, the Gulf Stream and Western Boundary Undercurrent, together represent one of the strongest low frequency horizontal flow systems in the world. Both currents have an important influence on slope waters. Warm and cold core rings that spin off the Gulf Stream are a persistent and ubiquitous feature of the northwest Atlantic Ocean (see the "Gulf Stream" section). The Western Boundary Undercurrent flows to the southwest along the lower slope and continental rise in a stream about 50 km wide. The boundary current is associated with the spread of North Atlantic Deep Water, and it forms part of the generally westward flow found in slope water. North of Cape Hatteras it crosses under the Gulf Stream in a manner not yet completely understood.

Shelf and slope waters of the northeast region are intermittently affected by the Gulf Stream. The Gulf Stream begins in the Gulf of Mexico and flows northeastward at an approximate rate of 1 m/s (2 knots), transporting warm waters north along the eastern coast of the United States, and then east towards the British Isles. Conditions and flow of the Gulf Stream are highly variable on time scales ranging from days to seasons. Intrusions from the Gulf Stream constitute the principal source of variability in slope waters off the northeastern shelf.

The location of the Gulf Stream's shoreward, western boundary is variable because of meanders and eddies. Gulf Stream eddies are formed when extended meanders enclose a parcel of seawater and pinch off. These eddies can be cyclonic, meaning they rotate counterclockwise and have a cold core formed by enclosed slope water (cold core ring), or anticyclonic, meaning they rotate clockwise and have a warm core of Sargasso Sea water (warm core ring). The rings are shaped like a funnel, wider at the top and narrower at the bottom, and can have depths of over 2000 m. They range in size from approximately 150 - 230 km in diameter. There are 35% more rings and meanders near Georges Bank than in the Mid-

Atlantic region. A net transfer of water on and off the shelf may result from the interaction of rings and shelf waters. These warm or cold core rings maintain their identity for several months until they are reabsorbed by the Gulf Stream. The rings and the Gulf Stream itself have a great influence over oceanographic conditions all along the continental shelf.

Invertebrates

Polychaete annelids represent the most important slope faunal group in terms of numbers of individuals and species (Wiebe *et al.* 1987). Ophiuroids (brittle stars) are considered to be among the most abundant slope organisms, but this group is comprised of relatively few species. The taxonomic group with the highest species diversity is the peracarid crustaceans (which includes amphipods, cumaceans, and isopods). Some species of the slope are widely distributed, while others appear to be restricted to particular ocean basins. The ophiuroids and bivalves appear to have the broadest distributions, while the peracarid crustaceans appear to be highly restricted because they brood their young, and lack a planktonic stage of development. In general, gastropods do not appear to be very abundant; however, past studies are inconclusive since they have not collected enough individuals for large-scale community and population studies.

In general, slope inhabiting benthic organisms are strongly zoned by depth and/or water temperature, although these patterns are modified by the presence of topography, including canyons, channels, and current zonations (Hecker 1990). Moreover, at depths of less than 800 m, the fauna is extremely variable and the relationships between faunal distribution and substrate, depth, and geography are less obvious (Wiebe *et al.* 1987). Fauna occupying hard surface sediments are not as dense as in comparable shallow water habitats (Wiebe *et al.* 1987), but there is an increase in species diversity from the shelf to the intermediate depths of the slope. Diversity then declines again in the deeper waters of the continental rise and plain. Hecker (1990) identified four megafaunal zones on the slope of Georges Bank and southern New England (Table 6.).

One group of organisms of interest because of the additional structure they can provide for habitat and their potential long life span are the Alcyonarian soft corals. Soft corals can be bush or treelike in shape; species found in this form attach to hard substrates such as rock outcrops or gravel. These species can range in size from a few millimeters to several meters, and the trunk diameter of large specimens can exceed 10 cm. Other Alcyonarians found in this region include sea pens and sea pansies (Order Pennatulacea), which are found in a wider range of substrate types.

As opposed to most slope environments, canyons may develop a lush epifauna. Hecker *et al.* (1983) found faunal differences between the canyons and slope environments. Hecker and Blechschmidt (1979) suggested that faunal differences were due at least in part to increased environmental heterogeneity in the canyons, including greater substrate variability and nutrient enrichment. Hecker *et al.* (1983) found highly patchy faunal assemblages in the canyons, and also found additional faunal groups located in the canyons, particularly on hard substrates, that do not appear to occur in other slope environments. Canyons are also thought to serve as nursery areas for a number of species (Cooper *et al.* 1987; Hecker 2001). The canyon habitats in Table 7. were classified by Cooper *et al.* (1987).

Demersal Fish

Most finfish identified as slope inhabitants on a broad spatial scale (Colvocoresses and Musick 1984; Overholtz and Tyler 1985; Gabriel 1992) (Tables 2) are associated with canyon features as well (Cooper *et al.* 1987) (Table 7). Finfish identified by broad studies that were not included in Cooper *et al.* (1987)

include offshore hake, fawn cusk-eel, longfin hake, witch flounder, and armored searobin. Canyon species (Cooper *et al.* 1987) that were not discussed in the broad scale studies include squirrel hake, conger eel, and tilefish. Cusk and ocean pout were identified by Cooper *et al.* (1987) as canyon species, but classified in other habitats by the broad scale studies.

Table 6. Faunal zones of the continental slope of Georges Bank and Southern New England.

Zone	**Approximate Depth (m)**	**Gradient**	**Current**	**Fauna**
Upper Slope	300 - 700	Low	Strong	Dense filter feeders; Scleratinians (*Dasmosmilia lymani, Flabellum alabastrum*), quill worm (*Hyalinoecia*)
Upper Middle Slope	500 - 1300	High	Moderate	Sparse scavengers; red crab (*Geryon quinqueidens*), long-nosed eel (*Synaphobranchus*), common grenadier (*Nezumia*). Alcyonarians (*Acanella arbuscula*, *Eunephthya florida*) in areas of hard substrate
Lower Middle Slope/Transition	1200 - 1700	High	Moderate	Sparse suspension feeders; cerianthids, sea pens (*Distichoptilum gracile*)
Lower Slope	> 1600	Low	Strong	Dense suspension and deposit feeders; ophiurid (*Ophiomusium lymani*), cerianthids, sea pens

From Hecker (1990)

Table 7. Habitat types for the canyons of Georges Bank, including characteristic fauna.

Habitat Type	**Geologic Description**	**Canyon Locations**	**Most Commonly Observed Fauna**
I	Sand or semiconsolidated silt substrate (claylike consistency) with less than 5% overlay of gravel. Relatively featureless except for conical sediment mounds.	Walls and axis	Cerianthid, pandalid shrimp, white colonial anemone, Jonah crab, starfishes, portunid crab, greeneye, brittle stars, mosaic worm, red hake, fourspot flounder, shellless hermit crab, silver hake, gulf stream flounder
II	Sand or semiconsolidated silt substrate (claylike consistency) with more than 5% overlay of gravel. Relatively featureless.	Walls	Cerianthids, galatheid crab, squirrel hake, white colonial anemone, Jonah crab, silver hake, sea stars, ocean pout, brittle stars, shellless hermit crab, greeneye
III	Sand or semiconsolidated silt (claylike consistency) overlain by siltstone outcrops and talus up to boulder size. Featured bottom with erosion by animals and scouring.	Walls	White colonial anemone, pandalid shrimp, cleaner shrimp, rock anemone, white hake, sea stars, ocean pout, conger eel, brittle stars, Jonah crab, lobster, blackbelly rosefish, galatheid crab, mosaic worm, tilefish
IV	Consolidated silt substrate, heavily burrowed/excavated. Slope generally more than 5º and less than 50º. Termed "pueblo village" habitat.	Walls	Sea stars, blackbelly rosefish, Jonah crab, lobster, white hake, cusk, ocean pout, cleaner shrimp, conger eel, tilefish, galatheid crab, shellless hermit crab
V	Sand dune substrate.	Axis	Sea stars, white hake, Jonah crab, goosefish

From Cooper *et al.* (1987).

Faunal characterization is for depths < 230 m only.

ESSENTIAL FISH HABITAT

The environment that could potentially be affected by the proposed action has been identified as EFH for benthic life stages of species that are managed under the NE Multispecies; Atlantic Sea Scallop; Monkfish; Deep-Sea Red Crab; Northeast Skate Complex; Atlantic Herring; Summer Flounder, Scup, and Black Sea Bass; Tilefish; Squid, Atlantic Mackerel, and Butterfish; Atlantic Surfclam and Ocean Quahog Fishery Management Plans. EFH for the species managed under these FMPs includes a wide variety of benthic habitats in state and federal waters throughout the Northeast U.S. Shelf Ecosystem. EFH descriptions of the geographic range, depth, and bottom types for all the benthic life stages of the species managed under these FMPs are summarized in the following table.

Species	Life Stage	Geographic Area of EFH	Depth (meters)	EFH Description
American plaice	juvenile	GOME and estuaries from Passamaquoddy Bay to Saco Bay, ME and from Mass. Bay to Cape Cod Bay, MA	45 - 150	Bottom habitats with fine grained sediments or a substrate of sand or gravel
American plaice	adult	GOME and estuaries from Passamaquoddy Bay to Saco Bay, ME and from Mass. Bay to Cape Cod Bay, MA	45 - 175	Bottom habitats with fine grained sediments or a substrate of sand or gravel
Atlantic cod	juvenile	GOME, GB, eastern portion of continental shelf off southern NE and following estuaries: Passamaquoddy Bay to Saco Bay; Mass. Bay, Boston Harbor, Cape Cod Bay, Buzzards Bay	25 - 75	Bottom habitats with a substrate of cobble or gravel
Atlantic cod	adult	GOME, GB, eastern portion of continental shelf off southern NE and following estuaries: Passamaquoddy Bay to Saco Bay; Mass. Bay, Boston Harbor, Cape Cod Bay, Buzzards Bay	10 - 150	Bottom habitats with a substrate of rocks, pebbles, or gravel
Atlantic halibut	juvenile	GOME, GB	20 - 60	Bottom habitats with a substrate of sand, gravel, or clay
Atlantic halibut	adult	GOME, GB	100 - 700	Bottom habitats with a substrate of sand, gravel, or clay
Atlantic herring	eggs	GOME, GB and following estuaries: Englishman/Machias Bay, Casco Bay, and Cape Cod Bay	20 – 80	Bottom habitats attached to gravel, sand, cobble or shell fragments, also on macrophytes
Atlantic sea scallop	juvenile	GOME, GB, southern NE and middle Atlantic south to Virginia-North Carolina border and following estuaries: Passamaquoddy Bay to Sheepscot R.; Casco Bay, Great Bay, Mass Bay, and Cape Cod Bay	18 - 110	Bottom habitats with a substrate of cobble, shells, and silt

Species	Life Stage	Geographic Area of EFH	Depth (meters)	EFH Description
Atlantic sea scallop	adult	GOME, GB, southern NE and middle Atlantic south to Virginia-North Carolina border and following estuaries: Passamaquoddy Bay to Sheepscot R.; Casco Bay, Great Bay, Mass Bay, and Cape Cod Bay	18 - 110	Bottom habitats with a substrate of cobble, shells, coarse/gravelly sand, and sand
Haddock	juvenile	GB, GOME, middle Atlantic south to Delaware Bay	35 - 100	Bottom habitats with a substrate of pebble and gravel
Haddock	adult	GB and eastern side of Nantucket Shoals, throughout GOME, *additional area of Nantucket Shoals, and Great South Channel	40 - 150	Bottom habitats with a substrate of broken ground, pebbles, smooth hard sand, and smooth areas between rocky patches
Monkfish	juvenile	Outer continental shelf in the middle Atlantic, mid-shelf off southern NE, all areas of GOME	25 - 200	Bottom habitats with substrates of a sandshell mix, algae covered rocks, hard sand, pebbly gravel, or mud
Monkfish	adult	Outer continental shelf in the middle Atlantic, mid-shelf off southern NE, outer perimeter of GB, all areas of GOME	25 - 200	Bottom habitats with substrates of a sandshell mix, algae covered rocks, hard sand, pebbly gravel, or mud
Ocean pout	eggs	GOME, GB, southern NE, and middle Atlantic south to Delaware Bay, and the following estuaries: Passamaquoddy Bay to Saco Bay, Massachusetts and Cape Cod Bay	<50	Bottom habitats, generally in hard bottom sheltered nests, holes, or crevices
Ocean pout	juvenile	GOME, GB, southern NE, middle Atlantic south to Delaware Bay and the following estuaries: Passamaquoddy Bay to Saco Bay; Mass. Bay, and Cape Cod Bay	< 50	Bottom habitats in close proximity to hard bottom nesting areas
Ocean pout	adult	GOME, GB, southern NE, middle Atlantic south to Delaware Bay and the following estuaries: Passamaquoddy Bay to Saco Bay; Mass. Bay, Boston Harbor, and Cape Cod Bay	< 80	Bottom habitats, often smooth bottom near rocks or algae
Offshore hake	juvenile	Outer continental shelf of GB and southern NE south to Cape Hatteras, NC	170 - 350	Bottom habitats
Offshore hake	adult	Outer continental shelf of GB and southern NE south to Cape Hatteras, NC	150 - 380	Bottom habitats
Pollock	juvenile	GOME, GB, and the following estuaries: Passamaquoddy Bay to Saco Bay; Great Bay to Waquoit Bay; Long Island Sound, Great South Bay	0 – 250	Bottom habitats with aquatic vegetation or a substrate of sand, mud, or rocks

Species	Life Stage	Geographic Area of EFH	Depth (meters)	EFH Description
Pollock	adult	GOME, GB, southern NE, and middle Atlantic south to New Jersey and the following estuaries: Passamaquoddy Bay, Damariscotta R., Mass Bay, Cape Cod Bay, Long Island Sound	15 – 365	Hard bottom habitats including artificial reefs
Red hake	juvenile	GOME, GB, continental shelf off southern NE, and middle Atlantic south to Cape Hatteras and the following estuaries: Passamaquoddy Bay to Saco Bay; Great Bay, Mass. Bay to Cape Cod Bay; Buzzards Bay to Conn. R.; Hudson R./ Raritan Bay, and Chesapeake Bay	< 100	Bottom habitats with substrate of shell fragments, including areas with an abundance of live scallops
Red hake	adult	GOME, GB, continental shelf off southern NE, and middle Atlantic south to Cape Hatteras and the following estuaries: Passamaquoddy Bay to Saco Bay; Great Bay, Mass. Bay to Cape Cod Bay; Buzzards Bay to Conn. R.; Hudson R./ Raritan Bay, Delaware Bay, and Chesapeake Bay	10 - 130	Bottom habitats in depressions with a substrate of sand and mud
Redfish	juvenile	GOME, southern edge of GB	25 - 400	Bottom habitats with a substrate of silt, mud, or hard bottom
Redfish	adult	GOME, southern edge of GB	50 - 350	Bottom habitats with a substrate of silt, mud, or hard bottom
White hake	adult	GOME, southern edge of GB, southern NE to middle Atlantic and the following estuaries: Passamaquoddy Bay to Great Bay; Mass. Bay to Cape Cod Bay	5 - 325	Bottom habitats with substrate of mud or fine grained sand
Silver hake	juvenile	GOME, GB, continental shelf off southern NE, middle Atlantic south to Cape Hatteras and the following estuaries: Passamaquoddy Bay to Casco Bay, Mass. Bay to Cape Cod Bay	20 – 270	Bottom habitats of all substrate types
Silver hake	adult	GOME, GB, continental shelf off southern NE, middle Atlantic south to Cape Hatteras and the following estuaries: Passamaquoddy Bay to Casco Bay, Mass. Bay to Cape Cod Bay	30 – 325	Bottom habitats of all substrate types
Windowpane flounder	juvenile	GOME, GB, southern NE, middle Atlantic south to Cape Hatteras and the following estuaries: Passamaquoddy Bay to Great Bay; Mass. Bay to Chesapeake Bay	1 - 100	Bottom habitats with substrate of mud or fine grained sand

Species	Life Stage	Geographic Area of EFH	Depth (meters)	EFH Description
Windowpane flounder	adult	GOME, GB, southern NE, middle Atlantic south to Virginia - NC border and the following estuaries: Passamaquoddy Bay to Great Bay; Mass. Bay to Chesapeake Bay	1 - 75	Bottom habitats with substrate of mud or fine grained sand
Winter flounder	eggs	GB, inshore areas of GOME, southern NE, and middle Atlantic south to Delaware Bay	<5	Bottom habitats with a substrate of sand, muddy sand, mud, and gravel
Winter flounder	juvenile	GB, inshore areas of GOME, southern NE, middle Atlantic south to Delaware Bay and the following estuaries: Passamaquoddy Bay to Chincoteague Bay	0.1 – 10 (1 - 50, age 1+)	Bottom habitats with a substrate of mud or fine grained sand
Winter flounder	adult	GB, inshore areas of GOME, southern NE, middle Atlantic south to Delaware Bay and the following estuaries: Passamaquoddy Bay to Chincoteague Bay	1 - 100	Bottom habitats including estuaries with substrates of mud, sand, grave
Witch flounder	juvenile	GOME, outer continental shelf from GB south to Cape Hatteras	50 - 450 to 1500	Bottom habitats with fine grained substrate
Witch flounder	adult	GOME, outer continental shelf from GB south to Chesapeake Bay	25 - 300	Bottom habitats with fine grained substrate
Yellowtail flounder	juvenile	GB, GOME, southern NE continental shelf south to Delaware Bay and the following estuaries: Sheepscot R., Casco Bay, Mass. Bay to Cape Cod Bay	20 - 50	Bottom habitats with substrate of sand or sand and mud
Yellowtail flounder	adult	GB, GOME, southern NE continental shelf south to Delaware Bay and the following estuaries: Sheepscot R., Casco Bay, Mass. Bay to Cape Cod Bay	20 - 50	Bottom habitats with substrate of sand or sand and mud
Red crab	juvenile	Southern flank of GB and south the Cape Hatteras, NC	700 - 1800	Bottom habitats of continental slope with a substrate of silts, clays, and all silt-clay-sand composites
Red crab	adult	Southern flank of GB and south the Cape Hatteras, NC	200 - 1300	Bottom habitats of continental slope with a substrate of silts, clays, and all silt-clay-sand composites
Black sea bass	juvenile	Demersal waters over continental shelf from GOME to Cape Hatteras, NC, also includes estuaries from Buzzards Bay to Long Island Sound; Gardiners Bay, Barnegat Bay to Chesapeake Bay; Tangier/ Pocomoke Sound, and James River	1 - 38	Rough bottom, shellfish and eelgrass beds, manmade structures in sandy-shelly areas, offshore clam beds, and shell patches may be used during wintering

Species	Life Stage	Geographic Area of EFH	Depth (meters)	EFH Description
Black sea bass	adult	Demersal waters over continental shelf from GOME to Cape Hatteras, NC, also includes estuaries: Buzzards Bay, Narragansett Bay, Gardiners Bay, Great South Bay, Barnegat Bay to Chesapeake Bay; Tangier/ Pocomoke Sound, and James River	20 - 50	Structured habitats (natural and manmade), sand and shell substrates preferred
Ocean quahog	juvenile	Eastern edge of GB and GOME throughout the Atlantic EEZ	8 - 245	Throughout substrate to a depth of 3 ft within federal waters, occurs progressively further offshore between Cape Cod and Cape Hatteras
Ocean quahog	adult	Eastern edge of GB and GOME throughout the Atlantic EEZ	8 - 245	Throughout substrate to a depth of 3 ft within federal waters, occurs progressively further offshore between Cape Cod and Cape Hatteras
Atlantic surfclam	juvenile	Eastern edge of GB and the GOME throughout Atlantic EEZ	0 - 60, low density beyond 38	Throughout substrate to a depth of 3 ft within federal waters, burrow in medium to coarse sand and gravel substrates, also found in silty to fine sand, but not in mud
Atlantic surfclam	adult	Eastern edge of GB and the GOME throughout Atlantic EEZ	0 - 60, low density beyond 38	Throughout substrate to a depth of 3 ft within federal waters
Scup	juvenile	Continental shelf from GOME to Cape Hatteras, NC includes the following estuaries: Mass. Bay, Cape Cod Bay to Long Island Sound; Gardiners Bay to Delaware Inland Bays; and Chesapeake Bay	(0 - 38)	Demersal waters north of Cape Hatteras and inshore on various sands, mud, mussel, and eelgrass bed type substrates
Scup	adult	Continental shelf from GOME to Cape Hatteras, NC includes the following estuaries: Cape Cod Bay to Long Island Sound; Gardiners Bay to Hudson R./ Raritan Bay; Delaware Bay and Inland Bays; and Chesapeake Bay	(2 -185)	Demersal waters north of Cape Hatteras and inshore estuaries (various substrate types)
Summer flounder	juvenile	Over continental shelf from GOME to Cape Hatteras, NC; south of Cape Hatteras to Florida; also includes estuaries from Waquoit Bay to James R.; Albemarle Sound to Indian R.	0.5 – 5 in estuary	Demersal waters, on muddy substrate but prefer mostly sand; found in the lower estuaries in flats, channels, salt marsh creeks, and eelgrass beds

Species	Life Stage	Geographic Area of EFH	Depth (meters)	EFH Description
Summer flounder	adult	Over continental shelf from GOME to Cape Hatteras, NC; south of Cape Hatteras to Florida; also includes estuaries from Buzzards Bay, Narragansett Bay, Conn. R. to James R.; Albemarle Sound to Broad R.; St. Johns R., and Indian R.	0 - 25	Demersal waters and estuaries
Tilefish	juvenile	US/Canadian boundary to VA/NC boundary (shelf break, submarine canyon walls, and flanks: GB to Cape Hatteras)	76 - 365	Rough bottom, small burrows, and sheltered areas; substrate rocky, stiff clay, human debris
Tilefish	adult	US/Canadian boundary to VA/NC boundary (shelf break, submarine canyon walls, and flanks: GB to Cape Hatteras)	76 - 365	Rough bottom, small burrows, and sheltered areas; substrate rocky, stiff clay, human debris
Longfin squid	eggs	GB, southern NE and middle Atlantic to mouth of Chesapeake Bay	<50	Egg masses attached to rocks, boulders and vegetation on sand or mud bottom
Golden crab	juvenile	Chesapeake Bay to the south through the Florida Straight (and into the Gulf of Mexico)	290 - 570	Continental slope in flat areas of foraminifera ooze, on distinct mounds of dead coral, ripple habitat, dunes, black pebble habitat, low outcrop, and soft bioturbated habitat
Golden crab	adult	Chesapeake Bay to the south through the Florida Straight (and into the Gulf of Mexico)	290 - 570	Continental slope in flat areas of foraminifera ooze, on distinct mounds of dead coral, ripple habitat, dunes, black pebble habitat, low outcrop, and soft bioturbated habitat
Barndoor skate	juvenile	Eastern GOME, GB, Southern NE, Mid-Atlantic Bight to Hudson Canyon	l0 - 750, mostly < 150	Bottom habitats with mud, gravel, and sand substrates
Barndoor skate	adult	Eastern GOME, GB, Southern NE, Mid-Atlantic Bight to Hudson Canyon	l0 - 750, mostly < 150	Bottom habitats with mud, gravel, and sand substrates
Clearnose skate	juvenile	GOME, along shelf to Cape Hatteras, NC; includes the estuaries from Hudson River/Raritan Bay south to the Chesapeake Bay mainstem	0 – 500, mostly < 111	Bottom habitats with substrate of soft bottom along continental shelf and rocky or gravelly bottom
Clearnose skate	adult	GOME, along shelf to Cape Hatteras, NC; includes the estuaries from Hudson River/Raritan Bay south to the Chesapeake Bay mainstem	0 – 500, mostly < 111	Bottom habitats with substrate of soft bottom along continental shelf and rocky or gravelly bottom

Species	Life Stage	Geographic Area of EFH	Depth (meters)	EFH Description
Little skate	juvenile	GB through Mid-Atlantic Bight to Cape Hatteras, NC; includes the estuaries from Buzzards Bay south to the Chesapeake Bay mainstem	0 - 137, mostly 73 - 91	Bottom habitats with sandy or gravelly substrate or mud
Little skate	adult	GB through Mid-Atlantic Bight to Cape Hatteras, NC; includes the estuaries from Buzzards Bay south to the Chesapeake Bay mainstem	0 - 137, mostly 73 - 91	Bottom habitats with sandy or gravelly substrate or mud
Rosette skate	juvenile	Nantucket shoals and southern edge of GB to Cape Hatteras, NC	33 - 530, mostly 74 - 274	Bottom habitats with soft substrate, including sand/mud bottoms, mud with echinoid and ophiuroid fragments, and shell and pteropod ooze
Rosette skate	adult	Nantucket shoals and southern edge of GB to Cape Hatteras, NC	33 - 530, mostly 74 - 274	Bottom habitats with soft substrate, including sand/mud bottoms, mud with echinoid and ophiuroid fragments, and shell and pteropod ooze
Smooth skate	juvenile	Offshore banks of GOME	31 – 874, mostly 110 - 457	Bottom habitats with a substrate of soft mud (silt and clay), sand, broken shells, gravel and pebbles
Smooth skate	adult	Offshore banks of GOME	31 – 874, mostly 110 - 457	Bottom habitats with a substrate of soft mud (silt and clay), sand, broken shells, gravel and pebbles
Thorny skate	juvenile	GOME and GB	18 - 2000, mostly 111 - 366	Bottom habitats with a substrate of sand, gravel, broken shell, pebbles, and soft mud
Thorny skate	adult	GOME and GB	18 - 2000, mostly 111 - 366	Bottom habitats with a substrate of sand, gravel, broken shell, pebbles, and soft mud
Winter skate	juvenile	Cape Cod Bay, GB, southern NE shelf through Mid-Atlantic Bight to North Carolina; includes the estuaries from Buzzards Bay south to the Chesapeake Bay mainstem	0 - 371, mostly < 111	Bottom habitats with substrate of sand and gravel or mud
Winter skate	adult	Cape Cod Bay, GB southern NE shelf through Mid-Atlantic Bight to North Carolina; includes the estuaries from Buzzards Bay south to the Chesapeake Bay mainstem	0 - 371, mostly < 111	Bottom habitats with substrate of sand and gravel or mud

Species	Life Stage	Geographic Area of EFH	Depth (meters)	EFH Description
White hake	juvenile	GOME, southern edge of GB, southern NE to middle Atlantic and the following estuaries: Passamaquoddy Bay to Great Bay; Mass. Bay to Cape Cod Bay	5 - 225	Pelagic stage - pelagic waters; demersal stage - bottom habitat with seagrass beds or substrate of mud or fine grained sand

Table 8 – EFH descriptions for all benthic life stages of federally-managed species in the U.S. Northeast Shelf Ecosystem. Species with EFH vulnerable to bottom tending gear are shaded (see Stevenson et al. 2004).

Habitat Effects of Fishing

Amendment 13 (NEFMC 2003) describes the general effects of bottom trawls and dredges on benthic marine habitats. The primary source document used for this analysis was an advisory report prepared for the International Council for the Exploration of the Seas (ICES 2000) that identified a number of possible effects of beam trawls and bottom otter trawls on benthic habitats. This report is based on scientific findings summarized in Lindeboom and de Groot (1998), which were peer-reviewed by an ICES working group. The focus of the report is the Irish Sea and North Sea, but it also includes assessments of effects in other areas. Two general conclusions were: 1) low-energy environments are more affected by bottom trawling; and 2) bottom trawling can affect the potential for habitat recovery (*i.e.*, after trawling ceases, benthic communities and habitats may not always return to their original pre-impacted state). Regarding direct habitat effects, the report also concluded that:

- Loss or dispersal of physical features such as peat banks or boulder reefs (<u>changes are always permanent</u> and lead to an overall change in habitat diversity, which can in turn lead to the local loss of species and species assemblages dependant on such features);

- Loss of structure-forming organisms such as bryozoans, tube-dwelling polychaetes, hydroids, seapens, sponges, mussel beds, and oyster beds (<u>changes may be permanent</u> and can lead to an overall change in habitat diversity which can in turn lead to the local loss of species and species assemblages dependant on such biogenic features);

- Reduction in complexity caused by redistributing and mixing of surface sediments and the degradation of habitat and biogenic features, leading to a decease in the physical patchiness of the sea floor (<u>changes are not likely to be permanent</u>);

- Alteration of the detailed physical features of the sea floor by reshaping seabed features such as sand ripples and damaging burrows and associated structures which provide important habitats for smaller animals and can be used by fish to reduce their energy requirements (<u>changes are not likely to be permanent</u>).

A more recent evaluation of the habitat effects of trawling and dredging was prepared by the Committee on Ecosystem Effects of Fishing for the National Research Council's Ocean Studies Board (NRC 2002). Trawl gear evaluated by the Committee included bottom otter trawls and beam trawls. Dredge gear included hydraulic clam dredges, non-hydraulic oyster, conch, and crab dredges, and scallop dredges with and without teeth. This report identified four general conclusions regarding the types of habitat modifications caused by trawls and dredges.

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

An additional source of information that relates specifically to the Northeast region is the report of a "Workshop on the Effects of Fishing Gear on Marine Habitats off the Northeastern U.S." sponsored by the New England and Mid-Atlantic Fishery Management Councils in October 2001 (NEFSC 2002). A panel of invited fishing industry members and experts in the fields of benthic ecology, fishery ecology, geology, and fishing gear technology was convened for the purpose of assisting the New England Fishery Management Council (NEFMC), the Mid-Atlantic Fishery Management Council (MAFMC) and NMFS with: 1) evaluating the existing scientific research on the effects of fishing gear on benthic habitats; 2) determining the degree of impact from various gear types on benthic habitats in the Northeast; 3) specifying the type of evidence that is available to support the conclusions made about the degree of impact.; 4) ranking the relative importance of gear impacts on various habitat types; and 5) providing recommendations on measures to minimize those adverse impacts. The panel was provided with a summary of available research studies that summarized information relating to the effects of bottom otter trawls, New Bedford style scallop dredges, and hydraulic clam dredges. Relying on this information plus professional judgment, the panel identified the effects, and the degree of impact, of these three gears plus bottom gillnets, pots, and longlines on mud, sand, and gravel/rock bottom habitats.

Additional information is provided in this report on the recovery times for each type of impact for all three gears in mud, sand, and gravel habitats ("gravel" includes other hard-bottom habitats). This information made it possible to rank these three substrates in terms of their vulnerability to the effects of bottom trawling and dredging, although other factors such as frequency of disturbance from fishing and from natural events are also important. In general, impacts were determined to be greater in gravel/rock habitats with attached epifauna. Impacts on biological structure were ranked higher than impacts on physical structure and otter trawls and scallop dredges were ranked much higher than hydraulic dredges or stationary gears. Effects of trawls on major physical features in mud (deep-water clay-bottom habitats) and gravel bottom were described as permanent, and impacts to biological and physical structure were given recovery times of months to years in mud and gravel. Impacts of trawling on physical structure in sand were of shorter duration (days to months) given the exposure of most continental shelf sand habitats to strong bottom currents and/or frequent storms. For scallop dredges in gravel, recovery from impacts to biological structure was estimated to take several years and, for impacts to physical structure, months to years. In sand, biological structure was estimated to recover within months to years and physical structure within days to months.

The contents of a second expert panel report, produced by the Pew Charitable Trusts and entitled "Shifting Gears: Addressing the Collateral Impacts of Fishing Methods in U.S. Waters" (Morgan and Chuenpagdee 2003), was also summarized in Amendment 13. This group evaluated the habitat effects of ten different commercial fishing gears used in U.S. waters. The report concluded that bottom trawls and dredges have very high habitat impacts, bottom gillnets and pots and traps have low to medium impacts, and bottom longlines have low impacts. As in the ICES and NRC reports, individual types of trawls and dredges were not evaluated. The impacts of bottom gill nets, traps, and longlines were limited to warm or shallow-water environments with rooted aquatic vegetation or "live bottom" environments (*e.g.*, coral reefs).

Results of a review of 44 gear effect studies published through the summer of 2002 that were relevant (same gears and habitats) to the NE region of the U.S. (see Stevenson et al. 2004) are also summarized in Amendment 13. Based on these studies, positive and negative effects of bottom otter trawls, New Bedford-style scallop dredges, and hydraulic clam dredges are summarized by substrate type in Amendment 13, along with recovery times (when known). Whenever possible, only statistically significant results were reported. In general, these studies confirm the previous determinations of potential adverse impacts of trawls and dredges found in the ICES (2000), NRC (2002), NEFSC (2002), and Morgan and Chuenpagdee (2003) reports. The results of these 44 studies are summarized below for each gear/habitat type combination. Studies of the effects of multiple gear types are not included. Physical and biological effects for each gear-substrate category are summarized in separate paragraphs. When necessary, biological effects are summarized separately for single disturbance and repeated disturbance experimental studies, and for non-experimental studies. For more detailed information, including the identification of each study, see Stevenson et al. (2004). An up-dated summary of gear effects research studies that are relevant to the NE region will be included in the revised gear effects section of the NEFMC Omnibus EFH Amendment 2 (Phase 2), which is currently being developed.

Otter Trawls – Mud

Results of 11 studies are summarized, five done in North America, four in Europe, and one in Australia. One was performed in an inter-tidal habitat, one in very deep water (250 m), and the rest in a depth range of 14-90 meters. Seven of them were experimental studies, three were observational, and one was both. Two examined physical effects, six of them assessed biological effects, and three studies examined physical and biological effects. One study evaluated geochemical sediment effects. In this habitat type, biological evaluations focused on infauna: all nine biological assessments examined infaunal organisms and four of them also included epifauna. Habitat recovery was monitored on five occasions. Two studies evaluated the long-term effects of commercial trawling, one by comparing benthic samples from a fishing ground with samples collected near a shipwreck, while another evaluated changes in macrofaunal abundance during periods of low, moderate, and high fishing effort during a 27-year time period. Four of the experimental studies were done in closed or previously un-trawled areas and three in commercially fished areas. One study examined the effects of a single tow and six involved multiple tows, five restricted trawling to a single event (*e.g.*, one day) and two examined the cumulative effects of continuous disturbance.

Physical Effects

Trawl doors produce furrows up to 10 cm deep and berms 10-20 cm high on mud bottom. Evidence from four studies indicates that there is a large variation in the duration of these features (2-18 months). There is also evidence that repeated tows increase bottom roughness, fine surface sediments are re-suspended and dispersed, and rollers compress sediment. A single pass of a trawl did not cause sediments to be turned over, but single and multiple tows smoothed surface features.

Biological Effects

Single disturbance experimental studies
Two single-event studies were conducted in commercially trawled areas. Experimental trawling in intertidal mud habitat in the Bay of Fundy (Canada) disrupted diatom mats and reduced the abundance of nematodes in trawl door furrows, but recovery was complete after 1-3 months. There were no effects on infaunal polychaetes. In a sub-tidal mud habitat (30-40 m deep), benthic infauna were not affected. In two assessments performed in areas that had not been affected by mobile bottom gear for many years, effects were more severe. In both cases, total infaunal abundance and the abundance of individual polychaete and bivalve species declined immediately after trawling. In one of these studies, there were also immediate and significant reductions in the number of species and species diversity. Positive effects included reduced porosity, increased food value, and increased chlorophyll production in surface sediments. Most of these effects lasted less than 3.5 months. In the other, two tows removed 28% of the epifauna on mud and sand substrate and epifauna in all trawled quadrats showed signs of damage. These results were not reported separately for mud bottom.

Repeated disturbance experimental studies
Two studies of the effects of repeated trawling were conducted in areas that had been closed to fishing for six years and >25 years. In one, multiple tows were made weekly for a year and, in the other, monthly for 16 months. In one case, 61% of the benthic species sampled tended to be negatively affected, but significant reductions were only noted for brittlestars. In the other, repeated trawling had no significant effect on the numbers of infaunal individuals or biomass. In this study, the number of infaunal species increased by the end of the disturbance period. Some species (*e.g.*, polychaetes) increased in abundance, while others (*e.g.*, bivalves) decreased. Community structure was altered after five months of trawling and did not fully recover until 18 months after trawling ended.

Observational studies
An analysis of benthic sample data collected from a fishing ground over a 27-year period of high, medium, and low levels of fishing effort showed an increased abundance of organisms belonging to taxa that were expected to increase at higher disturbance levels, whereas those that were expected to decrease did not change in abundance. Results of another study indicated that a trawling ground had fewer benthic organisms and fewer species than an un-exploited site near a shipwreck. Trawling in deep water apparently dislodged infaunal polychaetes, causing them to be suspended in near-bottom water.

Otter Trawls – Sand

Results of 14 studies are summarized. Six studies were conducted in North America (three in a single long-term experiment on the Grand Banks), four in Australia, and four in Europe. Ten are experimental studies. Eight of them were done in depths less than 60 m, one at 80 m, and four in depths greater than 100 m. Three studies examined the physical effects of trawling, ten were limited to biological effects, and one examined both. Five of the biological studies were restricted to epifauna, one only examined infauna, and five included epifauna and infauna. The only experiment that was designed to monitor recovery was the one on the Grand Banks, although surveys conducted in Australia documented changes in the abundance of benthic organisms five years after closed areas were established. Two studies compared benthic communities in trawled areas of sandy substrate with undisturbed areas near a shipwreck. Six studies were performed in commercially exploited areas, five in closed areas, two compared closed and open areas, and one was done in a test tank. All the experimental studies examined the effects of multiple tows (up to 6 per unit area of bottom) and observational studies in Australia assessed the effects of 1-4 tows on emergent epifauna. Trawling in four studies was limited to a single event (1 day to 1 week), whereas the Grand Banks experiment was designed to evaluate the immediate and cumulative effects of annual 5-day trawling events in a closed area over a three-year period.

Physical effects

A test tank experiment showed that trawl doors produce furrows in sandy bottom that are 2 cm deep, with a berm 5.5 cm high. In sandy substrate, trawls smoothed seafloor topographic features, re-suspended and dispersed finer surface sediment, but had no lasting effects on sediment composition. Trawl door tracks lasted up to one year in deep water, but only for a few days in shallow water. Seafloor topography recovered within a year.

Biological effects

Single disturbance experimental studies

Two single-event studies were conducted in commercially trawled areas. In one of these studies, otter trawling caused high mortalities of large sedentary and/or immobile epifaunal species. In the other, there were no effects on benthic community diversity. Neither of these studies investigated effects on total abundance or biomass. Two studies were performed in un-exploited areas. One study documented effects on attached epifauna. In one, single tows reduced the density of attached macrobenthos (>20 cm) by 15% and four tows by 50%. In the other, two tows removed 28% of the epifauna on mud and sand substrate and epifauna in all trawled quadrats showed signs of damage. These results were not reported separately for sand bottom. Total infaunal abundance was not affected, but the abundance of one family of polychaetes was reduced.

Repeated disturbance experimental studies

Intensive experimental trawling on the Grand Banks reduced the total abundance and biomass of epibenthic organisms and the biomass and average size of a number of epibenthic species.

Significant reductions in total infaunal abundance and the abundance of 15 taxa (mostly polychaetes) were detected during only one of three years, and there were no effects on biomass or taxonomic diversity.

Observational studies

Changes in macrofaunal abundance in a lightly trawled location in the North Sea were not correlated with historical changes in fishing effort, but there were fewer benthic organisms and species in a trawling ground in the Irish Sea than in an un-exploited site near a shipwreck. In the other "shipwreck study," however, changes in infaunal community structure at increasing distances from the wreck were related to changes in sediment grain size and organic carbon content. The Alaska study showed that epifauna attached to sand were less abundant inside a closed area, significantly so for sponges and anemones. A single tow in a closed area in Australia removed 89% of the large sponges in the trawl path.

Otter Trawls – Gravel/Rocky Substrate

Three studies of otter trawl effects were conducted on gravel and rocky substrates. All three were conducted in North America. Two were done in glacially-affected areas in depths of about 100 to 300 meters using submersibles and the third was done in a shallow coastal area in the southeast U.S. One involved observations made in a gravel/boulder habitat in two different years before and after trawling affected the bottom. The other two were experimental studies of the effects of single trawl tows. One of these was done in a relatively un-exploited gravel habitat and the other on a smooth rock substrate in an area not affected by trawling. Two studies examined effects to the seafloor and on attached epifauna and one only examined effects on epifauna. There were no assessments of effects on infauna. Recovery was evaluated in one case for a year.

Physical effects

Trawling displaced boulders and removed mud covering boulders and rocks and rubber tire ground gear left furrows 1-8 cm deep in less compact gravel sediment.

Biological effects

Trawling in gravel and rocky substrate reduced the abundance of attached benthic organisms (*e.g.*, sponges, anemones, and soft corals) and their associated epifauna and damaged sponges, soft corals, and brittle stars. Sponges were more severely damaged by a single pass of a trawl than soft corals, but 12 months after trawling all affected species – including one species of stony coral – had fully recovered to their original abundance and there were no signs of damage.

Otter Trawls – Mixed Substrates

Three studies of the effects of otter trawls on mixed substrates are summarized. All three were conducted in North America and relied on sonar and observations made by divers or from a submersible. One of them combined submersible observations and benthic sampling to compare the physical and biological effects of trawling in a lightly fished and heavily fished location in California with the same depth and variety of sediment types. One was a survey of seafloor features produced by trawls in a variety of bottom types and the other primarily examined the physical effects of single trawl tows on sand and mud bottom.

Physical effects

Trawl doors left tracks in sediments that ranged from less than 5 cm deep in sand to 15 cm deep in mud. In mud, fainter marks were also made between the door tracks, presumably by the footgear. A heavily trawled area had fewer rocks, shell fragments, and biogenic mounds than a lightly trawled area.

Biological effects

The heavily trawled area in California had lower densities of large epifaunal species (*e.g.*, sea slugs, sea pens, starfish, and anemones) and higher densities of brittle stars and infaunal nematodes, oligochaetes, and one species of polychaete. There were no differences in the abundance of molluscs, crustaceans, or nemerteans between the two areas. However, since this was not a controlled experiment, these differences could not be attributed to trawling. Single trawl tows in Long Island Sound attracted predators and suspended epibenthic organisms into the water column.

New Bedford Scallop Dredges – Sand

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

Physical effects

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

Biological effects

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

New Bedford Scallop Dredges - Mixed Substrates

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

Physical effects

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

Hydraulic Clam Dredges – Sand

Six hydraulic dredge studies were conducted in sandy substrates. Five of them examined the effects of "cage" dredges of the type used in the Northeast region of the U.S. and one examined the effects of escalator dredges, which affect sandy bottom habitats similarly to "cage" dredges. Three were performed in North America (two in the U.S. and one in Canada), one in the Adriatic Sea and two in Scotland. There have been no published studies in North America since 1982. One of the North American studies was conducted on the U.S. continental shelf at a depth of 37 m and two in near shore waters and depths of 7 – 12 m. The two European studies were done in even shallower water (1.5 – 7 m). The North American studies were all observational in nature and the European studies were controlled experiments. One study compared effects in commercially dredged and un-dredged areas and four were conducted in un-dredged areas. The sixth study compared infaunal communities in an actively dredged, a recently dredged, and an un-dredged location off the New Jersey coast. All six studies examined physical and biological effects of dredging. Recovery was evaluated in four cases for periods ranging from just a few minutes (sediment plumes) to 11 weeks.

Physical effects

Hydraulic clam dredges created steep-sided trenches 8-30 cm deep that started deteriorating immediately after they were formed. Trenches in a shallow, inshore location with strong bottom currents filled in within 24 hours. Trenches in shallow, protected, coastal lagoons were still visible two months after they were formed. Hydraulic dredges also fluidized sediments in the bottom and sides of trenches, created mounds of sediment along the edges of the trench, re-suspended and dispersed fine sediment, and caused a re-sorting of sediments that settled back into trenches. In one study, sediment in the bottom of trenches was initially fluidized to a depth of 30 cm and in the sides of the trench to 15 cm. After 11 weeks, sand in the bottom of the trench was still fluidized to a depth of 20 cm. Silt clouds only last for a few minutes or hours. Complete recovery of seafloor topography, sediment grain size, and sediment water content was noted after 40 days in a shallow, sandy environment that was exposed to winter storms.

Biological effects

Some of the larger infaunal organisms (*e.g.*, polychaetes, crustaceans) retained on the wire mesh of the conveyor belt used in an escalator dredge, or that drop off the end of the belt, presumably die. Benthic organisms that are dislodged from the sediment, or damaged by the dredge, temporarily provided food for foraging fish and invertebrates. Hydraulic dredging caused an immediate and significant reduction in the total number of infaunal organisms in two studies and in the number of macrofaunal organisms in a third study. There were also significant reductions in the number of infaunal species in one case and in the number of macrofaunal species and biomass in another. In this study, polychaetes were most affected. One study failed to detect any reduction in the abundance of individual taxa. Evidence from the study conducted off the New Jersey coast indicated that the number of infaunal organisms and species, and species composition, were the same in actively dredged and un-dredged locations.

Recovery times for infaunal communities were estimated in three studies. All of them were conducted in very shallow (1.5-7 m) water. Total infaunal abundance and species diversity had fully recovered only five days after dredging in one location where tidal currents reach maximum speeds of three knots. Some species had recovered after 11 weeks. Total abundance recovered 40 days after dredging in another location exposed to winter storms, when the site was re-visited for the first time. Total infaunal abundance (but not biomass) recovered within two months at a protected, commercially exploited site, where recovery was monitored at three-week intervals for two months, but not at a nearby, unexploited site. The actual recovery time at the exposed sub-tidal site was probably much quicker than 40 days, the only point in time when the post-experimental observations were made.

Hydraulic Clam Dredges - Mixed Substrates

An *in situ* evaluation of hydraulic dredge effects in sand, mud, and coarse gravel in the mid-Atlantic Bight indicated that trenches fill in quickly, within several days in fine sediment and more rapidly than that in coarse gravel. Dredging dislodged benthic organisms from the sediment, attracting predators.

7.4 HUMAN ENVIRONMENT

The purpose of this section is to describe and characterize the various fisheries in which skates are caught. It is meant to supplement and update sections of the 2000 Stock Assessment and Fishery Evaluation (SAFE) Report for the Northeast Skate Complex (NEFMC 2001), completed as part of the FEIS for the original Skate FMP (NEFMC 2003). Descriptive information on the fisheries is included, and where possible, quantitative commercial fishery and economic information is presented. The 2000 SAFE Report incorporated skate fishery data through 1999, so this report will use available data from 2000 on. Detailed historical aspects of skate fisheries are also documented in the 2000 SAFE Report.

7.4.1 Description of Directed Skate Fisheries

7.4.1.1 The Skate Bait Fishery

One of the primary markets for skate products in the northeast U.S. is for bait. Small, whole skates are among the preferred baits for the regional American lobster (*Homarus americanus*) fishery. Most of the skate bait fishery occurs in southern New England waters, and is largely comprised of little skate (>90%), with a smaller percentage of winter skate occurring seasonally. The following sections describe the major ports and other aspects of the skate bait fishery.

7.4.1.1.1 Rhode Island Bait Fishery

Skates have been targeted commercially in Rhode Island for decades for utilization primarily as lobster bait. The majority of bait skates landed in Rhode Island are little skates, with a small percentage of winter skates. There is also a seasonal gillnet incidental catch fishery as part of the directed monkfish gillnet fishery, in which skates (mostly winter skates) are sold both for lobster bait and as cut wings for processing. Fishermen have indicated that the market for skates as lobster bait has been relatively consistent.

The directed skate fishery by Rhode Island vessels occurs primarily in federal waters less than 40 fathoms from the Rhode Island/Connecticut/New York state waters boundary east to the waters south of Martha's Vineyard and Nantucket out to approximately 69 degrees. The vast majority of the landings are caught south of Block Island in federal waters. Effort on skates increases in state waters seasonally to accommodate the amplified effort in the spring through fall lobster fishery. In terms of the directed lobster bait fishery, it is estimated that between 20 - 30 Rhode Island otter trawl vessels ranging from 50 – 70 feet dominate the bait market. Approximately eight of those vessels from RI have identified directed skate bait fishing as their sole source of income between June – October annually, with less than 5% of their trip revenues from other species during that time.

Dayboat vessels (<24 hours) directing on skates land between 5,000 – 20,000 pounds of skates per trip, while trip boats fishing (>24 hours) generally 2 days, land approximately 40,000 – 50,000 pounds per trip. Incidental catches of skates from vessels targeting either groundfish or the southern New England mixed trawl fishery (squids, scup, fluke, whiting, mackerel, monkfish, etc.) are estimated at 500 – 2,000 pounds and are often sold directly to a lobster vessel (rather than through a dealer). Otherwise, many vessels indicate they do not bother to keep skates caught incidentally due to low market value or deck/hold capacity.

As the number of vessels targeting lobsters has decreased so has the demand for skates. Trap reductions in both the inshore and offshore fisheries as well as the collapse of the LI sound fishery have contributed to the decreased demand. Vessels that used to fish 3,500 traps now fish approximately 1,800. Skates are the preferred bait for the southern New England inshore and offshore lobster pot fishermen, as the skate meat is tough and holds up longer in the pot than other soft bait choices. Herring, mackerel, and menhaden are also used for bait, usually on trips of shorter duration, in colder water temperatures, or when skates are in short supply. Although there is an overall decrease in demand maintaining a supply is still very difficult for a variety of reasons. As DAS are adjusted via the Multispecies FMP, fewer days or hours can be allocated to fishing for low value species such as skates. These DAS will be reserved for groundfish or leased to other vessels. Many vessels run out of DAS by December also limiting supply and multispecies vessels are forced to take a 20 day block between March and May, prohibiting the use of a DAS which is a requirement of the directed skate fishery. More recently, high fuel prices are causing vessels to work on more profitable species. Rather than fishing an area where it is known to be largely skate, vessels now need to land a mixed trip (skate & groundfish) in order to justify the DAS usage.

Skates caught for lobster bait are landed whole by otter trawlers and either sold 1) fresh, 2) fresh salted, or 3) salted and strung or bagged for bait by the barrel. Inshore lobster boats usually use 2 – 3 skates per string, while offshore boats may use 3 – 5 per string. Offshore boats may actually “double bait” the pots during the winter months when anticipated weather conditions prevent the gear from being regularly tended. There has also been a tremendous increase in crabbing during these winter months (avg. $0.65/lb). The presence of sand fleas and parasites, water temperature, and anticipated soak time between trips are determining factors when factoring in the amount of bait per pot.

Size is a factor that drives the dockside price for bait skates. For the lobster bait market, a “dinner plate” is the preferable size to be strung and placed inside lobster pots. Little and winter skates are rarely sorted prior to landing, as fishermen acknowledge that species identification between little skates and small winter skates is very difficult. Ex-vessel skate prices remain relatively stable at an average of about $0.08 - $0.10 per pound. Quality and cleanliness of the skate are also factors in determining the price paid by the dealer, rather than just supply and demand. The quantity of skates landed on a particular day has little effect on price because there is has been ready supply of skates available for bait from the major dealers, and the demand for lobster bait has been relatively consistent. Numerous draggers and lobster vessels have historically worked out seasonal cooperative business arrangements with a stable pricing agreement for skates.

In Rhode Island, there are two major dealers involved in the skate bait market. One reports supplying skates to 100 lobster businesses located in Point Judith, Wickford, Newport, Westerly, and Jamestown, RI, along with businesses scattered throughout Connecticut and Massachusetts. The company buys from 12- 15 vessels throughout the year, and ten employees are charged with offloading, salting, and stringing bait for inshore and offshore lobster vessels. The lobster businesses supplied by the company employ between 2 - 4 crewmembers per vessel. The other major skate dealer in Rhode Island supplies local Newport, Sakonnet, and New Bedford vessels and numerous offshore lobster vessels fishing in the Gulf of Maine. Skates are supplied to this dealer from draggers working out of Newport and Tiverton, RI and New Bedford, MA.

Approximately eighty percent of the skates landed for bait are sold as strung bait, at about $1.04 for a string of three skates, usually 120 strings (of three) per barrel for $121.00. Under current lobster pot limitations, the minimum bait costs for inshore areas limited to 800 pots is estimated at $832 per trip and $2,000 per trip for offshore lobster vessels limited to 1800 pots. Offshore vessels reported carrying between 15 – 30 barrels of bait per trip, which could reflect different baiting patterns. Skates are also sold by the barrel unsalted and unstrung ($50 - $60) or by the barrel unstrung and salted ($65). A tremendous volume of salt is used in the bait operations, up to 130,000 pounds weekly during the peak of lobster season. Barrels of skates may weigh between 400 – 500 pounds. Menhaden bait (pogies) prices vary between $50 – $70 per barrel ($56 per 30gl barrel), depending upon the port and the weight.

Due to direct, independent contracts between draggers and lobster vessels landings of skates are estimated to be under-documented. While bait skates are always landed (rather than transferred at sea) they are not always reported because they can be sold directly to lobster vessels by non federally permitted vessels, which are not required to report as dealers.

7.4.1.1.2 Other Bait Fishery Ports

Vessels from other ports (New Bedford and Martha's Vineyard, MA; Block Island, Long Island, Stonington, CT, and, to a lesser degree, Chatham and Provincetown, MA) have been identified as participating in the directed skate bait fishery to some extent. Suppliers indicate that some of these vessels have independent contracts with lobster vessels and supply them directly with skates on a seasonal basis. Refer to Section 7.4.1.3.5 for a description of skate bait landings by port.

Lobster bait usage varies regionally and from port to port, based upon preference and availability. Some lobstermen in the northern area (north of Cape Cod) prefer herring, mackerel, menhaden and hakes (whiting and red hake) for bait, which hold up in colder water temperatures; however, the larger offshore lobster vessels still indicate a preference for skates and Acadian redfish in their pots. Some offshore boats have indicated they will use soft bait during the summer months when their soak time is shorter. Skates used by the Gulf of Maine vessels are caught by vessels fishing in the southern New England area.

7.4.1.1.3 The Southern New England Sink Gillnet Fishery

The southern New England sink gillnet fishery targets winter skates seasonally along with monkfish. Highest catch rates are in the early spring and late fall when the boats are targeting monkfish, at about a 5:1 average ratio of skates to monkfish. Little skates are also caught incidentally year-round in gillnets and sold for bait. Several gillnetters indicated that they keep the bodies of the winter skates cut for wings and also salt them for bait. Gillnetters have become more dependent upon incidental skate catch due to cutbacks in their fishery mandated by both the Monkfish and Multispecies FMPs. Gillnet vessels use 12-inch mesh when monkfishing, catching larger skates. Southern New England fishermen have reported increased catches of barndoor skates in the last few years.

7.4.1.1.4 Regulatory Issues for the Bait Fishery

Two existing and significant regulatory limitations on the directed bait skate fishery include lobster regulations which mandate a decrease in pot limits and groundfish DAS requirements. A majority of directed skate fishermen fish in federal waters, possess multispecies permits, and fish for skates with gear capable of catching multispecies. This, in turn, means that they must use a DAS when fishing for skates unless fishing in an exempted fishery. There are currently two exempted skate fisheries in the Southern New England Exemption Area; one gillnet fishery and one deepwater trawl fishery (see **Error! Reference source not found.** for a map of these areas).

Effort in the skate fishery is reduced during the winter months because it becomes more difficult to budget DAS usage, especially for vessels that fish for groundfish either seasonally or year-round (in addition to directing on skates). Due to effort reductions in the multispecies fishery (e.g., Amendment 13, Framework 42), the majority of full-time skate vessels are presently limited to less than 50 DAS per fishing year.

Since the implementation of the Skate FMP in 2003, vessels fishing in the skate bait fishery that wish to be exempt from the skate possession limits (see Section **Error! Reference source not found.**) must acquire a Letter of Authorization (LOA) from the Regional Administrator. A number of vessels remain under the mistaken impression that this LOA also exempts them from DAS requirements. However, these vessels must still be fishing in an exempted fishery to be exempt from DAS.

7.4.1.2 The Skate Wing Fishery

The other primary market for skates in the region is the wing market. Larger skates, mostly captured by trawl gear, have their pectoral flaps, or wings, cut off and sold into this market. Attempts to develop domestic markets were short-lived, and the bulk of the skate wing market remains overseas. Winter, thorny, and barndoor skates are considered sufficient in size for processing of wings, but due to their overfished status, possession and landing of thorny and barndoor skates has been prohibited since 2003. Winter skate is therefore the dominant component of the wing fishery, but illegal thorny and barndoor wings still occasionally occur in landings (Table 23).

Table 23. Preliminary skate wing fishery species composition (% total) in sampled landings by state (2006-2007). Source: Experimental skate wing dockside sampling process, NMFS Fisheries Statistics Office.

Species	ME	MA	RI	NJ
Winter	95.4	93.3	95.8	61.7
Thorny	3.0	6.7	0.2	0.0
Barndoor	1.6	0.0	0.1	0.0
Little*	0.0	0.0	4.0	14.9
Clearnose	0.0	0.0	0.0	23.4
Smooth	0.0	0.0	0.0	0.0
Rosette	0.0	0.0	0.0	0.0
N wings sampled	3,931	11,360	3,761	2,049

*likely misidentified winter skate

Only in recent years have skate wing landings been identified separately from general skate landings. Landed skate wings are seldom identified to species by dealers. Skate processors buy whole, hand-cut, and/or onboard machine-cut skates from vessels primarily out of Massachusetts and Rhode Island. Because of the need to cut the wings, it is relatively labor-intensive to fish for skates. Participation in the skate wing fishery, however, has recently grown due to increasing restrictions on other, more profitable groundfish species. It is assumed that more vessels land skate wings as an incidental catch in mixed fisheries than as a targeted species.

New Bedford emerged early-on as the leader in production, both in landed and processed skate wings, although skate wings are landed in ports throughout the Gulf of Maine and extending down into the Mid-Atlantic. New Bedford still lands and processes the greatest share of skate wings. Vessels landing skate wings in ports like Portland, ME, Portsmouth, NH, and Gloucester, MA are likely to be landing them incidentally while fishing for species like groundfish and monkfish. Refer to Section 7.4.1.3.5 for a description of skate wing landings by port.

The current market for skate wings remains primarily an export market. France, Korea, and Greece are the leading importers. There is a limited domestic demand for processed skate wings from the white tablecloth restaurant business. Winter skates landed by gillnet vessels are reported to go almost exclusively to the wing market. Fishermen indicate that dealers prefer large-sized winter skates for the wing market (over three pounds live weight).

7.4.1.3 Commercial Fishery Landings

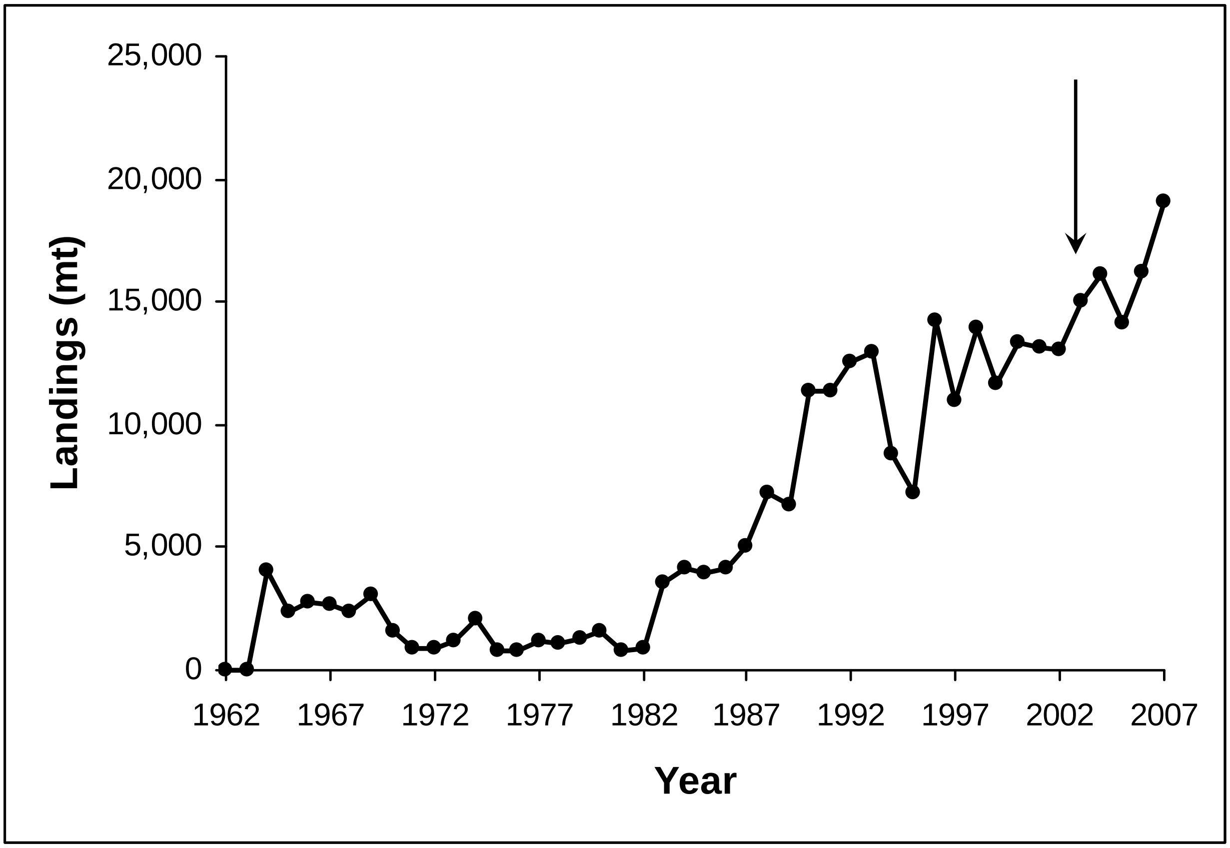
This section presents available commercial landings information for the northeast region skate complex from 2000-2007. This includes total annual landings; landings by market category; landings by state, gear type, port, and area fished; Canadian skate landings; and recreational skate landings. For data previous to 2000, refer to the 2000 SAFE Report (NEFMC 2001).

Note that NMFS estimates commercial skate landings from the dealer weighout database and reports total skate landings according to *live weight* (i.e., the weight of the whole skate). This means that a conversion factor is applied to all wing landings so that the estimated weight of the entire skate is reported and not just the wings. While *live weight* is necessary to consider from a biological and stock assessment perspective, it is important to remember that vessels' revenues associated with skate landings are for *landed weight* (vessels in the wing fishery only make money for the weight of wings they sell, not the weight of the entire skate from which the wings came).

7.4.1.3.1 Total Commercial Landings

Due to the relative absence of recreational skate fisheries, virtually all skate landings are derived from regional commercial fisheries. Skates have been reported in New England fishery landings since the late 1800s. However, commercial fishery landings never exceeded several hundred metric tons until the advent of distant-water fleets during the 1960s. Skate landings reached 9,500 mt in 1969, but declined quickly during the 1970s, falling to 800 mt in 1981 (Figure 8). Landings have since increased substantially, partially in response to increased demand for lobster bait and the increased export market for skate wings. In 2007, skate landings were the highest ever recorded, exceeding 19,000 mt. The increased demand for skate products since the mid-1980s has concurrently resulted in declining discard rates for skates (Figure 8).

Figure 8. Total Annual U.S. Landings (mt) of Atlantic Skates, 1962 – 2007. The arrow indicates the year that the Skate FMP was implemented (2003).



7.4.1.3.2 Landings by State

Table 24 presents commercial landings of skates by individual states from 2000 – 2007. Massachusetts and Rhode Island continue to dominate the skate fishery, averaging about 10 – 20 million lb annually across the time series. Skate landings from Massachusetts and Rhode Island comprised 85-94% of the total reported annual skate landings during this period. Rhode Island landings have remained fairly consistent, while Massachusetts landings have increased significantly since 2000. New Jersey, New York, Connecticut, Maine, New Hampshire, and Virginia land relatively small amounts of skates. Reported skate landings from Maine and New Hampshire have decreased in recent years. Very few skates are landed in Maryland and North Carolina, and Delaware reported minimal skate landings for the time series.

Table 24. U.S. Landings of Skates (thousands lbs) by State, 2000-2007.
Source: NMFS Fisheries Statistics Office

STATE	2000	2001	2002	2003	2004	2005	2006	2007
CT	1,088.64	1,364.42	810.33	956.05	973.70	779.03	572.33	564.89
DE	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
MA	14,369.07	14,734.32	13,966.06	17,852.75	22,213.16	19,816.73	24,542.89	29,881.92
MD	144.68	122.38	114.57	59.26	13.60	18.51	32.18	40.19
ME	304.30	304.73	302.43	168.38	29.34	23.92	3.31	65.81
NC	45.33	0.29	0.60	1.72	1.09	1.20	0.30	0.62
NH	84.74	73.12	53.99	32.83	23.31	20.72	24.75	12.29
NJ	1,244.64	1,377.30	1,283.85	989.25	825.08	738.01	995.64	1,155.47
NY	854.69	808.37	1,020.48	778.87	490.99	347.16	505.55	716.24
RI	10,637.12	10,000.49	11,088.15	12,161.75	10,760.55	9,301.28	8,931.88	9,522.51
VA	679.43	139.70	27.95	78.67	100.65	66.82	12.22	114.18
Grand Total	29,452.63	28,925.13	28,668.39	33,079.53	35,431.47	31,113.37	35,621.05	42,074.11

7.4.1.3.3 Landings by Market Category

The Skate FMP implemented new reporting requirements for skates beginning in 2003. A list of the available skate codes in the dealer weighout database is included in Table 25. Federally permitted dealers report most of the skate wings they purchase by two separate market categories: unclassified wings (code 3651) or “big skate” (code 3671). They mostly report whole/bait skate landings as little skate (code 3660) or unclassified whole skates (code 3650). Landings reported as little skate are known to include amounts of juvenile winter skate. Although reporting of skate landings by species has been encouraged, species identification by vessels and dealers remains problematic, and most landings continue to be unclassified or misrepresented (Figure 9).

While the landings by market category from the dealer weighout data may not be entirely complete, they can be examined to identify the general proportion of skate landings that are used for either the lobster bait market or the seafood market. They can also be disaggregated into individual ports to characterize skate fishing activity in the port.

According to Table 26, more pounds of skates are caught for the wing market than for the bait market. For the time series, skate wing landings (*live weight*) accounted for 65-74% of the total landings. In general, the proportion of skate landings reported as wings has increased since 2000, which is also apparent in landings data for the state of Massachusetts, presented in Table 24.

Revenues from wing landings are generated from *landed weight*. Wing landings receive a significantly higher ex-vessel price than bait landings, as fewer landed pounds of wings generated substantially higher revenues than the larger amounts of whole skates landed. Based on the data summarized in Table 26, the price for whole skates averaged $0.07-0.10 per lb, and the price for skate wings averaged $0.30-0.55 per lb. The price for whole skates has remained relatively constant, whereas the price for skate wings has been increasing since 2001.

Table 25. List of skate species and market codes used in the dealer weighout database since 2003. Note: Big skate is an alternative common name for winter skate (Leucoraja ocellata), and does not indicate the Pacific big skate (Raja binoculata).

Species Code (NESPP4)	Common Name	Grade Description	Market Description
3650	SKATES	ROUND	MIXED OR UNSIZED
3650	SKATES	ROUND	UNKNOWN
3670	SKATE, BIG	ROUND	UNKNOWN
3720	SKATE, CLEARNOSE	ROUND	UNKNOWN
3660	SKATE,LITTLE	ROUND	UNKNOWN
3640	SKATE, ROSETTE	ROUND	UNKNOWN
3680	SKATE,BARNDOOR	ROUND	UNKNOWN
3670	SKATE, WINTER	ROUND	UNKNOWN
3700	SKATE, THORNY	ROUND	UNKNOWN
3690	SKATE, SMOOTH	ROUND	UNKNOWN
3651	SKATES	WINGS	MIXED OR UNSIZED
3651	SKATES	WINGS	UNKNOWN
3671	SKATE, BIG	WINGS	UNKNOWN
3721	SKATE, CLEARNOSE	WINGS	UNKNOWN
3661	SKATE,LITTLE	WINGS	UNKNOWN
3641	SKATE, ROSETTE	WINGS	UNKNOWN
3681	SKATE,BARNDOOR	WINGS	UNKNOWN
3671	SKATE, WINTER	WINGS	UNKNOWN
3701	SKATE, THORNY	WINGS	UNKNOWN
3691	SKATE, SMOOTH	WINGS	UNKNOWN

Figure 9. Weights of landed skates by reported species code in the dealer weighout database, 2007.

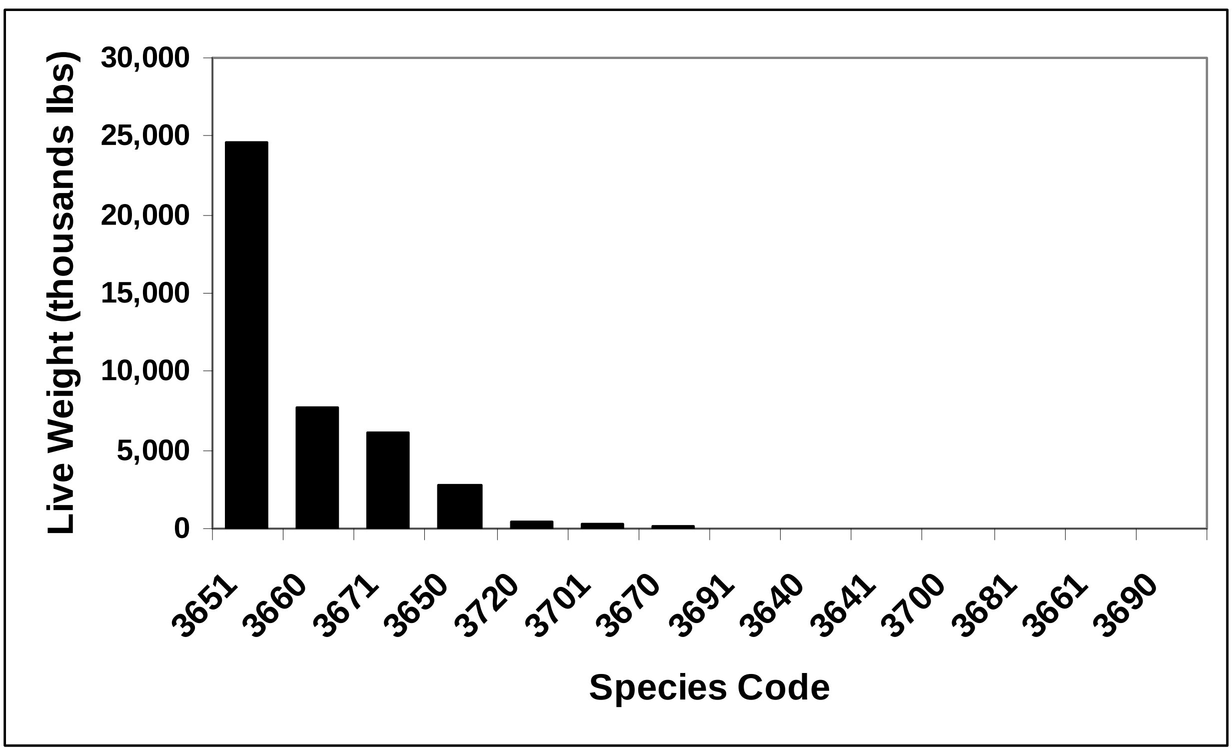


Table 26. Total Annual Landings and Revenue of Skates by Market Category (2000-2007).
Source: Dealer Weighout Database, NMFS
Revenues are generated from landed pounds.

YEAR	Category	Landed Weight (lb)	Live Weight (lb)	Revenue
2000	Whole	10,293,442	10,293,442	$754,767
	Wings	8,440,041	19,159,191	$3,069,363
2000 Total		18,733,483	29,452,633	$3,824,130
2001	Whole	9,704,044	9,704,044	$818,533
	Wings	8,467,303	19,221,086	$2,535,978
2001 Total		18,171,347	28,925,130	$3,354,511
2002	Whole	9,693,394	9,693,394	$866,305
	Wings	8,358,879	18,974,996	$2,679,627
2002 Total		18,052,273	28,668,390	$3,545,932
2003	Whole	9,543,292	9,543,292	$716,735
	Wings	10,368,270	23,536,237	$3,370,561
2003 Total		19,911,562	33,079,529	$4,087,296
2004	Whole	8,538,845	8,538,845	$673,390
	Wings	11,846,858	26,892,626	$4,399,004
2004 Total		20,385,703	35,431,471	$5,072,394
2005	Whole	8,770,170	8,770,170	$908,503
	Wings	9,842,683	22,343,201	$4,286,557
2005 Total		18,612,853	31,113,371	$5,195,060
2006	Whole	9,958,544	9,958,544	$968,720
	Wings	11,304,925	25,662,509	$5,927,302
2006 Total		21,263,469	35,621,053	$6,896,022
2007	Whole	11,028,358	11,028,358	$1,089,444
	Wings	13,676,353	31,045,755	$7,573,756
2007 Total		24,704,711	42,074,113	$8,663,200

7.4.1.3.4 Landings by Gear

Table 27 presents annual skate landings (2000-2007) from the dealer weighout database by gear type and by market category as a percentage of the annual total. Otter trawl is the primary gear used to catch skates. Approximately 65-86% of the total skate landings during this period were captured by trawl gear. About 40% of the skates caught with otter trawls are landed for the lobster bait market, with the other 60% landed for the wing market (Table 27). Almost all skates caught for the lobster bait fishery are caught with a trawl. Gillnets are the secondary gear used to catch skates. Almost all skates that are caught with gillnets are landed as wings. Between 2000 and 2007, 93-98% of the total gillnet landings of skates were wings (Table 27). Gillnet landings of skates increased over the time series, representing 13.6% of the total landings in 2000, but up to 32.6% of the total in 2007.

Other gears in which skates are consistently caught include traps, hook gear (including longlines), and scallop dredges. Almost 100% of the skates that are caught with hook gear are landed as wings. The overall contribution of skate landings from gears other than trawl and gillnets is relatively insignificant.

Table 27. Annual Skate Landings (Live Weight, thousands lbs) by Gear Type and Market Category as a Percentage of Total Skate Landings
Source: Dealer Weighout Database, NEFSC
* Landings from other codes were incorporated into the 3650 category.

Hook and Line includes bottom longlines, handlines (rod and reel), and the combined troll and handline category.
Gillnet includes sink, stake, and drift gillnets.
Otter trawl includes fish, shrimp, scallop, and other otter trawls.
Seines include common, Danish, and Scottish seines.
Pots/traps include floating, fish, and lobster traps.
Other dredges include crab, conch, and surf clam/ocean quahog dredges.
Other gear includes pound nets, fyke nets, beam trawls, and trammel nets

GEAR NAME	CATEGORY	2007	2006	2005	2004	2003	2002	2001	2000
TRAWL	**Whole**	10,686	9,483	8,106	8,341	9,023	9,198	9,542	10,094
	% Whole	38.7%	40.9%	39.6%	33.1%	38.8%	43.3%	40.0%	40.0%
	Wings	16,950	13,723	12,371	16,826	14,243	12,037	14,287	15,137
	% Wings	61.3%	59.1%	60.4%	66.9%	61.2%	56.7%	60.0%	60.0%
Trawls Total		27,636	23,206	20,477	25,167	23,266	21,235	23,828	25,232
	% of Total Landings	**65.7%**	**65.1%**	**65.8%**	**71.0%**	**70.3%**	**74.1%**	**82.4%**	**85.7%**
GILLNET	**Whole**	289	363	298	181	484	488	157	142
	% Whole	2.1%	3.4%	3.7%	1.9%	5.0%	6.6%	3.1%	3.6%
	Wings	13,411	10,194	7,717	9,168	9,185	6,864	4,856	3,854
	% Wings	97.9%	96.6%	96.3%	98.1%	95.0%	93.4%	96.9%	96.4%
Gill nets Total		13,699	10,557	8,015	9,349	9,669	7,352	5,013	3,997
	% of Total Landings	**32.6%**	**29.6%**	**25.8%**	**26.4%**	**29.2%**	**25.6%**	**17.3%**	**13.6%**
OTHER NET	**Whole**	17	58	107	1	1	3	3	2
	% Whole	3.6%	7.3%	14.4%	0.1%	7.1%	15.6%	13.8%	6.2%
	Wings	465	735	636	585	8	18	20	27
	% Wings	96.4%	92.7%	85.6%	99.9%	92.9%	84.4%	86.2%	93.8%
Other nets Total		482	793	743	586	9	21	23	29
	% of Total Landings	**1.1%**	**2.2%**	**2.4%**	**1.7%**	**0.0%**	**0.1%**	**0.1%**	**0.1%**
UNKNOWN	**Whole**	23	22	217	7	0	0	0	24
	% Whole	12.0%	3.0%	17.6%	3.9%	0.0%	0.0%	9.4%	69.1%

	Wings	170	687	1,016	170	0	0	5	11
	% Wings	88.0%	97.0%	82.4%	96.1%	0.0%	100.0%	90.6%	30.9%
Unknown Total		193	709	1,233	176	0	0	5	34
	% of Total Landings	**0.5%**	**2.0%**	**4.0%**	**0.5%**	**0.0%**	**0.0%**	**0.0%**	**0.1%**
LONGLINE	**Whole**	3	2	1	0	0	2	0	0
	% Whole	10.2%	9.6%	0.3%	0.0%	0.0%	6.0%	0.0%	0.0%
	Wings	24	23	387	55	66	29	29	83
	% Wings	89.8%	90.4%	99.7%	100.0%	100.0%	94.0%	100.0%	100.0%
Long lines Total		27	25	388	55	66	31	29	83
	% of Total Landings	**0.1%**	**0.1%**	**1.2%**	**0.2%**	**0.2%**	**0.1%**	**0.1%**	**0.3%**
DREDGE	**Whole**	8	12	3	0	0	0	0	0
	% Whole	72.9%	4.2%	2.2%	0.0%	10.3%	0.0%	0.0%	0.0%
	Wings	3	279	139	9	4	3	8	3
	% Wings	27.1%	95.8%	97.8%	100.0%	89.7%	100.0%	100.0%	100.0%
Dredges Total		11	291	143	9	4	3	8	3
	% of Total Landings	**0.0%**	**0.8%**	**0.5%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**
TRAPS	**Whole**	2	3	5	4	35	1	0	32
	% Whole	17.4%	18.4%	14.9%	8.2%	85.4%	9.0%	2.9%	49.0%
	Wings	12	13	29	43	6	13	14	33
	% Wings	82.6%	81.6%	85.1%	91.8%	14.6%	91.0%	97.1%	51.0%
Traps Total		14	15	34	47	41	15	15	65
	% of Total Landings	**0.0%**	**0.0%**	**0.1%**	**0.1%**	**0.1%**	**0.1%**	**0.1%**	**0.2%**
HOOK	**Whole**	0	16	0	5	0	1	1	0
	% Whole	2.2%	65.2%	0.2%	12.5%	0.3%	18.5%	31.2%	0.7%
	Wings	12	8	47	32	24	3	3	11
	% Wings	97.8%	34.8%	99.8%	87.5%	99.7%	81.5%	68.8%	99.3%
Hook Total		12	24	47	37	25	4	4	11
	% of Total Landings	**0.0%**	**0.1%**	**0.2%**	**0.1%**	**0.1%**	**0.0%**	**0.0%**	**0.0%**
HAND	**Whole**	0	0	33	0	0	0	0	0
	% Whole	0.0%	100.0%	100.0%	3.2%	0.0%	0.0%	0.0%	0.0%

	Wings	0	0	0	5	0	7	0	0
	% Wings	0.0%	0.0%	0.0%	96.8%	0.0%	100.0%	0.0%	0.0%
Hand Total		0	0.025	33	4.927	0	7.366	0	0
	% of Total Landings	**0.0%**	**0.0%**	**0.1%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**
OTHER	**Whole**	0	0	0	0.71	0	0	0	0
	% Whole	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%
	Wings	0	0.633	1.055	0	0	0	0	0
	% Wings	0.0%	100.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Other Total		0	0.633	1.055	0.71	0	0	0	0
	% of Total Landings	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**
Grand Total		**42,074**	**35,621**	**31,113**	**35,431**	**33,080**	**28,668**	**28,925**	**29,453**

7.4.1.3.5 Landings By Port

Table 28 and Figure 10 present annual skate landings (from the dealer weighout database) by port and by market category for 2000-2007. The top 10 ports in 2007 represented over 94% of the total skate landings in the region (Figure 10). The top ports landing skates (total) currently are New Bedford, MA; Chatham, MA; Point Judith, RI; Tiverton, RI; Newport, RI; Boston, MA; Stonington, CT; Gloucester, MA; Barnegat Light, NJ; and Hampton Bays, NY.

Currently, the top ports landing whole skates for lobster bait are:

1. Point Judith, RI
2. Tiverton, RI
3. New Bedford, MA
4. Newport, RI
5. Stonington, CT

Currently, the top ports landing skate wings are:

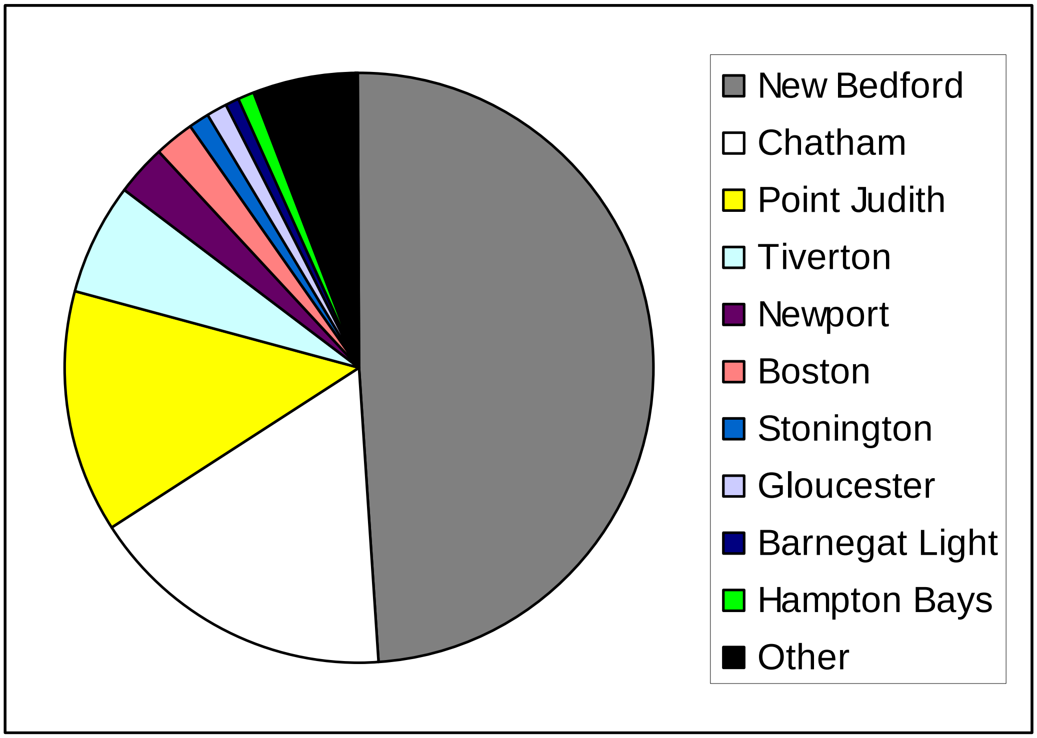
1. New Bedford, MA
2. Chatham, MA
3. Point Judith, RI
4. Boston, MA
5. Barnegat Light, NJ

New Bedford, MA and Point Judith RI clearly dominate skate landings, averaging over 60% of the total skate landings across the time series. New Bedford dominates skate wing landings, and Point Judith dominates skate bait landings. Between 2000-2007, an average of 97% of New Bedford's skate landings were classified as wings, and an average of 77% of Point Judith's skate landings were classified as whole skates (Table 28). Since 2000, skate wing landings in Provincetown, MA have declined, while landings in Chatham, MA have increased substantially. New Bedford's wing landings have accounted for about 47-62% of the total annual wing landings between 2000-2007. Point Judith's bait landings have accounted for 39-67% of the total annual bait landings from 2000-2007, with a decline in recent years. This appears to be due to significant increases in bait skate landings in New Bedford, MA, and Newport and Tiverton, RI (Table 28).

Table 28. Annual Skate Landings (Live Weight, thousands lbs) for Top 10 Ports by Market Category and as a Percentage of Total Skate Landings (2000-2007).
Source: Dealer Weighout Database, NEFSC
* Landings from other codes were incorporated into the 3650 category.

Table 40 is redacted to comply with confidentiality laws in the Magnuson-Stevens Act.

Figure 10. Top 10 ports for skate landings in 2007, based on the percentage of total landings by port.



7.4.1.3.6 Landings by Day-at-Sea Program

Upon implementation of the Skate FMP in 2003, vessels were required to fish on a Multispecies, Monkfish, or Scallop Day-at-Sea (DAS) to possess skates, unless fishing in an exempted fishery. This management measure was an indirect method to control effort in the skate fishery, which has a great deal of overlap with these fisheries. The tables and figures below characterize the skate landings in each of these DAS programs.

The vast majority (73-84%) of skate landings from a DAS program are landed on Multispecies A DAS (Table 29). During the time series, 15.3 – 22.2 million lb of skates were landed in this program. This program represents the majority of effort in the northeast groundfish fleet. Landings by vessels fishing on Monkfish DAS have been relatively stable at 0.6 – 1.9 million lb per year. Vessels fishing on combination Monkfish/Multispecies A DAS landed 2.0 – 5.6 million lb annually. Skate landings by vessels fishing on Scallop DAS have been relatively negligible. Skates captured by scallop dredge vessels tend to be discarded.

Landings in the Multispecies B DAS program have increased since its implementation in 2004 (Table 29). This program was designed to allow vessels to target healthy groundfish stocks, primarily haddock, in specific areas using certain gears without using their A DAS. Since B DAS vessels fishing with trawl gear may only possess up to 500 lb of skates, the increase in skate landings observed in 2007 in this program was mainly attributed to vessels fishing with gillnets (Figure 13). Virtually all of the skate landings in the Multispecies B DAS program are landed for the wing market (Figure 11).

Table 29. Total skate landings (lb live weight) by DAS program, 2000-2007.

Calender Year	MUL A	MUL B	MNK	MNK/MUL	SC
2000	16,673,711	NA	1,037,993	2,817,080	66,012
2001	15,320,262	NA	764,437	3,037,382	6,405
2002	17,538,086	NA	665,661	3,845,897	2,796
2003	22,205,726	NA	601,063	4,123,343	63
2004	19,760,823	547,717	1,271,352	1,991,829	0
2005	17,715,403	967,069	1,911,588	2,754,418	10,835
2006	19,083,200	64,956	1,358,881	5,652,650	4,629
2007	20,349,972	1,715,633	1,087,857	2,571,196	0

Source: NMFS, Fisheries Statistics Office

In the earlier parts of this time series, skate wing landings by trawl vessels far exceeded the landings of other gears on A DAS. Since 2003, however, gillnets have become the dominant gear landing skate wings on A DAS (Figure 12). As noted above, gillnets are also the primary gear for skate wings in the B DAS program.

Figure 11. Skate Bait and Wing landings by Multispecies A and B vessels, 2000-2007.

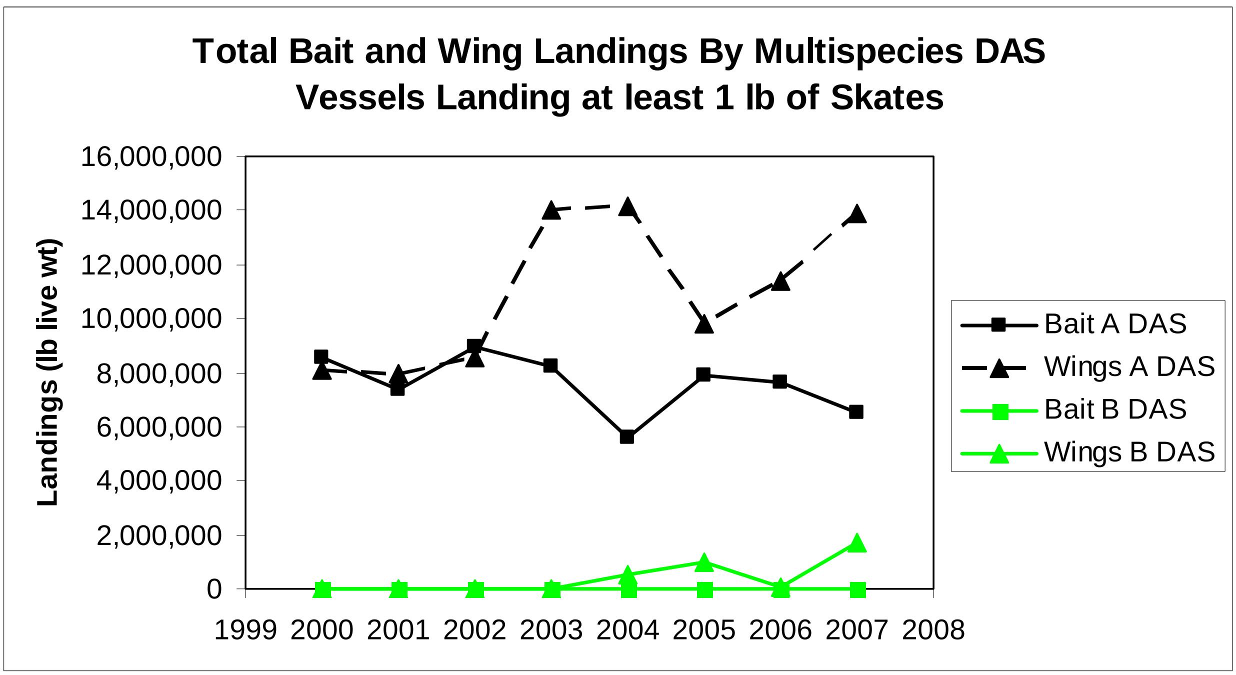


Figure 12. Skate Wing landings by gear type on Multispecies A DAS, 2000-2007

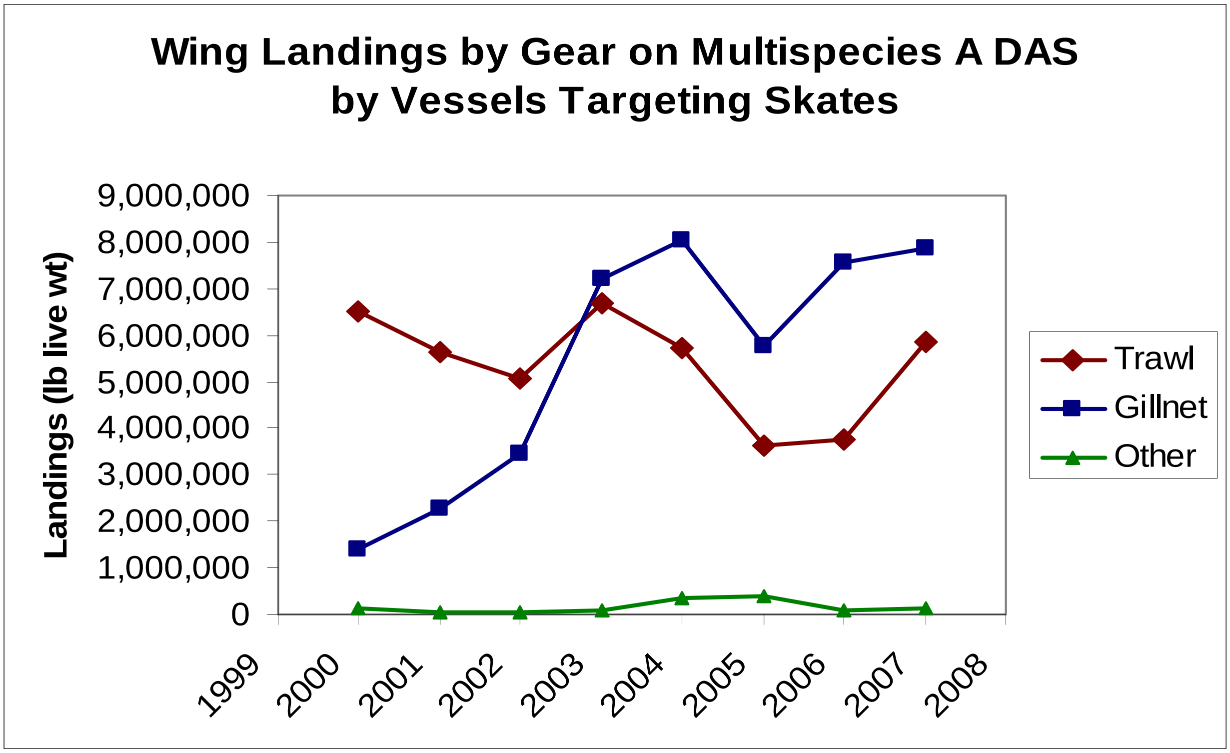
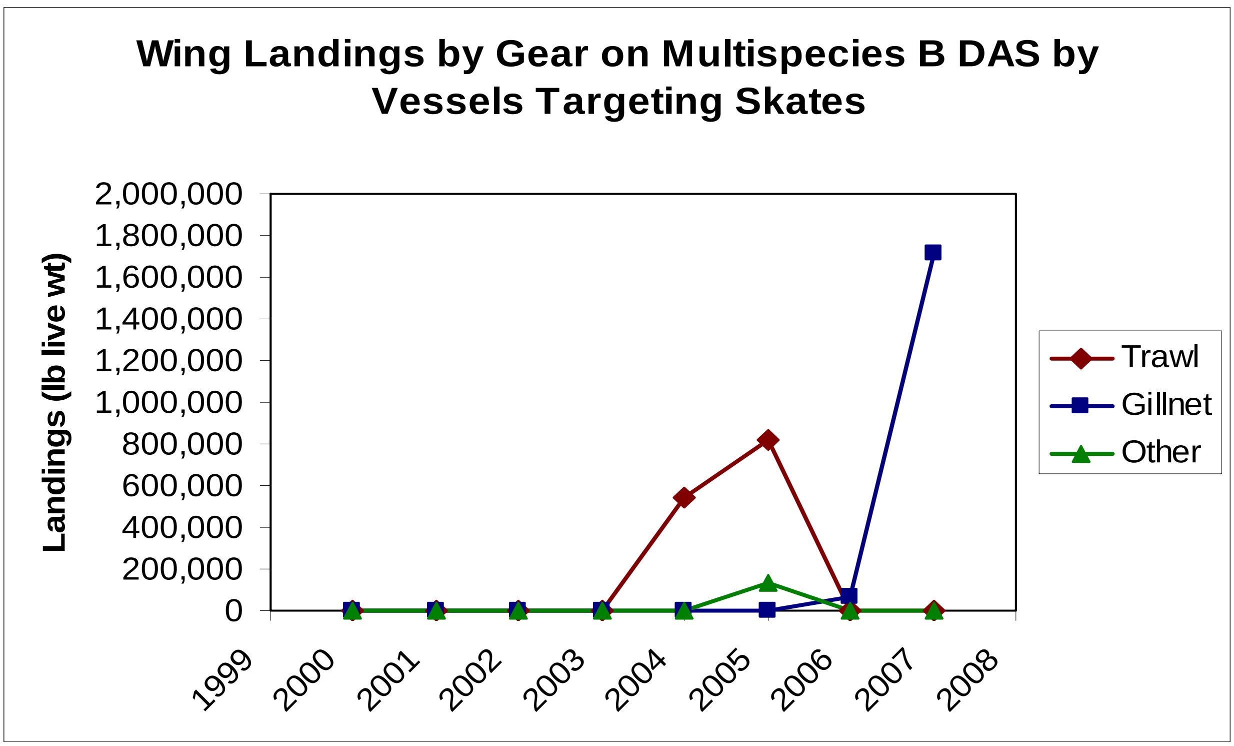


Figure 13. Skate Wing landings by gear type on Multispecies B DAS, 2000-2007.



7.4.1.4 Fishing Areas

Vessels landing skates for the wing market either target skates on Georges Bank, in the Great South Channel near Cape Cod, MA, or west of the Nantucket Lightship Area in Southern New England waters. Maps of effort distributions are presented in Section **Error! Reference source not found.** , which analyzes the effect of skate management areas on skate fishing. Vessels using gillnets often target skates to supply the wing market by fishing east of Cape Cod, MA.

Other vessels land skates for the wing market while fishing for other species. Vessels fishing for groundfish and in particularly flounders often land an incidental catch of skates. These vessels often fish in Massachusetts Bay and on Georges Bank. Some vessels fishing for scallops using dredges also land skates, but in particular scallop vessels with general category permits that fished in the Great South Channel often land skates. There is also a mixed monkfish/skate fishery that occurs west of the Nantucket Lightship Area and off Northern NJ, near Point Pleasant.

A skate fishery in RI and to a lesser extent in New Bedford supplies a lobster bait market, by landing whole skates while fishing inshore waters of Southern New England. Most of these vessels use trawls and often fish in an exempted fishery.

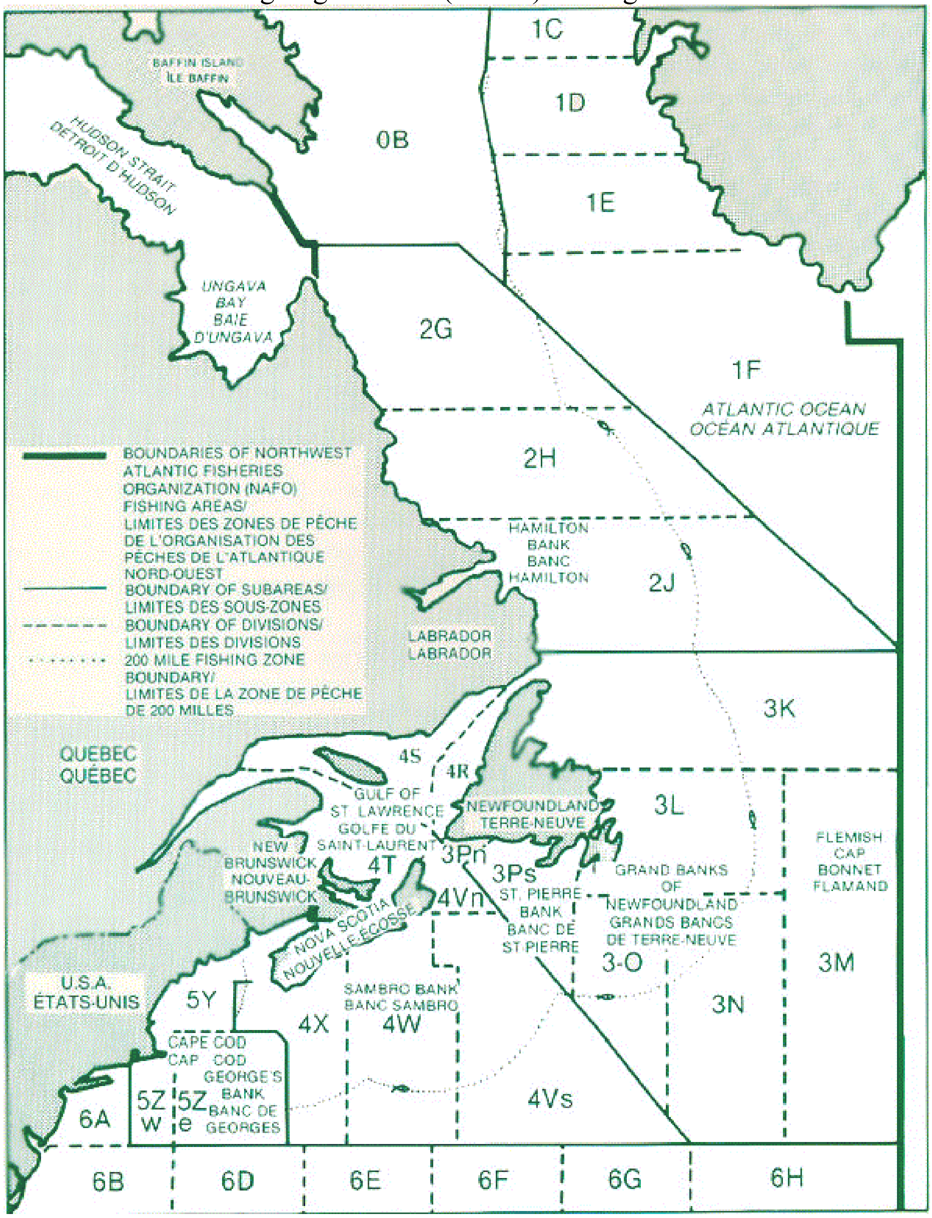
7.4.1.5 Canadian Landings of Skates

Historical information on Canadian skate fisheries and management was described in the 2000 SAFE Report for skates, and can also be found in Swain et al. (2006) and Kulka et al. (2007). Prior to 1994, skates were only caught incidentally in Canadian fisheries like those for groundfish. However, a Canadian directed skate fishery was initiated in 1994 as a response to closures in the traditional Canadian groundfish fishery and an increasing international market for skate wings. Canadian skate catches have declined from 4200t in 1994, to 1100t in 2006 (Kulka et al. 2007).

The directed skate fishery evolved on the eastern Scotian Shelf, in NAFO Divisions 4Vs and 4W (Map 20) and targets primarily winter skate (~90%) with a small bycatch of thorny skate (less than 10%) (NEFMC 2001). A Total Allowable Catch (TAC) for the directed skate fishery in 4VsW was set in 1994 and every year thereafter to ensure that the fishery would not expand beyond sustainable levels. The TAC has been lowered almost every year since 1994 in response to interim assessments, concerns over the response of winter skate to directed fishing, and decreasing participation in the fishery. In 1994, winter skate landings exceeded 2000 mt, but as the quota has been progressively reduced, landings have fallen to less than 300 mt since 2001 (Swain et al. 2006) (Table 30). In 2005, winter skate in the southern Gulf of St. Lawrence was designated as endangered by the Committee on the Status of Endangered Wildlife in Canada. Winter skate on the eastern Scotian Shelf was also designated as threatened (Swain et al. 2006). In addition to fishing mortality, observed winter skate population declines may be influenced by natural mortality, specifically increased predation by seals (Swain et al. 2006).

While winter skate range from south of Georges Bank to the Gulf of St. Lawrence, they are near their northern limit of distribution on the offshore banks of the eastern Scotian Shelf. From observations of discontinuities in distribution, Canadian scientists believe that the winter skates in Division 4VsW are probably part of a separate stock (although very little work has been completed on skate stock delineation). Frisk et al. (2008), however, hypothesize that population connectivity exists between winter skates on the Scotian Shelf and on Georges Bank, based on trends in U.S. and Canadian trawl survey data.

Map 20. Northwest Atlantic Fishing Organization (NAFO) Fishing Areas



Map Source: Nova Scotia Department of Fisheries and Aquaculture, http://www.gov.ns.ca/fish/

Table 30. Estimated winter skate removals (tons) from NAFO Areas 4VsW, 1999-2004.

YEAR	TONS OF SKATES
1999	592
2000	358
2001	235
2002	278
2003	39
2004	233

Source: Swain et al. (2006)

In addition to the directed winter skate fishery in Division 4VsW, there is a fishery for thorny skates in the Grand Banks, Divisions 3L, 3N, 3O, and 3Ps depicted in Map 20. Table 31 summarizes the skate landings from these areas. Since 1998, the gears used in this fishery have been evenly distributed between gillnet, longline, and otter trawl.

Thorny skate range from Greenland to South Carolina in the northwest Atlantic, with a center of abundance on the Grand Banks. It is not presently known if the population comprises a single stock, or if there is structure between U.S., Canada, and other regional populations. Canadian assessments indicate that the thorny skate population in Areas 3LNOPs has been near historic low levels for the last 14 years, and there is evidence of hyper-aggregation (Kulka et al. 2007). The current TACs for thorny skate in Canada exceed the recommended level of exploitation to rebuild the stock.

Table 31. Canadian skate landings (tons) from NAFO Areas 3LNOPs, 1999-2006.

	NAFO Areas			
Year	**3L**	**3N**	**3O**	**3Ps**
1999	74	85	1,166	1,284
2000	139	156	620	1,053
2001	273	270	644	2,007
2002	245	385	1,175	1,503
2003	80	404	1,032	2,014
2004	50	209	536	1,200
2005	40	294	798	963
2006	23	0	246	1,149

Source: Kulka et al. (2007)

7.4.1.6 Recreational Fishery Catch

In general, skates have little to no recreational value and are not intentionally pursued in any recreational fisheries. Catch information for Atlantic coast skates from the Marine Recreational Fishery Statistics Survey (MRFSS) is presented in Table 32 and Table 33. Recreational skate catches between 2000 and 2007 ranged from 1.4 million fish in 2001 to 3.3 million fish in 2003. Recreational *harvest* of skates (MRFSS A+B1 data), where skates were retained and/or killed by the angler, represent only 0.4 – 3.0% of the estimated total catch during this time period Table 32. The vast majority of skates caught by recreational anglers are therefore released alive.

New Jersey, New York, North Carolina, Massachusetts, and Virginia reported the largest recreational skate catches over the time series, but the annual catch estimates for each of those states appear to be rather inconsistent and do not illustrate any clear trends. Recreational fishers in Maine did not report catching any skates in 2004, 2006, and 2007. Catch estimates from Delaware, Maryland, Virginia, and North Carolina suggest that some of the skates caught recreationally are either clearnose or rosette skate, or other species of skates that are not included in the northeast complex.

Reliability of skate recreational catch estimates from MRFSS is a concern. The shaded cells in Table 32 and Table 33 indicate that the catch estimate is associated with a proportional standard error (PSE) of 0.2 or less. PSEs provide a measure of precision and represent another way to express error associated with a point estimate. Estimates with a PSE of 0.2 or less are considered to be more reliable than those with higher PSEs, and generally, PSEs of 0.2 or less are considered acceptable for fisheries data. Note that many cells in Table 32 and Table 33 are not shaded. This suggests that skate recreational catch data from MRFSS are not very reliable. Total catch estimates (A+B1+B2), however, appear to be more reliable than harvest estimates (A+B1 only). Since skates are not valuable and heavily-fished recreational species, the number of MRFSS intercepts from which these estimates are derived is likely to have been very low. The fewer intercepts from which to extrapolate total catch estimates there are, the less reliable the total catch estimates will be.

Table 32. Recreational Harvest and Total Catch of Skates (Family Rajidae) on Atlantic Coast, 2000-2007.

Type A catch is fish that are landed in a form that can be identified by trained interviewers.

Type B1 catch is fish that are used for bait, released dead, or filleted - they are killed, but identification is by individual anglers rather than trained interviewers.

Type B2 catch are fish that are released alive.

Year	HARVEST (TYPE A + B1)	TOTAL CATCH (TYPE A + B1 + B2)
2000	47,106	1,640,629
2001	5,799	1,422,319
2002	10,540	1,965,316
2003	17,297	3,264,740
2004	13,306	2,623,681
2005	19,090	2,731,706
2006	138,880	2,863,752
2007	69,857	2,303,413

Shaded values are those associated with a proportional standard error (PSE) of 0.20 or less and are considered more reliable than those with higher PSEs.

Source: National Marine Fisheries Service, MRFSS

Table 33. Recreational Catch (A + B1 + B2) in Numbers of Skates by State, 2000-2007.

	2000	2001	2002	2003	2004	2005	2006	2007
Maine	702	392	438	575	0	2,640	0	0
New Hampshire	26,751	21,052	23,029	11,792	14,998	18,872	13,070	82,478
Massachusetts	124,894	190,288	242,652	174,619	347,101	126,173	149,497	161,860
Rhode Island	61,777	78,199	100,512	53,007	86,039	65,711	66,680	112,061
Connecticut	181,702	3,213	9,163	125,226	38,606	34,603	70,184	57,347
New York	81,504	219,977	362,120	629,360	441,955	612,763	806,481	708,476
New Jersey	437,377	389,688	772,825	1,482,234	761,320	731,176	1,032,249	676,716
Delaware	42,346	71,405	71,186	136,875	150,229	160,301	166,025	77,725
Maryland	12,287	6,392	20,419	64,920	24,508	26,825	55,721	19,585
Virginia	83,611	142,068	102,231	114,594	171,898	412,604	207,181	151,542
North Carolina	577,586	290,527	248,340	439,677	565,723	528,014	287,051	234,890

Shaded values are those associated with a proportional standard error (PSE) of 0.20 or less and are considered more reliable than those with higher PSEs.

Source: National Marine Fisheries Service,MRFSS

7.4.1.7 Discards

Commercial fishery discard estimates of skates, for all species combined, were calculated and described in SAW 44 (NEFSC 2006). The method for calculating discards was revised from the method used in the previous skate assessment (SAW 30). The estimates were derived by a ratio-estimator approach, using discard/kept ratios, as described by Rago et al. (2005). Data from 1989 – 2005 are presented in the SAW 44 report, but updated estimates for 2000-2006, using the same method, are presented in Table 34. Discards have largely exceeded reported skate landings.

Table 34. Total estimated skate discards (mt) in Northeast Region commercial fisheries, 2000-2006.

Year	Total Discards
2000	47,995
2001	30,240
2002	49,296
2003	45,377
2004	19,885
2005	25,176
2006	15,372

Source: NEFSC

In general, skate discards have been declining since the 1990s (NEFSC 2006). Estimated discards for 2006 were by far the lowest of the recent time series (Table 34). Since 2000, approximately 65 – 83% of the total discards have been derived from otter trawl fisheries. Scallop dredge gear is the second largest discard component, followed by sink gillnet gear (NEFSC 2006). Effort reductions in the groundfish and scallop fisheries since the 1990s are thought to contribute to the decreasing trends in total skate discards, but increasing demand for skate wings may also be a significant factor (NEFSC 2006).

The discard mortality rates of skates captured by commercial fishing gear remains one of the biggest unknowns in the skate fisheries biology. A review of the primary literature reveals very little information on discard mortality of skate species of the northwest Atlantic or elsewhere. Acute mortality of several ray and skate species in an Australian prawn fishery was estimated at 56%, with highest mortality in smaller individuals and male specimens (Stobutzki et al. 2002). In a squid trawl fishery off the Falkland Islands, the acute mortality of several ray species was estimated at about 40% (Laptikhovsky 2004). Benoit (2006) hypothesized that winter skate acute discard mortality is at least 50% based on observations aboard trawl survey vessels in Canada. Based on this limited information, the Skate PDT and SSC have set all catch limits and associated targets using a 50% discard mortality assumption.

Delayed mortality resulting from injury, disease, or increased predation risk has not yet been investigated in any skate or ray species. Mortality is likely influenced by a suite of factors, including species, size, sex, gear, handling time and method, and environmental conditions. Research is currently under way to empirically assess acute and delayed discard mortality in members of the NE skate complex.

7.4.2 Description of the Skate Processing Sector

This section has not been updated since the 2000 SAFE Report for skates (NEFMC 2001). Much of the following information is also presented in Sections 7.4.1.1 and 7.4.1.2 of this SAFE Report.

Skates caught for lobster bait are landed whole by otter trawlers and either sold 1) fresh, 2) fresh salted, or 3) salted and strung or bagged for bait by the barrel. Bait skates are "processed" in that most are salted and strung or bagged by the buyers as preparation for use in lobster pots. A tremendous volume of salt is used in the bait operations, up to 130,000 pounds weekly during the peak of lobster season. Barrels of skates may weigh between 500 – 600 pounds. All "processing" of skates for lobster bait occurs at the level of the buyer/dealer and not the processor. No processing facilities are involved with skate products for use as lobster bait.

Skate wings are processed for export to various international markets. Winter skate, thorny skate, and barndoor skate are considered sufficient in size for processing of wings. Processors state that they prefer skate wings of at least 1-1 1/4 lb. skin-on. A one-pound skinless wing is estimated to weigh about 1.3-pounds skin-on. Skate processors buy whole, hand-cut, and/or onboard machine-cut skates from vessels primarily out of Massachusetts and Rhode Island. Cutting machines were developed in 1988 in response to increasing markets for skate wings and increased participation in the fishery. However, the practice of onboard machine cutting has decreased since that time and may not exist at all anymore. Cutting machines have been somewhat problematic because they can leave wing meat on the body of the skate or cut too close to the cartilage, decreasing the quality of the product and/or requiring additional hand-cutting. Processors prefer hand-cut wings because hand-cutting generally produces a better product and higher yield.

There are currently four known major skate wing processors in New England and another two companies in the Mid-Atlantic. The companies reportedly buy wings from vessels mostly from New Bedford and Mid-Atlantic ports. One major skate processing facility in New Bedford reports that about 90% of its product is landed in New Bedford, with the remainder trucked from Provincetown, Scituate, and other ports primarily in Massachusetts. Processors report that while demand for the product is generally consistent, profit margins are extremely low.

In total, nine processors from MA, RI, NY, and NH reported processing 3.9 million pounds of unspecified skate products. No further description of product form is available (e.g., whether frozen or fresh). Sales amounted to $3.2 million, for an average price of $0.81. These firms employ 514 workers.

The activities involved with skate processing depend on the market which the product serves. However, almost all wings are frozen for export. Wings processed for export to Europe are either skinless or skinless and boneless, and they are individually wrapped. In contrast, the Korean market prefers a whole frozen skate.

Data of annual production of processed and exported skate products is sparse. Limited trade data was collected by NOAA/NMFS for the New England Fisheries Development Program in 1975. Reports from an international seafood trade expert at the Seafood Institute indicate that skate export poundage was tracked through “Euro Stat Data” until 1995 or 1996, then abandoned. Customs does not track the exports, and no census data exists specific to skate exports.

7.4.3 Domestic and International Markets for Skates

This section has not been updated since the 2000 SAFE Report for skates (NEFMC 2001). Much of the following information is also presented in Sections 7.4.1.1 and 7.4.1.2 of this SAFE Report.

The current market for skate wings remains primarily an export market. France, Korea, and Greece are the leading importers. France prefers skate wings, a processed product that is either skinless or skinless and boneless; frozen individually wrapped in poly (IWP). The Korean market generally prefers whole processed skates, and there is a Japanese market for wings. There is also a market for skate wings in Portugal. The Portuguese market is reported to prefer barndoor skates over winter and thorny skates because they are the least stringy, most tender and flavorful of the wing skates. Interestingly, barndoor skates are said to fetch the lowest ex-vessel prices of the wing skates because they cannot be skinned by machine, as the skin tears too easily.

Brokers have also secured skates for the European and Asian markets from Argentina and Canada. Argentina initially produced a significant amount of skates, but they were reportedly of poor quality. Processing techniques have improved, and Argentina now provides the bulk of the European and Asian market. Argentina supplements their skate production with large skates produced from the U.S. west coast fishery. Canadian production of skates for the export market has diminished, as some of the industry switched toward more lucrative crab and shrimp fisheries.

7.4.4 Economic information

This section presents available economic information on the skate fishery. This includes a brief summary of the economic frameworks (supply and demand) for both the lobster bait market and the wing market; information about dockside prices for skates; trends in revenues from skate landings; and information about skate vessels, dealers, processors, and trade.

7.4.4.1 Economic Framework

The dockside markets for skate wings and bait are depicted in Figure 14 and Figure 15 in stylized form. These graphs are intended only to convey a sense of the economic benefits and costs of regulating skate fisheries. That is, we do not yet have the data necessary to estimate empirical demand and supply relationships.

The dockside demand for skate wings is derived from consumer demand in overseas markets Figure 14. In the most simple case where the U.S. provides only a small quantity of the global supply of skate wings, dockside price is set by international demand and supply of raw fish. The dockside prices of other export products such as Atlantic bluefin tuna, monkfish, and sea urchin roe are probably similarly determined. A restriction on skate wing landings (if that happens) puts a kink in the U.S. landings supply at the dotted line. The short run costs of such a restriction on the fishing industry and U.S. economy is triangular area ***A*** in Figure 14, which is above the competitive supply curve (which traces costs) and below the price line. (Impacts on foreign businesses and consumers generally are not factored into a benefit-cost analysis of domestic fisheries management.) Over the long run, recovery of skate populations (if that is a problem) would increase supply (i.e., shift the supply curve to the right), so the net effect of current losses and future gains would have to be weighed.

In contrast, the demand for skate bait is an input demand from the lobster fishery Figure 15. In this case, a regulation that reduces skate bait landings in the short run could increase dockside price from "low" where demand and supply intersect to "high" where the new, lower landings hit demand. Conventional economic wisdom would then have costs increase in the lobster fishery, reducing supply. The area ***A'*** in Figure 15 is the overall short run loss of net benefits felt by the lobster fishery and, to an extent, consumers and the seafood sector (depending on the type of demand). Likewise, area ***A*** in Figure 15 measures the same loss in the dockside skate market. In the long run, the economic sense of such a regulation depends on the cumulative results over time.

Figure 14 and Figure 15 oversimplify the skate wing and bait markets in order to illustrate essential market economics. For example, the cost of skate wing landings would be close to zero when skates are, in fact, an incidental harvest in other fisheries. In addition, these graphs leave out a number of factors that comprise dockside demand, including attributes of the landed products and the prices of substitutes. For example, "dinner plates" are the preferred size of skate bait, and herring, mackerel, and menhaden are also used for lobster bait depending on the harvesters' preferences. Finally, these few lines do not adequately distinguish between benefit-cost analysis on the one hand and regional economic and financial analyses on the other. See Edwards (1994) for a primer.

7.4.4.2 Dockside Prices for Skates

Prices reveal important information about the economic benefits and costs of fishery regulations. Only a general review of 1999 prices will be provided in this first Skate SAFE Report.

During 1999, virtually all skate landings reported in the dealer reports (weighout data) were classified as skate wings (n=14,027 trips) or "unclassified skates" (n=1434 trips). The low average price of $0.06 per pound for "unclassified skates" suggests that these landings were primarily intended for lobster bait. This is supported by the bait utilization code reported by most dealers. About 67 percent of the assumed bait landings were priced at $0.06, and over 99 percent of the trips were priced at $0.13 or less. In contrast, the average trip price for skate wings was $0.38 in 1999, and 99 percent of the prices were a dollar or less. The average price of barndoor skates reportedly landed on 25 trips was $0.13.

The price data were analyzed for differences across month, state, and fishing gear. The "unclassified skate" data were limited to records that dealers identified as skate bait and were priced at $0.13 or less (n=1079). Skate wing records were limited to those priced at $1 or less (n=13,550).

Average dockside prices of skate landings during 1999 are reported by month in Figure 16 and Figure 17. Bait prices varied significantly by month with $0.06 lows during February and September and a $0.08 peak in June (Figure 16). There were also significant monthly differences in dockside skate wing prices with a low of $0.28 in June and high of $0.54 in March (Figure 17).

Price differences were also found among fishing gears. Skate bait caught by fish otter trawls averaged about $0.06 during 1999 (n=952) compared to about $0.08 received by sink gillnetters (n=112). Other gears that landed skate bait took fewer than 10 trips. The prices of skate wings landed by otter trawl vessels (n=8318) were similar but significantly greater than sink gillnet dockside prices (n=4551) (Figure 18). The other gears included in Figure 18 had fewer than 250 trips.

Finally, skate prices also varied by state during 1999. Bait prices in NJ where skates are caught primarily by gillnet vessels averaged 2 cents more than what otter trawl vessels received in RI ($0.08 versus $0.06). Dealer reports from the CT general canvas do not specify the intended use of skate landings, but the average price of $0.06 suggests bait. In contrast, skate wings are landed throughout the northeast region except in NC (Figure 19). Maine fishermen were paid an average of $0.45 for skate wing landings compared to $0.40 in MA, NY, and NJ. Average prices in other states were significantly less than $0.40.

Figure 14 Stylized Dockside Market for Skate Wings

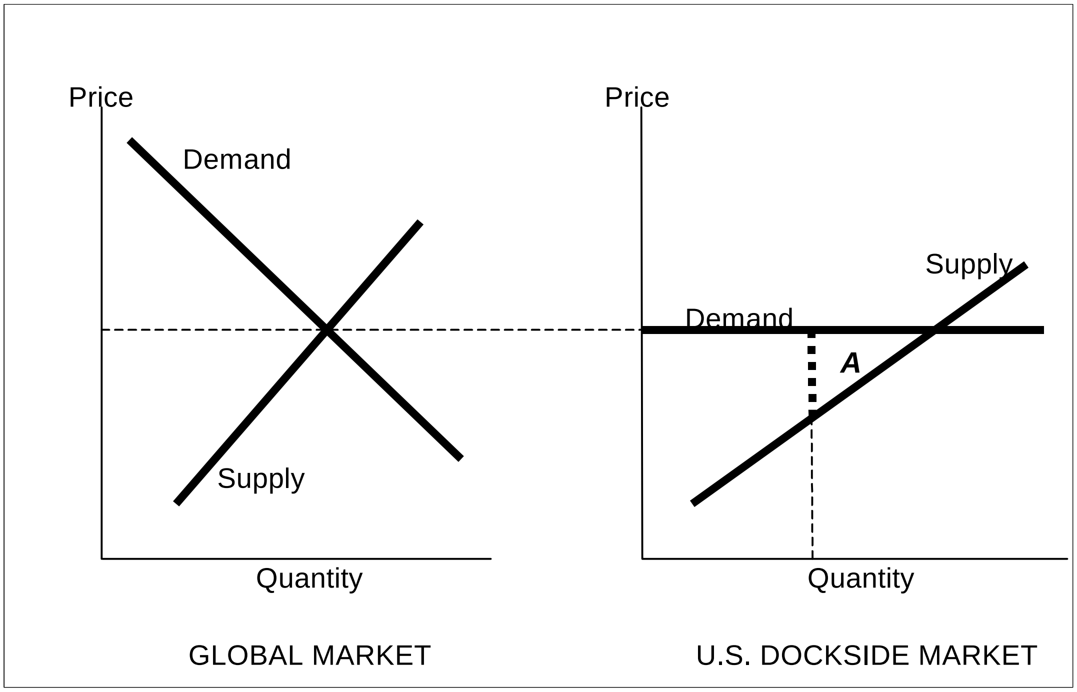


Figure 15 Stylized Dockside Market for Skates as Lobster Bait

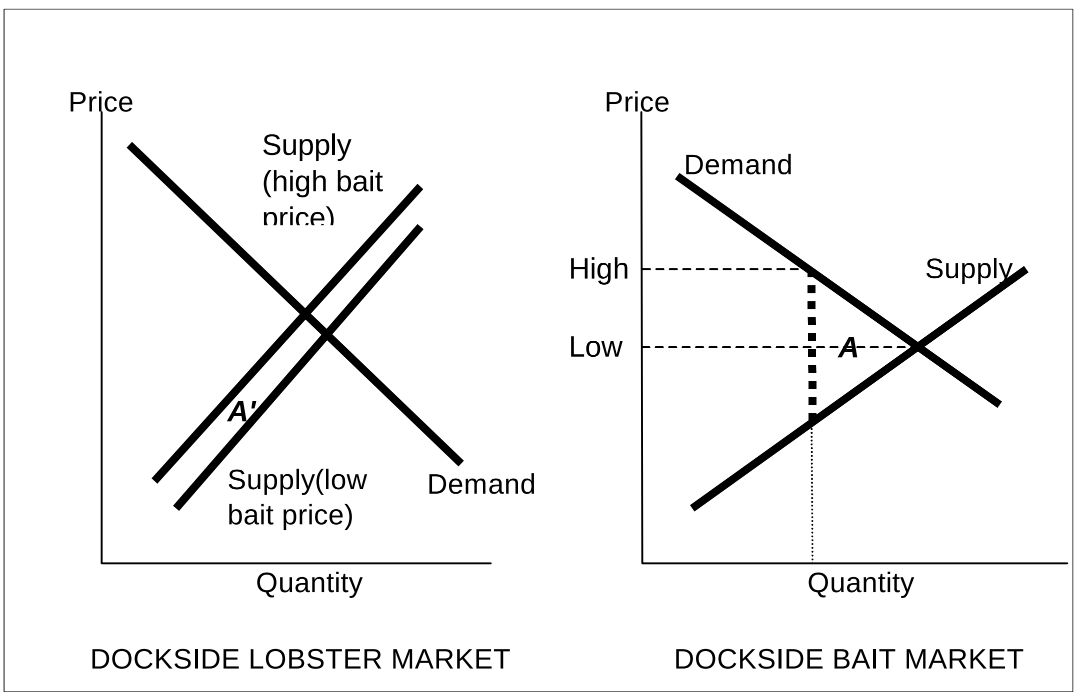


Figure 16 Monthly Averages of Individual Trip Skate Bait Prices ($ per pound landed)

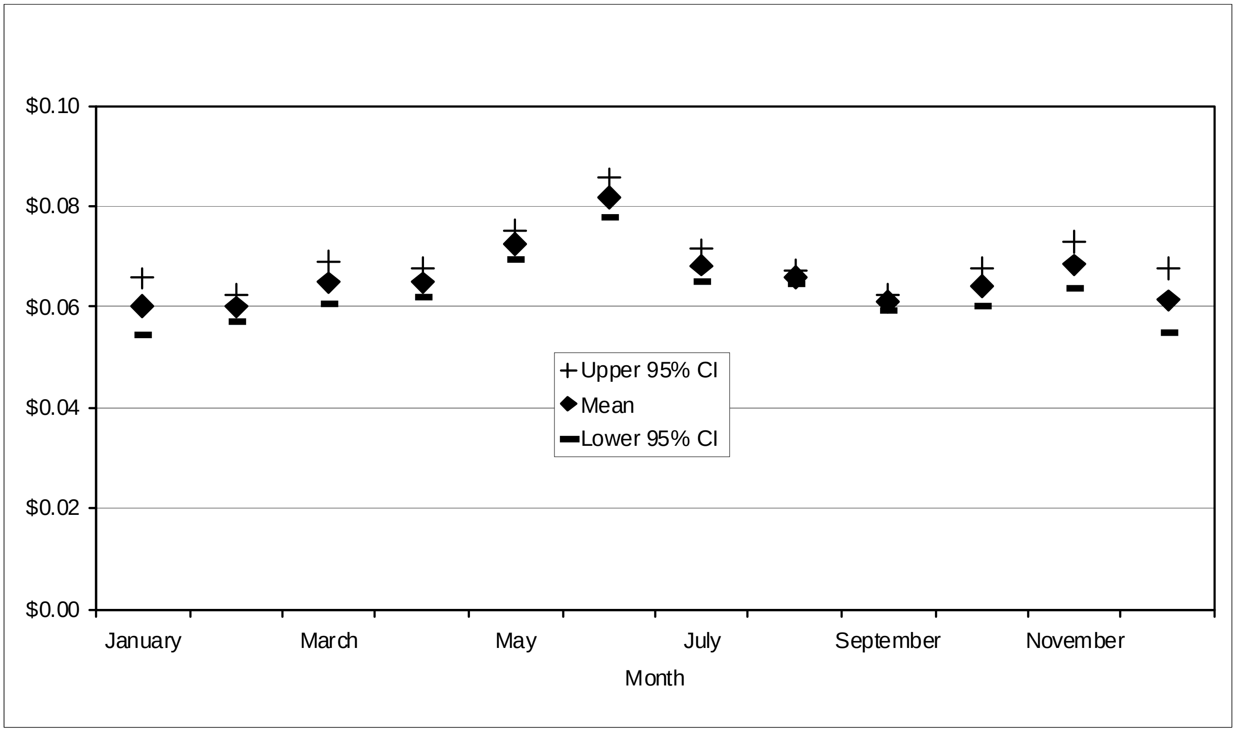


Figure 17 Monthly Averages of Individual Trip Skate Wing Prices ($ per pound landed)

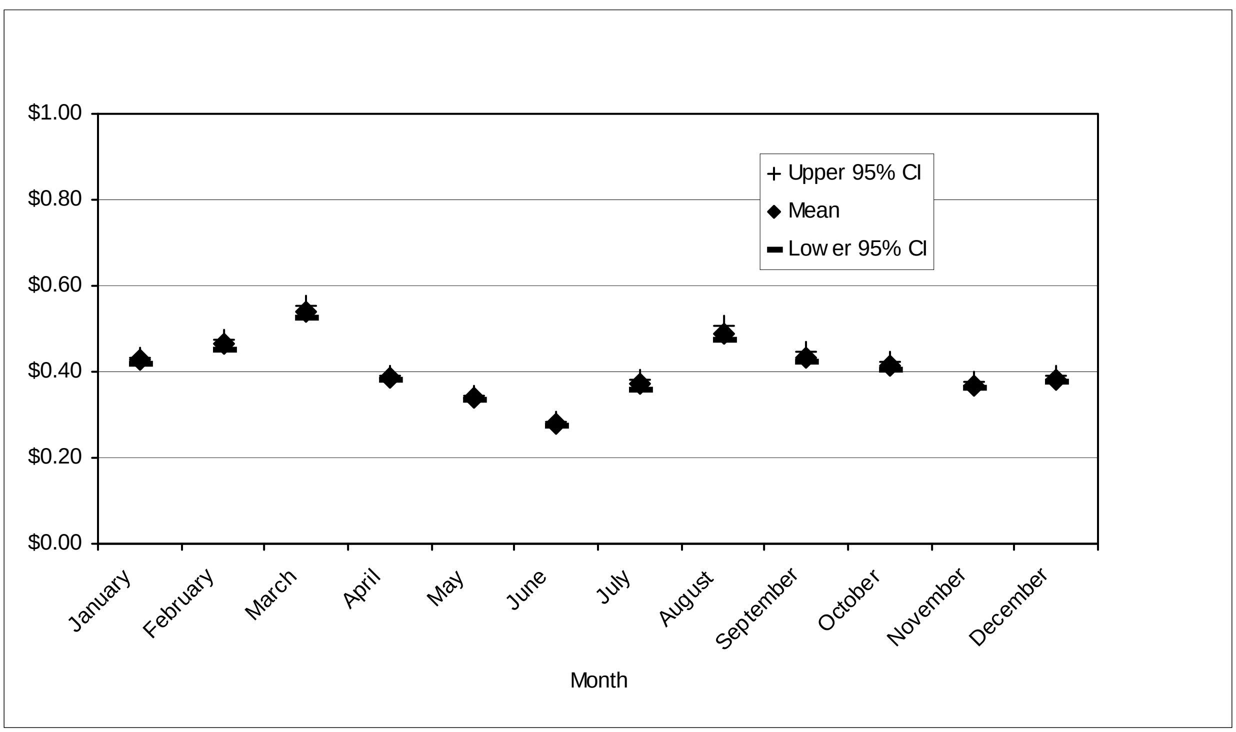


Figure 18 Comparison of Average Skate Wing Prices ($ per pound) by Gear, 1999

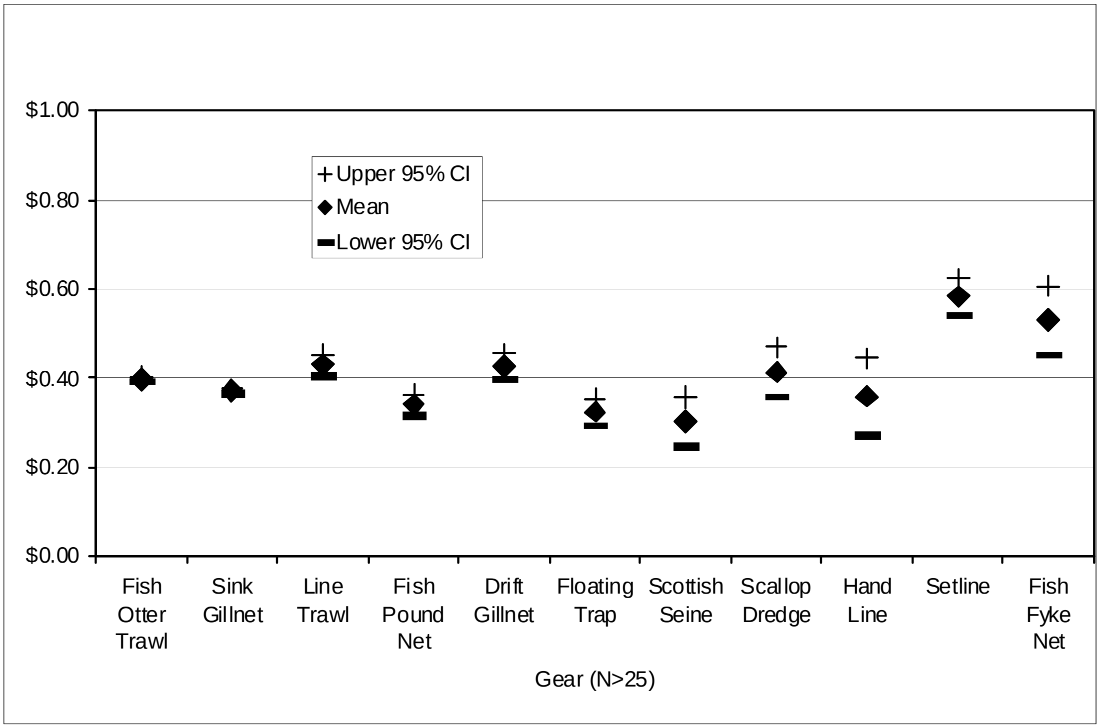
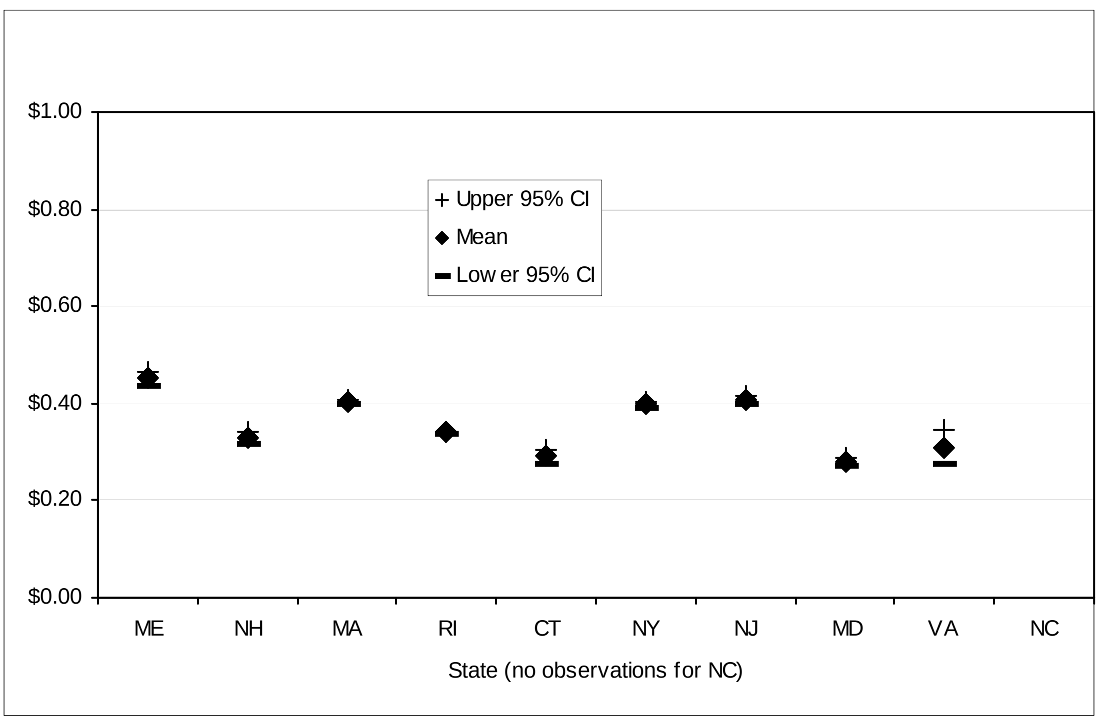


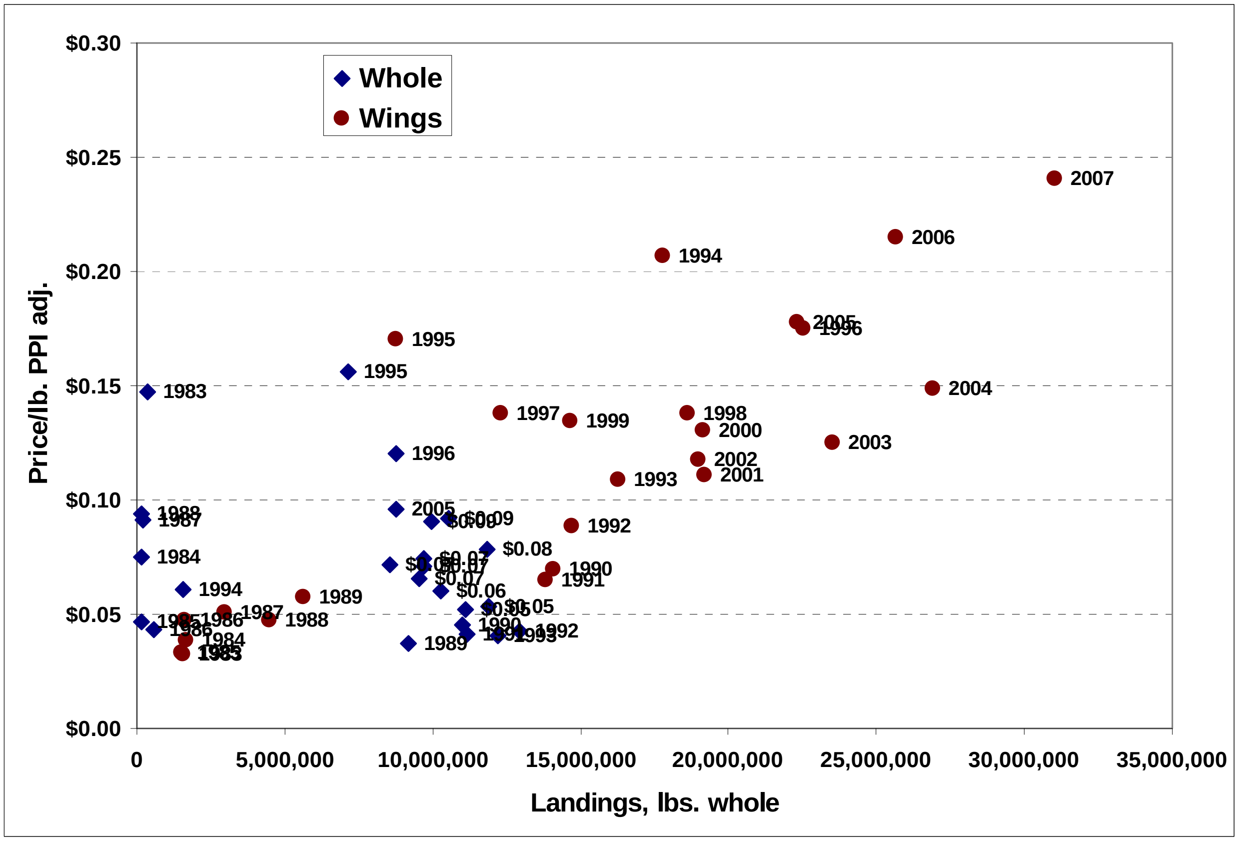
Figure 19 Comparison of Average Skate Wing Prices ($ per pound) by State



More recently, PPI-adjusted prices for skate wings have risen (Figure 20) and landings have risen, partially as a result of the higher prices but also because vessels with DAS allocations have been subject to greater groundfish fishing restrictions. Generally, the prices paid for skate wings has been higher than those paid for whole skates (presumably product quality is better for a food market) and since 2004, prices have been above $0.15 per pound.1 Average skate wing prices in 2007 rose to nearly $0.25 per pound and the 2007 skate wing landings were the highest on record.

PPI-adjusted prices for whole skates, most of which are landed to supply bait to the lobster fishery, have been relatively stable. Except for three years2, whole skate prices have been generally less than $0.10 per pound and annual landings in recent years have been around 10,000,000 lbs.

Figure 20. PPI adjusted annual prices for skate wing and whole skate landings compared to quantity landed (whole weight).



7.4.4.3 Price Models

See Section **Error! Reference source not found.** which analyzes the effects of Amendment 3 alternatives and updates skate price models to estimate producer and consumer surplus.

7.4.4.4 Revenues from Skate Landings

Fishermen in the northeast region earned $3.178 million from skate landings in 1999. Skate wings returned $2.461 million, and revenues in the dealer "unclassified" market category – nearly all skate bait

1 Prices for skate wings are actually higher by a factor of 2.27, but these wing prices have been converted to a whole-weight equivalent to be on the same metric as prices for whole skate landings.
2 The higher prices in 1983, 1995, and 1996 may have been influenced by mis-reported (or erroneously recorded) landings of skate wings.

– were $0.717 million. Dockside skate revenues contributed less than 0.3 percent to total fisheries revenues in the northeast region in 1999.

Revenues from skate landings are reported by state in Figure 21. Rhode Island was the leading skate bait state where fishermen grossed $571 thousand for skate bait, more than all other states combined. Fishermen from Connecticut and New Jersey received an order of magnitude less revenue from skate bait landings – $59 thousand and $50 thousand, respectively. Skate bait revenues were less than $8 thousand in all other states. In contrast, Massachusetts lead all states in skate wings dockside revenues with more than $1.8 million, followed distantly by RI ($196 thousand), NJ ($187 thousand), NY ($129 thousand), and ME ($105 thousand) (Figure 21). Skate wings revenues were less than $25 thousand in all other states.

Figure 21 also reports the relative contribution of skate dockside revenues to total state fishery revenues in 1999. In Rhode Island, the leading skate bait state, total skate revenues (bait and wings) was not quite one percent of total fisheries earnings. In Massachusetts, the leading skate wings state, total skate returns were 0.7 percent of total dockside revenues. Revenues from skate landings amounted to less than 0.25 percent of total fisheries revenues in all other states.

Figure 22 reports the contribution of skate landings to total dockside revenues during 1999 by gear type. Otter trawl fishermen received $2.644 million from skate wings and bait landings – 83 percent of total skate revenues in the region – which amounted to 1.5 percent of total gross returns for this gear. Sink gillnet fishermen were paid $447 thousand for skate landings – 14 percent of total skate revenues – which amounted to one percent of the gear's total earnings in the region. Skate landings contributed less than 0.25 percent to returns from other gear sectors.

The state and gear data were cross-tabulated to more closely examine dependence on skate earnings. Figure 23 shows results for combinations of states and gear types with at least 0.5 percent dependence on skates. Sink gillnet fishermen in New Jersey received 4.3 percent of their total annual revenues from skate landings, followed by line trawl fishermen with 3.9 percent. All other combinations were less than 3 percent dependent on skates landings during 1999, including otter trawl and sink gillnet fishermen in Massachusetts and Rhode Island.

Finally, skate dockside revenues were also investigated by port (Figure 24). Provincetown, Massachusetts received 6.1 percent of its total $3.5 million in dockside revenues from skate landings, followed by Tiverton, Rhode Island with 4.2 percent out of $3.8 million for the entire port. The principal skate ports – Point Judith, RI for bait and New Bedford, MA for wings – obtained 1.1 percent of total fisheries revenues from skate landings.

Figure 21 Contribution of Skate Landings to Total State Fisheries Revenue, 1999

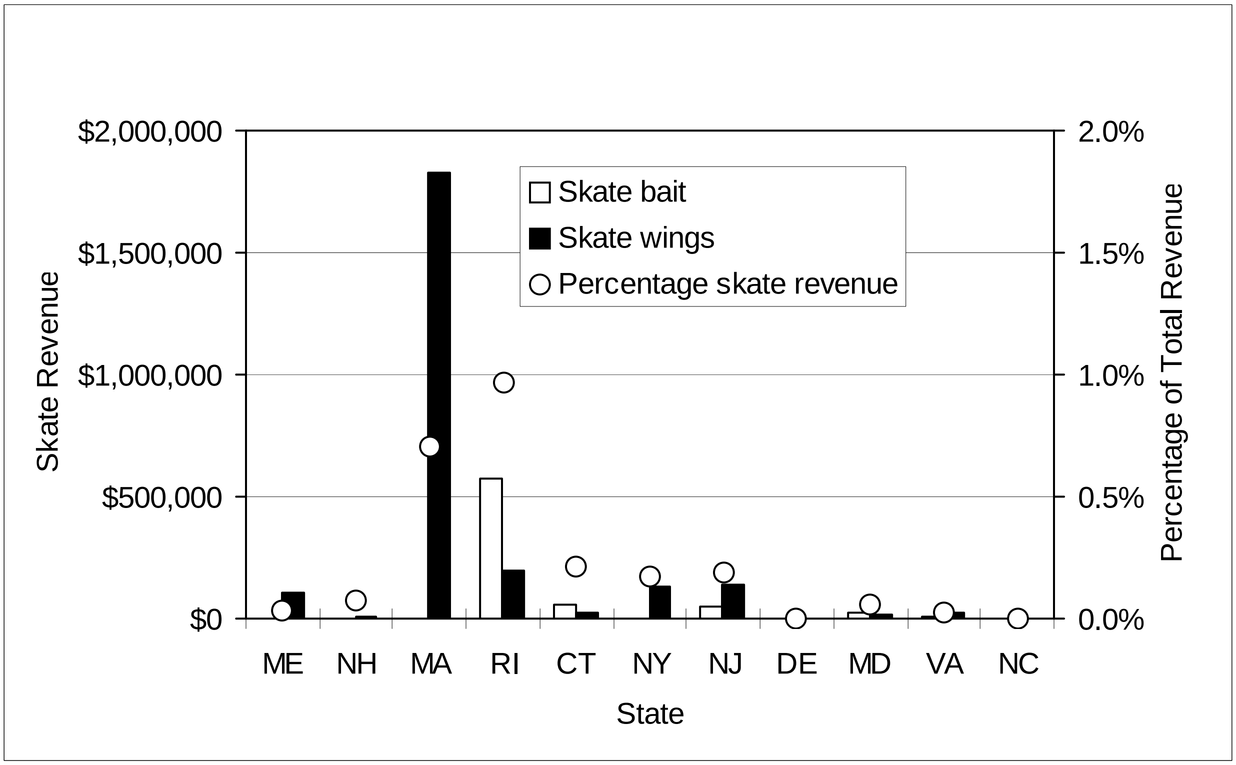


Figure 22 Contribution of Skate Landings to Total Gear Revenue, 1999

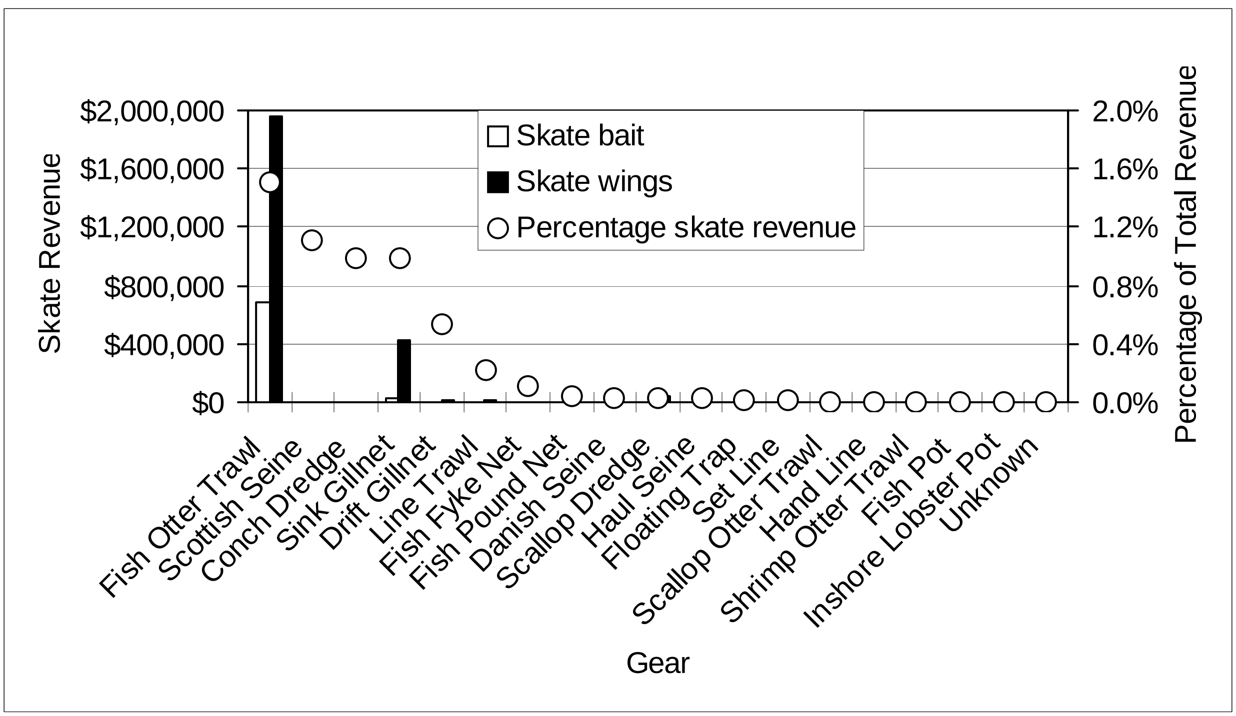


Figure 23 Contribution of Skate Revenues (0.5% or more) to Combinations of Gear and State, 1999

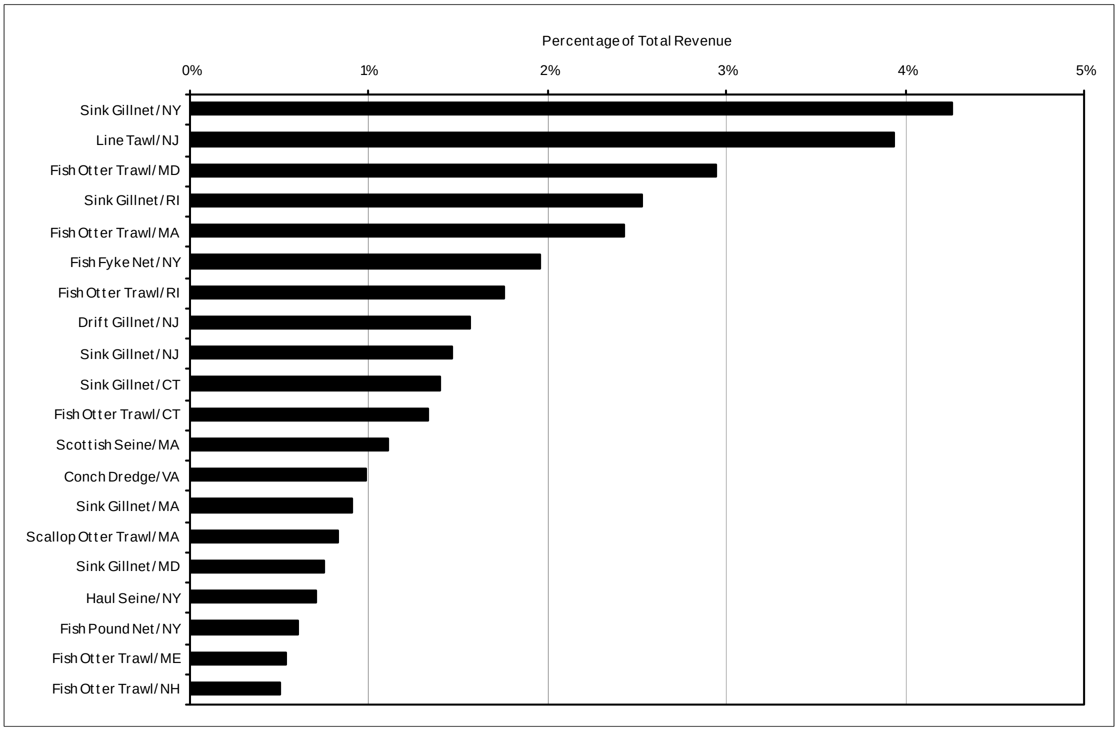
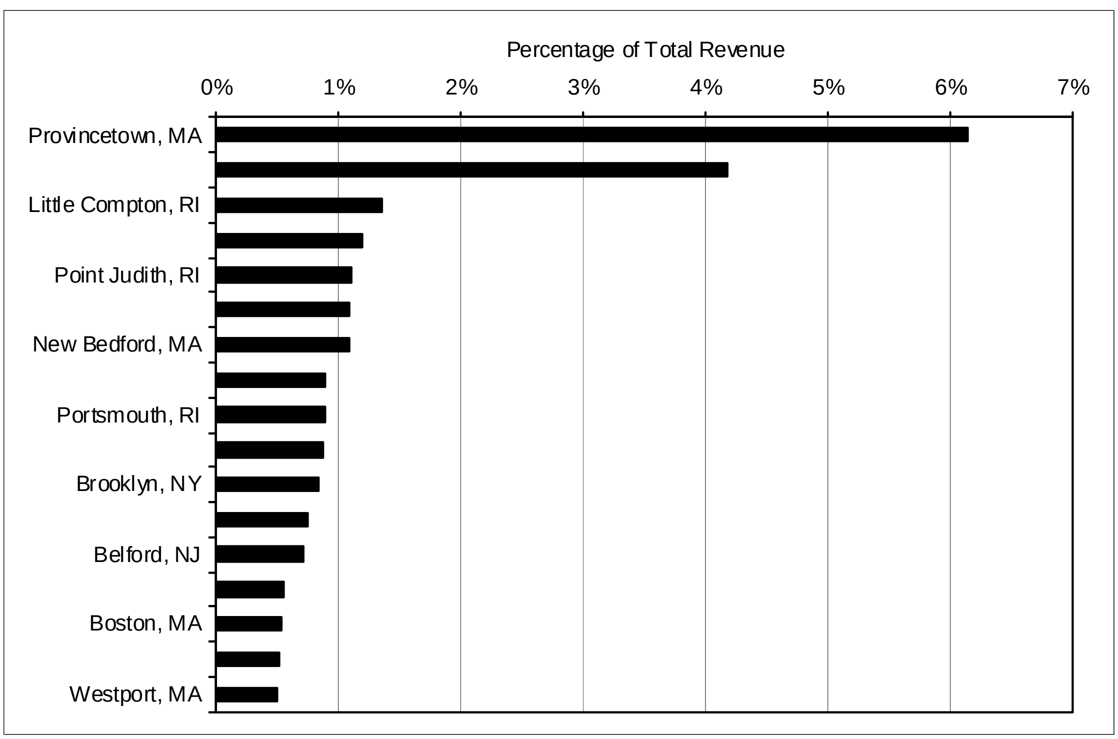


Figure 24 Contribution of Skate Revenues (0.5% or more) to Ports



7.4.5 Skate Vessels

Fishery landings data were investigated for skate landings at the vessel level during 1999. According to the fishermen's logbook source, 817 vessels reported skate landings on 15,500 fishing trips in 1999. The dealer report (so-called "weighout") figures were similar – 802 vessels landing skates on 14,508 trips. The difference between these two sources - 15 vessels and 992 trips - is due to information missing from state General Canvas data at the vessel and trip levels, especially from CT, NY, and NJ.

Vessel and trip counts from dealer data were also made by market category. "Unclassified skates" (primarily skate bait) was landed by 120 vessels on 1,304 trips, and 775 vessels landed skate wings on 13,614 trips. A comparison of these market category results with the combined results reported above indicate that 93 vessels landed both skate bait and wings on 410 trips. As above, vessels aggregated in the state General Canvas reports could not be included.

The vessel and trip counts from 1999 dealer data are separated by ton class in Table 35. About 56 percent of the vessels that landed skate bait or skate wings during 1999 were of ton class 2 size, and these vessels made the most trips. Ton class 3 vessels were also common, especially among vessels that landed skate bait where they comprised 40 percent of both the vessel population and trips. The 72 ton class 4 vessels that landed skate wings comprised over nine percent of the vessel population and less than five percent of trips. Ton class 2 and 3 vessels which landed skate bait averaged 11 trips. In contrast, ton class 2 and 3 vessels which landed skate wings averaged 20 trips and 16 trips, respectively.

Table 35 also contains information related to vessel gross performance (landings and gross revenues before costs). Although ton class 2 vessels were most numerous and took most trips, ton class 3 vessels landed two (wings) to three (bait) times more skates in 1999. Total dockside revenues were likewise greater. In addition, ton class 2 vessels were less productive than ton class 3 vessels. For example, ton class 3 vessels averaged 14.3 thousand pounds of skate bait per trip and $875 per trip compared to 3.3 thousand pounds and $210 by ton class 2 vessels. Similarly, ton class 4 vessels averaged $650 per trip from skate wing landings compared to $350 and $65 by ton class 3 and 2 vessels, respectively. Average revenues per trip were at least 2.5 times greater for skate bait landings than for skate wing landings.

Information in Table 35 also highlights the contribution of skate revenues to total trip and annual revenues. Skate bait landings comprised about 21 percent and 30 percent of total trip revenues for the ton class 2 and 3 vessels, respectively. When total annual fishing activity is considered (all fisheries), the contribution of skate bait drops to about three percent or less for these vessels. From a different standpoint, revenues earned from all trips that landed skate bait (all species on these trips) contributed about ten percent of annual gross returns from all fisheries for both ton classes.

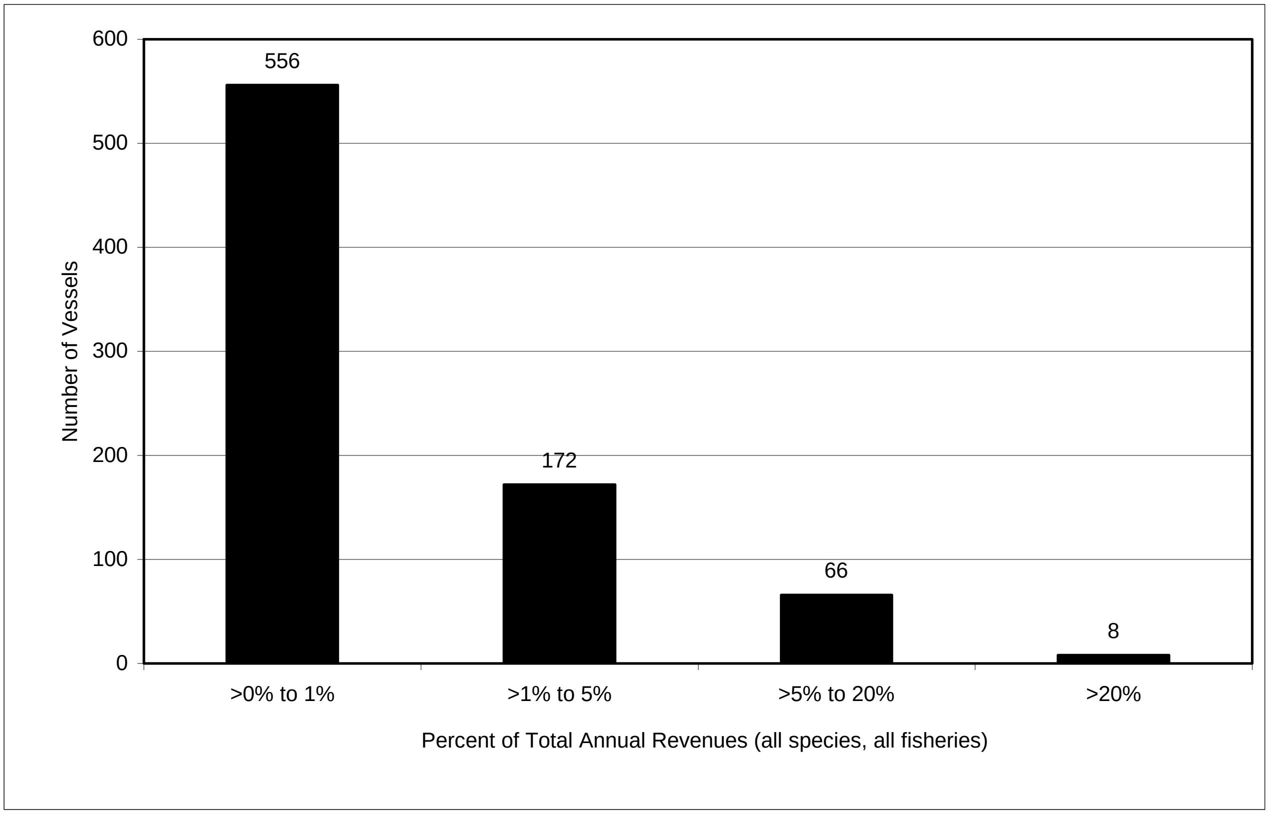
Overall, vessels that land skate wings are less dependent on skate resources for annual revenues (Table 35). Ton class 3 vessels derived 5.5 percent of trip revenues from skate wings compared to about three percent by the ton class 2 and 4 vessels. Once all species are included for the year, the dependence on skate wings drops to less than two percent for each tonnage class. Total revenues from trips that landed skate wings amounted to 28 percent or more of total annual revenues for each ton class.

Figure 25 groups the 802 vessels from the 1999 dealer reports into categories depending on the relative importance of skate revenues to total annual revenues from all species. Nearly 70 percent of these vessels earned one percent or less of total annual revenues from skate bait and wings landings during 1999. In contrast, eight vessels – one percent of total vessels landing skates in 1999 – derived at least 20 percent of gross revenues from skates.

Table 35 Vessel Counts, Trip Counts, and Measures of Economic Importance
**Trips Were Limited To Vessels Identified In The Weighout Data*

Categories	Measure	Tonnage Class			
		1	2	3	4
Trips Landing Bait	Number of vessels	1	68	48	3
	Number of trips	1	766	524	13
	Trips per vessel	-	11	11	4
	Landed weight (M lbs)	-	2.496	7.477	0.021
	Landings per trip (lbs)	-	3260	14,270	1600
	Dockside revenue ($K)	-	$162	$459	$2.5
	Revenue per trip ($)	-	$210	$875	$190
	Revenue per vessel ($)	-	$2380	$9560	$830
	Total trip revenue (all species caught) ($K)	-	$786	$1539	$36
	Skate revenue (% of trip revenues)	-	20.6%	29.8%	6.9%
	Vessels' total annual revenue ($K)	-	$8041	$14,727	$1,568
	Skate revenue (% of annual revenue)	-	2.0%	3.1%	0.2%
	Trip revenues (% of annual revenue)	-	9.8%	10.4%	2.3%
Trips Landing Wings	Number of vessels	1	437	265	72
	Number of trips	1	8838	4137	638
	Trips per vessel	-	20	16	9
	Landed weight (M lbs)	-	1.693	3.636	1.018
	Landings per trip (lbs)	-	190	880	1600
	Dockside revenue ($K)	-	$570	$1437	$414
	Revenue per trip ($)	-	$65	$350	$650
	Revenue per vessel ($)	-	$1300	$5420	$5750
	Total trip revenue (all species caught) ($K)	-	$18,329	$25,968	$14,325
	Skate revenue (% of trip revenues)	-	3.1%	5.5%	2.9%
	Vessels' total annual revenue ($K)	-	$51,443	$87,363	$51,515
	Skate revenue (% of annual revenue)	-	1.1%	1.6%	0.8%
	Skate trip revenue (% of annual revenue)	-	35.6%	29.7%	27.8%
Trips Landing Bait and/or Wings	Number of vessels	1	455	272	74
	Number of trips	1	9446	4410	650
	Landed weight (M lbs)	-	4.189	11.113	1.039
	Dockside revenue ($K)	-	$732	$1896	$416
	Total trip revenue (all species caught) ($K)	-	$18,834	$26,473	$14,357
	Skate revenue (% of trip revenues)	-	3.8%	7.2%	2.9%
	Skate trip revenue (% of annual revenue)	-	1.4%	2.1%	0.8%

Figure 25 Dependence of Individual Vessels (N=802) on Skate Revenues in 1999: Percent of Total Annual Revenues



The results in Table 35 suggest that there is a skate bait fishery but that skate wings are caught primarily in mixed-species fisheries. These possibilities were explored by looking at only a subset of vessels that met the following two arbitrary criteria: (1) landed skate bait (wings) on at least four trips; and (2) skate revenues amounted to at least 25 percent of total trip revenues. These criteria resulted in 21 vessels (mostly ton class 2) that landed skate bait on 699 trips, and 37 different vessels (mostly ton class 3) that landed skate wings on 598 trips. Nineteen of the skate bait vessels used otter trawl gear, and the other two vessels used sink gillnets. Regarding skate wings, 31 vessels used otter trawls, five vessels used gillnets, and one vessel used a sea scallop dredge.

The 21 vessels that presumably targeted skates for bait landed 7.8 million pounds of skates in 1999, or 80 percent of the total skate bait landings by vessels identified in the dealer weighout data. These vessels averaged 33 trips in 1999 (three times more than the total population average). Skate landings (11.1 thousand pounds) and revenues ($680) per trip averaged more than three times more than the population average for ton class 3. (These results are influenced somewhat by the inclusion of six ton class 4 vessels). Skate revenues averaged nearly 50 percent of total trip revenues and 15 percent of total annual revenues for these vessels.

The 37 vessels that presumably targeted skates for wings landed 2.0 million pounds of skate wings, or nearly a third of the total skate bait landings by vessels identified in the dealer weighout data. The average of 16 trips a year did not differ from the population of ton class 2 and 3 vessels, but average skate landings (3.3 thousand pounds) and revenues ($1300) per trip were considerably greater. Skate revenues averaged 44 percent of total trip revenues and six percent of total annual revenues for these vessels.

Other species harvested while on presumed skate trips are summarized in Table 36. In this case, a targeted trip (vis-à-vis vessels that target skates during the year as addressed above) was arbitrarily defined as follows: (1) skate bait landings >=10,000 pounds; and (2) skate wing landings >=4,000 pounds (9,000 pounds live weight). This selection resulted in 317 skate bait trips by 15 vessels, and 304 skate wing trips by 80 vessels.

Skates amounted to 93 percent of total landings, by weight, on the skate bait trips but only 47 percent of trip revenues. Groundfish, monkfish, and summer flounder comprised 49 percent of total revenues one these trips. Skates amounted to 58 percent of total landings on skate wing trips (live-weight basis), but only 17 percent of total trip revenues. Groundfish was the most important source of revenues (69 percent), but monkfish (7 percent) and lobster (6 percent) were also important to the profit margin.

Table 36 Other Species Landed While Targeting Skates
Trips were selected if the following criteria were met: (1) skate bait landings >=10,000 pounds; and (2) skate wing landings >=4,000 pounds (9,000 pounds live weight). This selection resulted in 317 skate bait trips by 15 vessels, and 304 skate wing trips by 80 vessels. Landings are on a live weight basis in thousands of pounds. Revenues are in thousand of dollars.

Species/FMP	Skate Bait Trips		Skate Wings Trips	
	Landings	Revenues	Landings	Revenues
Skates	7773	$479	6266	$1074
Groundfish (10 large mesh species)	191	$215	3890	$4445
Groundfish (3 small mesh species)	35	$8.3	0.1	$0.07
Monkfish	251	$186	535	$466
Summer flounder	41	$97	22	$46
Squid/Mackerel/Butterfish	19	$14	1.7	$1.6
Scup/Black sea bass	6.8	$8.6	0	0
Sea scallop (General Category)	0.8	$0.5	20	15
Lobster	0.4	$1.6	85	$391
Spiny dogfish	0	0	0.01	$0.004
Other	23	$9.7	65	$15

Table 37 provides additional preliminary information on the economic performance of skate bait vessels in Rhode Island. This information was taken from the 1999 vessel logbook data instead of dealer reports because logbooks are the only source of data on crew size and trip length. In order to single out directed trips, the analysis was restricted to trips that landed at least 10,000 pounds of skates (captain's hail weight on logbooks) and were no more than four days long. Revenues were calculated using a $0.06 price per pound.

The (non-random) sample of directed bait trips was partitioned by tonnage class and trip length (Table 37). Day-trips by tonnage class 2 and 3 vessels each averaged 0.5 days, but the larger vessels used one more crew and had greater horsepower. As a consequence, skate landings and revenues were greater on overnight trips which averaged at least two days. However, catch and revenues per unit effort were at least twice as large on day-trips. Trip expenses such as fuel need to be factored in before the profitability of trip lengths can be assessed.

The data summarized in Table 37 were also used to estimate a preliminary trip production function for vessels targeting skate bait. The Cobb-Douglas algebraic form – i.e.,
$Q = aL^bK^c$, where L is labor, K is capital, and lower case letters are parameters that need to be estimated – was selected because of its familiarity. This form is linear in the parameters when transformed by natural logarithms. Trip landings were regressed on fishing effort, crew, and horsepower. Know that crew size

was increased by one for all records because the natural logarithm of crew size when crew is equal to one is undefined. These data were from only 1999, but a longer time series would also require specification of skate stock size (i.e., natural capital).

Table 37 Vessel Characteristics and Gross Performance of RI Vessels that Targeted Skate Bait During 1999

Data are from vessel logbooks. Values other than number of vessels and trips are averages. CPUE is skate landings per unit effort (i.e., day-at-sea), and RPUE is skate revenue per unit effort.

Variable	Tonnage Class 2 (5-50 GRT)		Tonnage Class 3 (51-150 GRT)	
	Trip <=1 Day	Trip >1 to 4 Days	Trip <=1 Day	Trip >1 to 4 Days
Number of vessels	6	5	6	7
Number of trips	185	33	239	115
Effort (days-at-sea)	0.5	2.4	0.5	2.0
Landings (hail weight in pounds)	8166	13,492	16,091	33,110
CPUE	15,457	6055	34,892	16,919
Revenues	$491	$810	$965	$1987
RPUE	$927	$363	$2094	$1015
Skate as percentage of total trip landings	97%	93%	96%	93%
Crew size	1.9	1.7	2.7	2.9
Horsepower	271	293	545	425
Gross registered tons	26	21	93	93

The estimated skate bait trip production model is reported in Table 38. More than 50 percent of the variation in trip landings is explained by this model (R^2=0.53). Much of the remaining variation probably could be explained by captain skill and within year changes in stock size and fish size. Each input is a significant determinant of landings. There appear to be diminishing returns to effort. That is, a one percent change in effort results in less than a one percent change in landings. In contrast, the crew size and horsepower parameters are about equal to one, which suggests that landings change in equal proportions. The potential effects of multicollinearity on parameter estimates should be investigated before this model is used to predict the effects of these inputs on landings, however.

Similar production functions were not estimated for mixed species trips that landed skate bait or wings because this requires specifying more complex models with joint outputs. That is, substantial quantities of species other than skates are landed on other trips.

7.4.5.1 Skate Dealers

Nearly three-quarters of the 522 dealers who bought raw fish from fishermen in the northeast region in 1999 did not purchase skate landings. Skates amounted to one percent or less of total expenditures for raw fish by 104 dealers (Figure 26). In contrast, payments for skate landings amounted to at least five percent of total dockside purchases for 11 dealers from MA (8), RI (2) and NY (1). Three of these dealers were at least 20% dependent on skates for their total dockside purchases in 1999. Dealers that are not specifically identified in the General Canvas reports from some states (e.g., CT) are not included in these totals.

Table 38 Preliminary Regression Model of Skate Bait Landings on Targeted Trips by RI Trawl Vessels, 1999

The regression (F-statistic) and parameters (t-statistic) are significant at the 99 percent level of confidence. The dependent (landings) and independent (production inputs) are natural log transformed. Some trips had only one crew which has an undefined logarithm; there, 1 was added to all values of crew. The regression (F-statistic) and parameters (t-statistic) are significant at the 99 percent level of confidence.

Regressor	Parameter Estimate	t-statistic	N	F-statistic	R^2
Intercept	3.012	7.067	572	214.22	0.53
Effort (days-at-sea)	0.574	15.58			
Crew (value plus 1)	1.157	7.26			
Horsepower	0.868	9.93			

7.4.5.2 Processors

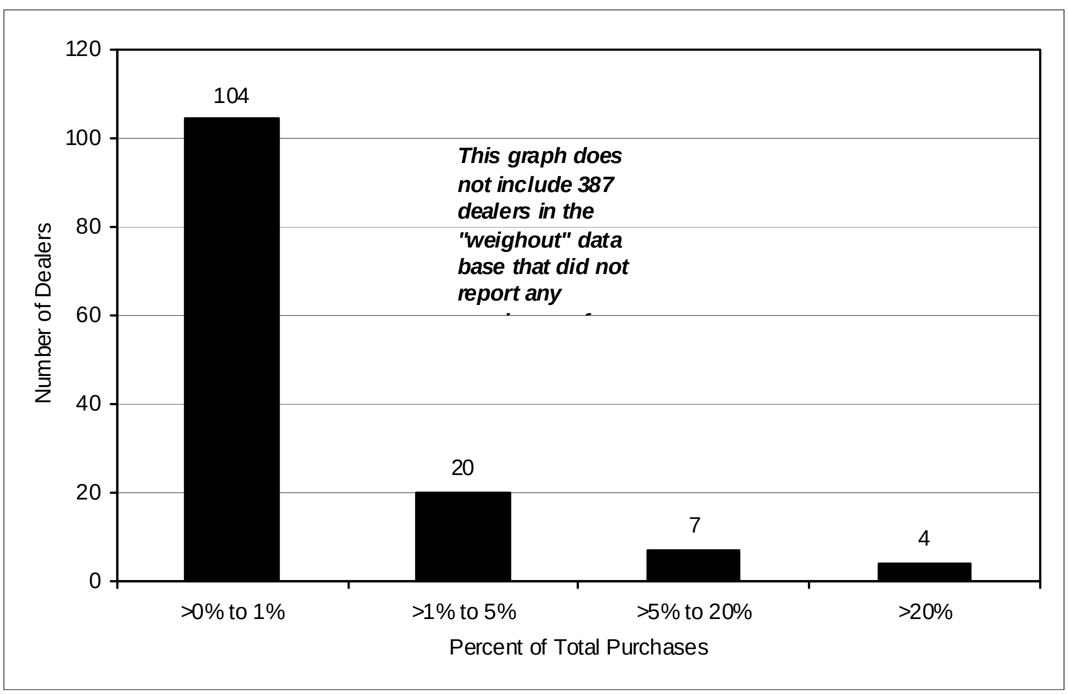
Current information about skate processors is presented in Section 7.4.2 of this document.

Nine processors from MA, RI, NY, and NH reported processing 3.9 million pounds of unspecified skate wings in 1999. No further description of product form is available (e.g., whether frozen or fresh). Sales amounted to $3.2 million, for an average price of $0.81. These firms employ approximately 514 workers.

7.4.5.3 International Trade

The U.S. Customs Bureau and U.S. Census do not report separate trade statistics for skate products.

Figure 26 Dependence of Individual Dealers on Skate Landings: Percent of Total Purchases of Raw Fish



SOCIAL AFFECTED HUMAN ENVIRONMENT

Vessels by Homeport and Owner's Residence

When applying for a permit the vessel owner must identify a "Homeport" for the vessel, theoretically the port where their vessel is primarily docked when not at sea. Further, the vessel owner must his or her home address. There are 62 towns with 10 or more permits in one or both of these categories. Of these, 14 towns (in italics) have 30 or more permits listing it as either homeport or town of owner's residence. Only 9 (also in bold) have 50 or more permits. These are, in descending order of number of permits, New Bedford (261 & 207) and Gloucester (210 & 152), MA; Cape May, NJ (170 & 89); Point Judith/Narragansett, RI (124 & 27); Montauk, NY (111 & 72); Chatham, MA (85 & 29); Barnegat Light/Long Beach, NJ (75 & 36); Portland, ME (63 & 31); Point Pleasant/Point Pleasant Beach, NJ (55 & 20); and Ocean City/West Ocean City (50 & 6).

When examined as a percent of all skate permits only these nine plus Hampton Bays/Shinnecock have at least 2% of all skate permits either as homeport or as residence. Only four ports have at least 5%: New Bedford and Gloucester, MA; Cape May, NJ and Point Judith/Narragansett, RI. It is interesting that Cape May has so many permits, as it has a relatively low level of landings (see Table below). Ocean City also has a very low level of landings.

Table 39. All Towns listed on 10 or more Northeast Skate Permits as Homeport or Owner's Residence for 2007

ST	CITY	HOMEPORT	RESIDENCE	% HOMEPRT of ALL SKT Permits	% RESIDENCE OF ALL SKT PERMITS
MA	**New Bedford**	**261**	**207**	***9.72%***	***7.71%***
MA	**Gloucester**	**210**	**152**	***7.82%***	***5.66%***
NJ	**Cape May**	**170**	**89**	***6.33%***	***3.31%***
RI	**Point Judith/Narragansett**	**124**	**27**	***4.62%***	***1.01%***
NY	**Montauk**	**111**	**72**	***4.13%***	***2.68%***
MA	**Chatham**	**85**	**29**	***3.17%***	***1.08%***
NJ	**Barnegat Light/Long Beach**	**75**	**36**	***2.79%***	***1.34%***
ME	**Portland**	**63**	**31**	***2.35%***	***1.15%***
NJ	**Point Pleasant/Point Pleasant Beach**	**55**	**20**	***2.05%***	***0.74%***
MD	**Ocean City/West Ocean City**	**50**	**6**	***1.86%***	***0.22%***
NY	*Hampton Bays/Shinnecock*	*41*	*23*	1.53%	0.86%
MA	Boston	38		1.42%	0.00%
NH	Portsmouth	37	11	1.38%	0.41%
VA	Newport News	34	12	1.27%	0.45%
MA	Scituate	30	23	1.12%	0.86%
NC	Wanchese	29	17	1.08%	0.63%
RI	Newport	28	16	1.04%	0.60%
NH	Seabrook	27	21	1.01%	0.78%
MA	Plymouth	27	18	1.01%	0.67%
NJ	Belford/Middletown	27	7	1.01%	0.26%
MA	Fairhaven	26	36	0.97%	1.34%

ST	CITY	HOMEPORT	RESIDENCE	% HOMEPRT of ALL SKT Permits	% RESIDENCE OF ALL SKT PERMITS
MA	Provincetown	22	11	0.82%	0.41%
MA	Newburyport	21	8	0.78%	0.30%
NH	Rye	20	16	0.74%	0.60%
MA	Harwich	19	22	0.71%	0.82%
CT	New London	19	0	0.71%	0.00%
VA	Chincoteague	18	6	0.67%	0.22%
VA	Hampton	17	15	0.63%	0.56%
NC	Beaufort	17	8	0.63%	0.30%
NJ	Port Norris	16	8	0.60%	0.30%
NJ	Sea Isle City	16	5	0.60%	0.19%
NJ	Atlantic Beach	16		0.60%	0.00%
NC	Oriental	14	16	0.52%	0.60%
NH	Hampton	14	16	0.52%	0.60%
NC	New Bern	14	14	0.52%	0.52%
MA	Marshfield	14	11	0.52%	0.41%
NY	New York	14		0.52%	0.00%
ME	Harpswell	13	20	0.48%	0.74%
VA	Virginia Beach	13	14	0.48%	0.52%
NY	Freeport	13	10	0.48%	0.37%
MA	Green Harbor	13		0.48%	0.00%
MA	Rockport	12	13	0.45%	0.48%
VA	Seaford	12	13	0.45%	0.48%
MA	Westport	11	14	0.41%	0.52%
NH	Newington	11	12	0.41%	0.45%
NC	Lowland	11	11	0.41%	0.41%
MA	South Bristol	11	10	0.41%	0.37%
MA	Sandwich	11		0.41%	0.00%
ME	Bremen	10	9	0.37%	0.34%
CT	Noank	10		0.37%	0.00%
NC	Engelhard	10		0.37%	0.00%
RI	Little Compton	7	13	0.26%	0.48%
RI	Wakefield		55	0.00%	2.05%
RI	Charlestown		20	0.00%	0.74%
NJ	Cape May Courthouse		17	0.00%	0.63%
MA	Manchester		15	0.00%	0.56%
MA	West Chatham		15	0.00%	0.56%
MD	Berlin		15	0.00%	0.56%
MA	South Chatham		14	0.00%	0.52%
NJ	West Creek		13	0.00%	0.48%
NJ	Brick		12	0.00%	0.45%
NJ	North Cape May		11	0.00%	0.41%

Other Permits Held by Skate Permit Holders

In 2007 there were 2,685 vessels with a Skate Permit. Of these, most held permits in a variety of other Northeast fisheries. This is actually a common pattern for all Northeast vessels, which typically hold permits even in fisheries in which they are not active. The most common other permits held were Bluefish, Multispecies, Dogfish and Monkfish.

Bluefish were solidly category 1 (2,123) - Commercial. Most lobster permits (1002) were in category 1 – Commercial, Non-Trap. Multispecies permits were primarily in category A (992) - DAS - and category HB (704) – Open Access Handgear. There is only one dogfish category – General. Monkfish were 75% in category E (1,691) – Incidental Catch. Looking at other permits held, Scallop permits were primarily in categories 1A (1102) – General Category with no VMS and 1B (786) General Category with VMS. SMB permits were primarily in the Atlantic Mackerel (2,066 permits) and Squid/Butterfish Incidental Catch (1,829 permits) categories. Two thirds of Summer Flounder permits were in category 1 (881) – Commercial Moratorium. Black Sea Bass were primarily in category 1 (740) – Commercial Moratorium, as were Scup (744). Over 80% of Herring permits were in category 2 (1,688) – Open Access, will catch under 500mt. For Skate, 99% were category D (2019) Incidental Catch. Red Crab were almost entirely category A (1,603) – Open Access.

Table 40. Other Permits Held by the 2,685 Vessels with Skate Permits in 2007

Multi-species	Monk fish	Dog fish	Blue fish	Squid/ Mackerel/ Butter fish	Scallop	Skate	Red Crab	Lobster	Summer Flounder	Black Sea Bass	Scup	Her-ring
2438	2413	2443	2530	2401	2208	2041	1605	1445	1279	1101	1102	2072

Commercial Ports of Landing

There are a total of 88 ports where skate was landed in 2007. They include ports from all states in the Northeast plus North Carolina.

Table 41. All Ports Landing Skates in 2007

ST	CNTY	PORT
CT	MIDDLESEX	OLD SAYBROOK
CT	NEW HAVEN	BRANFORD
CT	NEW HAVEN	GUILFORD
CT	NEW LONDON	EAST LYME
CT	NEW LONDON	NEW LONDON
CT	NEW LONDON	NOANK
CT	NEW LONDON	STONINGTON
CT	NEW LONDON	WATERFORD
DE	SUSSEX	INDIAN RIVER
DE	SUSSEX	MISPILLION
MA	BARNSTABLE	CHATHAM
MA	BARNSTABLE	DENNIS
MA	BARNSTABLE	FALMOUTH
MA	BARNSTABLE	HARWICHPORT
MA	BARNSTABLE	HYANNISPORT

ST	CNTY	PORT
MA	BARNSTABLE	ORLEANS
MA	BARNSTABLE	OTHER BARNSTABLE
MA	BARNSTABLE	PROVINCETOWN
MA	BARNSTABLE	SANDWICH
MA	BARNSTABLE	WOODS HOLE
MA	BRISTOL	FAIRHAVEN
MA	BRISTOL	FALL RIVER
MA	BRISTOL	NEW BEDFORD
MA	BRISTOL	WESTPORT
MA	ESSEX	GLOUCESTER
MA	ESSEX	NEWBURYPORT
MA	ESSEX	ROCKPORT
MA	MIDDLESEX	CAMBRIDGE
MA	PLYMOUTH	MARSHFIELD
MA	PLYMOUTH	OTHER PLYMOUTH
MA	PLYMOUTH	PLYMOUTH
MA	PLYMOUTH	SCITUATE
MA	SUFFOLK	BOSTON
MD	NOT-SPECIFIED	OTHER MARYLAND
MD	WORCESTER	OCEAN CITY
ME	CUMBERLAND	PORTLAND
NC	CARTERET	BEAUFORT
NC	DARE	HATTERAS
NC	DARE	WANCHESE
NC	HYDE	ENGELHARD
NC	HYDE	OCRACOKE
NC	PAMLICO	ORIENTAL
NH	ROCKINGHAM	PORTSMOUTH
NH	ROCKINGHAM	RYE
NH	ROCKINGHAM	SEABROOK
NJ	CAPE MAY	AVALON
NJ	CAPE MAY	CAPE MAY
NJ	CAPE MAY	SEA ISLE CITY
NJ	MONMOUTH	BELFORD
NJ	OCEAN	BARNEGAT
NJ	OCEAN	BARNEGAT LIGHT/LONG BEACH
NJ	OCEAN	POINT PLEASANT
NJ	OCEAN	WARETOWN
NY	NASSAU	FREEPORT
NY	NASSAU	POINT LOOKOUT
NY	SUFFOLK	AMAGANSETT
NY	SUFFOLK	CENTER MORICHES
NY	SUFFOLK	GREENPORT
NY	SUFFOLK	HAMPTON BAYS
NY	SUFFOLK	ISLIP
NY	SUFFOLK	MATTITUCK
NY	SUFFOLK	MONTAUK
NY	SUFFOLK	OTHER SUFFOLK
NY	SUFFOLK	SHINNECOCK

ST	CNTY	PORT
NY	SUFFOLK	WAINSCOTT
RI	NEWPORT	LITTLE COMPTON
RI	NEWPORT	NEWPORT
RI	NEWPORT	OTHER NEWPORT
RI	NEWPORT	TIVERTON
RI	WASHINGTON	CHARLESTOWN
RI	WASHINGTON	POINT JUDITH
RI	WASHINGTON	SOUTH KINGSTOWN
RI	WASHINGTON	WESTERLEY
VA	ACCOMACK	ACCOMAC
VA	ACCOMACK	CHINCOTEAGUE
VA	ACCOMACK	WACHAPREAGUE
VA	CITY OF HAMPTON	HAMPTON
VA	CITY OF HAMPTON	OTHER CITY OF HAMPTON
VA	CITY OF NEWPORT NEWS	NEWPORT NEWS
VA	CITY OF NORFOLK	NORFOLK
VA	CITY OF VIRGINIA BEACH	VIRGINIA BEACH/LYNNHAVEN
VA	GLOUCESTER	OTHER GLOUCESTER
VA	LANCASTER	OTHER LANCASTER
VA	MATHEWS	MATHEWS
VA	MIDDLESEX	OTHER MIDDLESEX
VA	NORTHAMPTON	CAPE CHARLES
VA	NORTHAMPTON	OTHER NORTHAMPTON
VA	NORTHUMBERLAND	OTHER NORTHUMBERLAND

There are several ways to present landings data to show different kinds of importance of skate to communities. Three tables below illustrate importance due to total levels of revenue and landings versus importance due to percent of skate revenue and landings relative to all commercial revenue and landings by port.

Only 31 ports (32 if you include the port of "Other Suffolk, NY") receive at least $10,000 per year from skate; only 9 ports receive at least $100,000 per year. In descending order of revenue received these are: New Bedford, MA; Chatham, MA; Point Judith, RI; Boston, MA; Tiverton, RI; Newport, RI; Barnegat Light/Long Beach, NJ; Gloucester, MA and Provincetown, MA (in bold).

There are 34 ports (37 if you include the three "Other something" ports) that landed at least 10,000lbs of skate; 15 ports landed at least 100,000lbs. In descending order of pounds landed they are: New Bedford, MA; Point Judith, RI; Chatham, MA; Tiverton, RI; Newport, RI; Boston, MA; Stonington, CT; Sea Isle City, NJ; Barnegat Light/Long Beach, NJ; Gloucester, MA; Hampton Bays, NY; Provincetown, MA; Fall River, MA; Belford, NJ and Montauk, NY (in italics).

Table 42. Top skate ports by value and pounds: Ports with at least $10,000 or 10,000lbs of skate in 2007

ST	CNTY	PORT	SKTVAL	SKLBS
MA	***BRISTOL***	***NEW BEDFORD***	***$4,869,521***	***10,179,163***
MA	***BARNSTABLE***	***CHATHAM***	***$1,550,200***	***3,101,339***
RI	***WASHINGTON***	***POINT JUDITH***	***$658,754***	***4,841,657***

ST	CNTY	PORT	SKTVAL	SKLBS
MA	***SUFFOLK***	***BOSTON***	***$294,610***	***497,194***
RI	***NEWPORT***	***TIVERTON***	***$239,485***	***2,632,083***
RI	***NEWPORT***	***NEWPORT***	***$179,018***	***925,977***
NJ	***OCEAN***	***BARNEGAT LIGHT/LONG BEACH***	***$158,096***	***210,091***
MA	***ESSEX***	***GLOUCESTER***	***$107,764***	***205,707***
MA	***BARNSTABLE***	***PROVINCETOWN***	***$103,502***	***166,160***
NY	*SUFFOLK*	*HAMPTON BAYS*	*$92,426*	*167,340*
NJ	OCEAN	POINT PLEASANT	$59,587	97,608
NJ	*MONMOUTH*	*BELFORD*	*$57,748*	*106,536*
NY	*SUFFOLK*	*MONTAUK*	*$56,364*	*101,295*
MA	PLYMOUTH	SCITUATE	$47,130	82,957
CT	*NEW LONDON*	*STONINGTON*	*$46,406*	*441,302*
NJ	*CAPE MAY*	*SEA ISLE CITY*	*$36,357*	*300,445*
RI	NEWPORT	LITTLE COMPTON	$36,267	75,243
VA	ACCOMACK	ACCOMAC	$31,389	24,128
VA	CITY OF VIRGINIA BEACH	VIRGINIA BEACH/LYNNHAVEN	$20,023	12,537
VA	ACCOMACK	CHINCOTEAGUE	$18,078	45,794
MA	BARNSTABLE	SANDWICH	$17,557	42,644
ME	CUMBERLAND	PORTLAND	$16,794	28,990
NY	SUFFOLK	CENTER MORICHES	$16,721	33,883
NJ	CAPE MAY	CAPE MAY	$14,960	91,715
MA	BRISTOL	WESTPORT	$14,388	32,515
MA	PLYMOUTH	OTHER PLYMOUTH	$13,897	24,425
NJ	CAPE MAY	AVALON	$13,733	17,459
NY	SUFFOLK	ISLIP	$13,376	18,278
MA	PLYMOUTH	PLYMOUTH	$11,943	35,952
MA	*BRISTOL*	*FALL RIVER*	*$11,270*	*124,220*
NY	SUFFOLK	OTHER SUFFOLK	$10,657	18,259
NY	SUFFOLK	SHINNECOCK	$8,598	16,578
CT	NEW LONDON	NEW LONDON	$7,872	44,808
MD	NOT-SPECIFIED	OTHER MARYLAND	$7,758	19,872
RI	NEWPORT	OTHER NEWPORT	$6,937	10,005
VA	CITY OF HAMPTON	HAMPTON*	$5,665	3,793
VA	ACCOMACK	WACHAPREAGUE	$5,264	20,712
MD	WORCESTER	OCEAN CITY	$5,027	10,309

*Included because it is noted in the economic analyses, even though it does not reach either $10,000 or 10,000lbs.

In terms of actual value or pound dependence, a slightly different picture emerges. Some of the ports with the highest levels of skate landings also have very high levels of other landings and so are only minimally dependent on skate in terms of their importance relative to total landed pounds or revenue. Only 3 ports depend on skate for at least 10% of their revenue. Here Center Moriches, NY - which has low total skate landings and low landings overall – appears as more dependent on skate than some of the larger landings ports. Only 9 ports depend on skate for at least 10% of their pounds landed. Here Center Moriches appears again, as well as Cambridge, MA – which lands under 100lbs of skate and under 500 lbs of any fish and thus is technically highly dependent but in actual fact does not rely on skate to maintain its economy.

However, it is interesting to note that Chatham and Tiverton, which are among the top skate ports by actual revenue and pounds are also among the highly dependent ports. And Point Judith, Newport and Provincetown which have high levels of landings and revenue are dependent by pounds landed. This means, too, that the counties of Barnstable, MA and Washington, RI each have 2 dependent ports. For RI the addition of neighboring Newport County is also notable.

Table 43. Top skate ports by value dependence

ST	CNTY	PORT	SKTVAL/TOTVAL	SKTLBS/TOTLBS
RI	NEWPORT	TIVERTON	33%	89%
MA	BARNSTABLE	CHATHAM	11%	37%
NY	SUFFOLK	CENTER MORICHES	10%	26%

Table 44. Top skate ports by pounds landed dependence

ST	CNTY	PORT	SKTVAL/TOTVAL	SKTLBS/TOTLBS
RI	NEWPORT	TIVERTON	33%	89%
MA	BARNSTABLE	CHATHAM	11%	37%
NJ	CAPE MAY	SEA ISLE CITY	2%	36%
NY	SUFFOLK	CENTER MORICHES	10%	26%
CT	NEW LONDON	STONINGTON	1%	16%
MA	MIDDLESEX	CAMBRIDGE	2%	14%
RI	WASHINGTON	POINT JUDITH	2%	14%
MA	BARNSTABLE	PROVINCETOWN	3%	12%
RI	NEWPORT	NEWPORT	1%	11%

Census Data for Top Skate Ports

The communities, then, for which profiles will be provided in Appendix I, Document 15 are: Boston, New Bedford, Gloucester, Provincetown, Chatham and Fall River, MA; Stonington, CT; Tiverton, Point Judith, Little Compton and Newport, RI; Montauk and Hampton Bays/Shinnecock, NY; Belford/Middleton, Barnegat Light/Long Beach, Sea Isle City, Cape May, and Point Pleasant/Point Pleasant Beach, NJ and Portland, ME. In addition, a profile will be added for Virginia Beach, VA as a result of the Economic analysis. As can be seen in Table 45, levels of occupations in fishing farming and forestry vary widely, as do levels of families in poverty and of education. Communities with higher dependence on fishing, higher poverty and lower educational level are generally more at risk, though these factors must also be considered in relation to relative dependence specifically on skate.

These and other census data can be found in the port profiles in Appendix I, Document 15, where they are placed in greater context. Here they are order by descending percentage of occupations in farming, fishing and forestry relative to all occupations. It should be kept in mind, however, that fishermen may be undercounted due to being listed as self-employed. The top three communities for percent occupations in farming, fishing and forestry are Long Beach/Barnegat Light, NJ; Montauk, NY and Chatham, MA. These are, of course, all species and gears and cannot be broken out to show skate only. The three communities with the highest percentages of families in poverty are New Bedford, Boston and Fall River, MA. The three communities with the lowest total population are Chatham, MA; Sea Isle City, NJ and Provincetown, MA. The three communities with the lowest percentage of persons age 25 or over who have graduated at least high school are Fall River and Boston, MA and Tiverton, RI. The three communities with the highest unemployment levels are Montauk and Hampton Bays/Shinnecock, NY and Gloucester, MA.

Of the top three ports by total landings and pounds (New Bedford, Chatham and Point Judith), Chatham has the highest level of occupational dependence, while New Bedford has the highest poverty level and lowest level of education. Of the three top ports by pounds and dollar dependence (Tiverton, Chatham and Sea Isle City), Chatham has the highest level of occupational dependence while Sea Isle City has the highest level of poverty and Tiverton has the lowest level of education.

Table 45. Selected census variables for profiled communities

ST	Port Community	Median cost of a home	Occupations in farming, fishing and forestry*	Median household income	Families in poverty	Total pop.	Median Age	Pop. (25 or over) High School Graduate or Higher	% Pop. Over 16 In Labor Force and Unemployed
ME	*Portland*	$121,200	7.10%	$48,763	9.20%	64,257	35.7	88.30%	3.30%
NJ	*Long Beach/ Barnegat Light*	$334,400/ $299,400	None*/ 6.50%	$48,697/ $52,361	3.8%/ 2.60%	3,329/ 764	57.3/ 54.9	92.0%/ 92.10%	2.3%/ 1.20%
NY	*Montauk*	$290,400	6.10%	$42,329	8.30%	3,851	39.3	84.00%	7.70%
MA	*Chatham*	$372,900	3.60%	$47,037	0.90%	1,667	53.3	89.90%	2.00%
NJ	*Point Pleasant/ Point Pleasant Beach*	$160,100/ $223,600	0.3%/ 2.60%	$55,987/ $51,105	2.00%/ 5.00%	19,366/ 5,112	39.4/ 42.6	88.50%/ 87.10%	2.50%/ 3.10%
NJ	*Belford/ Middletown*+	$146,000/ $210,700	2.3%/ 0.20%	$66,964/ $75,566	1.3%/ 1.90%	1,340/ 66,327	35.8/ 38.8	89.7%/ 90.70%	2.20% 2.20%
RI	*Little Compton*	$228,200	2.10%	$55,368	3.70%	3,593	43.5	91.00%	2.00%
MA	*Gloucester*	$204,600	2.00%	$47,722	7.10%	30,273	40.2	85.70%	3.20%
NY	*Hampton Bays/ Shinnecock*#	$178,000	1.70%	$50,161	6.70%	12,236	38.8	86.60%	3.40%
RI	*Point Judith/ Narragansett*#	$195,500	1.60%	$39,918	8.80%	3,671	44.5	87.50%	2.20%
MA	*Provincetown*	$333,100	1.00%	$32,731	8.70%	3,192	45.4	85.10%	13.10%
MA	*New Bedford*	$113,500	1.00%	$27,569	17.30%	93,768	35.9	57.60%	5.00%
RI	*Newport*	$161,700	0.60%	$40,669	12.90%	26,475	34.9	87.00%	4.70%
RI	*Tiverton*	$144,400	0.60%	$49,977	2.90%	15,260	40.8	79.50%	3.40%
NJ	*Cape May*	$212,900	0.40%	$33,462	7.70%	4,668	47.4	87.60%	3.80%
ME	*Portland*	$121.20	0.40%	$48,763	9.20%	64,257	35.7	88.30%	3.30%
CT	*Stonington*	$168,200	0.30%	$52,437	2.90%	17,906	41.7	88.20%	2.00%
MA	*Fall River*	$132,900	0.30%	$29,014	14.00%	91,938	35.7	56.60%	4.10%
VA	*Hampton*	$91,100	0.30%	$39,532	8.80%	146,437	34	85.50%	3.70%
MA	*Boston*	$190,600	0.10%	$39,629	15.30%	589,141	31.1	78.90%	4.60%
NJ	*Sea Isle City*	$280,100	None*	$45,708	6.40%	2,835	51.3	85.20%	3.70%

***** The census is known to undercount those employed in fishing. Further, fishing data are unavailable as a unique category due to confidentiality issues. Finally, those who fish out of this community may not live there.
+ These communities have two sets of census data, though socially and in terms of fishing they are best treated as a single community. For example, in some cases fish are landed in one area but fishermen live in the other, or sometimes one houses the majority of the recreational fishing and the other the majority of commercial fishing.
# These communities include a port of landing for which no census data are available plus census data for the

smallest census unit which encompasses the port.

Skate Dealers

There were 195 skate dealers in 2007. The vast majority (156) depended on skate for only 0-5% of the ex-vessel value of all species they bought, though there were 4 dealers that depended on skate for 95-100% of this value. The absolute amount of this percentage varied widely, however, with the largest group of dealers (56) reporting an ex-vessel value of $100,000 to $500,000 for skate and groups of 20-30 vessels reporting anywhere from $1,000 to $10,000 and $1,000,000 to $5,000,000.

Table 46. Federally permitted dealer dependence on skate in 2007

Percentage Level of Dependence	Number of Dealers	Absolute Level of Dependence	Number of Dealers
0-5%	156	$0-100	0
6-10%	12	$101-1000	4
11-15%	7	$1001-10,000	25
16-20%	4	$10,001-50,000	21
21-25%	3	$50,001-$100,000	30
26-30%	1	$100,001-500,000	56
31-35%	0	$500,001-1,000,000	17
36-40%	1	$1,000,001-5,000,000	28
41-45%	0	$5,000,001-$10,000,000	5
46-50%	0		
51-55%	2		
56-60%	1		
61-65%	1		
66-70%	2		
71-75%	0		
76-80%	0		
81-85%	1		
86-90%	0		
91-95%	0		
96-100%	4		
TOTAL	195		186

There were 55 ports where dealers bought skate (57 if you count the "Other something" ports). Of these only 4 had 10 or more dealers: Hampton Bays/Shinnecock, NY (20), Montauk, NY (17), Point Judith, RI (15), and New Bedford, MA (12). An additional 7 had at least 5 dealers: Chatham, Provincetown and Gloucester, MA; Little Compton and Newport, RI (6 each), Scituate, MA and Mattituck, NY (5 each). Here the total number of dealers may exceed 195, as some dealers buy in multiple ports. On factor to note in regard to the large number of dealers in Montauk is that many individual vessel owners have acquired dealers permits in order to sell skate as bait to local lobster and whelk fishermen3.

3 Pers. Comm.. from Victor Vecchio, NMFS Port Agent in East Hampton, NY.

Table 47. Federally permitted dealer dependence on skate in 2007 – by port*

State	Port	Number of Federal Skate Dealers	Percentage Dependence on Skate of These Dealers	Number of Federal Skate Dealers	Absolute Dependence on Skate of These Dealers
Massachusetts	Chatham	6	0-100%	6	$1k-5M
	Cambridge	1			
	New Bedford	12	0-5% (6), 10-60% (6)	9	$1k-5M
	Fall River	2			
	Westport	4			
	Fairhaven	1			
	Gloucester	6	0-10%	4	$10k-1M
	Boston	4	0-10%	4	$500k-1M
	Newburyport	1			
	Orleans	1			
	Other Barnstable	2			
	Other Plymouth	1			
	Provincetown	6	0-10%	6	$10k-5M
	Rockport	1			
	Sandwich	2			
	Scituate	5	0-15%	5	$10k-5M
	Westport	4	0-70%	4	$10-100k
	Woods Hole	1			
	Dennis	1			
	Falmouth	2			
	Harwichport	1			
	Hyannisport	1			
	Marshfield	2			
Maryland	Ocean City	2			
Maine	Portland	1			
North Carolina	Wanchese	1			
New Hampshire	Portsmouth	2			
New Jersey	Avalon	2			
	Barnegat	1			
	Belford/Middleton	3			
	Cape May	4	0-5%	2	
	Point Pleasant	2			
	Long Beach/ Barnegat Light	3			
	Sea Isle City	3			
	Waretown	1			
New York	Amagansett	4	0-5%	4	$50-500k
	Center Moriches	2			
	Freeport	1			

State	Port	Number of Federal Skate Dealers	Percentage Dependence on Skate of These Dealers	Number of Federal Skate Dealers	Absolute Dependence on Skate of These Dealers
	Montauk	17	0-10%	17	$0-100k (5), $500k (6), $1-5M (6)
	Hampton Bays/ Shinnecock	20	0-5% (19)	20	$1-10k (5), $50-100k (5), $500k (5), $1-5M (5)
	Mattituck	5	0-5%	5	$10-500k
	Greenport	3			
	Islip	3			
	Other Suffolk	3			
	Point Lookout	2			
	Wainscott	3			
Rhode Island	Charlestown	1			
	Little Compton	6	0-15%	6	$10k-5M
	Newport	6	0-5% (4)		$10k-5M
	Other Newport	1			
	Point Judith	15	0-5% (12)	15	$10-100k (6), $5000k-1M (4), $5-10M (5)
	South Kingstown	1			
	Tiverton	3			
	Westerley	1			
Virginia	Cape Charles	1			
	Chincoteague	1			
	Wachapreague	1			

* Data on ports with 3 or fewer dealers not reported for reasons of confidentiality.

Skate Processors

Skate processors include: AML International (about 90 employees), Bergie's Seafood (about 35 employees), Sea Trade (about 75 employees), and the Whaling City Auction (about 30 employees) in New Bedford, MA; Sea Fresh in Portland, ME and Point Judith, RI (about 50 employees total); Zeus Packing (about 200 employees) in Gloucester, MA; Ideal Seafood in Boston, MA; Agger Company in Brooklyn, NY.

Old Point Packing in Newport News, VA and Amory Seafood in Hampton, VA previously worked a lot with skate, but not at present.

Table 48. All ports for which profiles are provided in Appendix I, Document 15.

CT Stonington
MA Boston
MA Chatham
MA Fall River

MA	Gloucester
MA	New Bedford
MA	Provincetown
MD	Ocean City/West Ocean City
ME	Portland
NJ	Barnegat Light/Long Beach
NJ	Belford/Middletown
NJ	Cape May
NJ	Point Pleasant/Point Pleasant Beach
NJ	Sea Isle City
NY	Hampton Bays/Shinnecock
NY	Montauk
RI	Little Compton
RI	Newport
RI	Point Judith/Narragansett
RI	Tiverton
VA	Hampton

Bait Skate versus Food Skate and Targeted Skate versus Bycatch Skate

Among the top ports listed above, ports which heavily land skate for bait include: Point Judith, Tiverton, Newport, New Bedford and Stonington (CT) Secondarily, bait skate is landed in, Chatham and Provincetown. Point Judith's landings have accounted for 39-67% of bait landings between 2000-2007. Point Judith landings have declined somewhat in recent years, while landings in Newport, Tiverton and New Bedford have risen significantly. Other ports such as Montauk have individual vessels which sell skate directly to lobster and other pot fishermen for bait, though there are no major skate bait dealers here. Bait skate is primarily landed by trawlers, often as a secondary species while targeting monkfish or groundfish. Since 2003, with the implementation of the original Skate FMP, all vessels landing skate must be on a groundfish Day-at-Sea (DAS).

New Bedford is one of the major skate wing or food skate ports. Skate wings are also landed significantly in Gloucester, Chatham, Point Judith, Boston and Barnegat Light. Secondarily they are landed in Portland. Since 2000, skate wing landings in Provincetown have been on the decline, while Chatham landings have risen. Both trawlers and gillnets catch food skate. Some trawlers target skate, with others catching skate as a bycatch. Most of the gillnet vessels are targeting skate. The gillnets are based largely in Chatham but also in New Bedford. There is a very small skate wing fleet in Virginia, though it has dramatically declined in recent years. Most of these are monkfish gillnets though some draggers caught skate as a bycatch at the height of the fishery.

Skate Fishing Areas

Vessels landing skates for the wing market generally fish on Georges Bank, in the Great South Channel near Cape Cod, or west of the Nantucket Lightship Area in Southern New England (SNE) waters. Gillnet wing vessels often also fish east of Cape Cod.

Vessels that land skate as a bycatch often fish in Massachusetts Bay and on Georges Bank. Scallop dredges with general category permits often catch skate while fishing in the Great South Channel. There is also a mixed monkfish/skate fishery west of the Nantucket Lightship Area and off northern New Jersey, near Point Pleasant.

Vessels landing bait skate generally fish in the inshore waters of SNE, are most often trawlers, and frequently fish in an exempted fishery.

Data on Lobster Fishing in Top Skate Ports

By order of dependence on lobster landings, the top five lobster ports where skate is also landed are in Other Rhode Island, followed by Sea Isle City, NJ; Portland ME; Fall River, MA; and Little Compton, RI. It should be noted, however, that Portland lobstermen do not currently use skate for bait. By total value of lobster landings, the top five lobster ports where skate are also landed are: Gloucester, MA; Portland, ME; Point Judith, RI; New Bedford, MA and Other Rhode Island.

Table 49. Lobster landings and value of at least $10,000 or 10,000lbs in skate ports

ST	COUNTY	PORT	LOBVAL	LOBLBS	LOBVAL /TOTVAL	LOBLBS /TOTLBS	Rank in Value of ALL Lobster Ports
RI	NOT-SPECIFIED	OTHER R.I.	$5,083,319	967,196	75.95%	87.66%	19th
MA	BARNSTABLE	PROVINCETOWN	$1,664,494	306,541	45.34%	22.13%	58th
NJ	CAPE MAY	SEA ISLE CITY	$832,688	143,406	41.69%	17.34%	87th
ME	CUMBERLAND	PORTLAND	$9,108,218	1,966,185	38.00%	6.09%	8th
MA	BRISTOL	FALL RIVER	$1,348,898	252,701	26.66%	1.67%	69th
RI	NEWPORT	LITTLE COMPTON	$768,022	145,012	25.26%	5.21%	98th
MA	BARNSTABLE	CHATHAM	$3,368,519	621,526	23.15%	7.40%	36th
RI	WASHINGTON	POINT JUDITH	$8,417,621	1,609,982	22.91%	4.51%	10th
MA	ESSEX	GLOUCESTER	$9,971,471	2,001,331	21.29%	2.22%	5th
MA	SUFFOLK	BOSTON	$2,525,594	506,079	20.06%	5.99%	41st
NJ	OCEAN	POINT PLEASANT	$2,271,733	384,764	9.99%	1.65%	48th
NY	SUFFOLK	MONTAUK	$1,208,908	202,767	6.81%	1.89%	72nd
MA	BRISTOL	NEW BEDFORD	$5,901,537	1,159,697	2.21%	0.86%	15th
NJ	CAPE MAY	CAPE MAY	$748,991	118,191	1.42%	0.18%	91st
NY	SUFFOLK	HAMPTON BAYS	$37,819	5,774	0.62%	0.12%	183rd

In terms of permit homeport and town of owner's residence, when looking at all profiled towns for this amendment, only two (in bold) have more than 5% of all lobster permits. These are Gloucester and New Bedford, MA. An additional nine have between 1-4% of homeport and/or owner's residence for all lobster permits. These are (in italics) Portland, ME, Cape May, NJ, Montauk, NY, Chatham, MA, Boston, MA, Newport, RI, Barnegat Light/Long Beach, NJ, Belford/Middletown, NJ, and Point Judith/Narragansett, RI. It should again be noted that Portland lobstermen do not currently use skate for bait.

Table 50. Northeast Lobster Permit Homeport and Owner's Residence Listings for 2007 Among Profiled Skate Ports

ST	CITY	HOMEPORT	RESIDENCE	% HOMEPRT of ALL LOB Permits	% RESIDENCE OF ALL LOB Permits

ST	CITY	HOMEPORT	RESIDENCE	% HOMEPRT of ALL LOB Permits	% RESIDENCE OF ALL LOB Permits
MA	***Gloucester***	***338***	***246***	***8.16%***	***5.94%***
MA	***New Bedford***	***255***	***187***	***6.16%***	***4.51%***
ME	*Portland*	*128*	*42*	*3.09%*	*1.01%*
NJ	*Cape May*	*92*	*50*	*2.22%*	*1.21%*
NY	*Montauk*	*88*	*63*	*2.13%*	*1.52%*
MA	*Chatham*	*81*	*35*	*1.96%*	*0.85%*
MA	*Boston*	*71*	*6*	*1.71%*	*0.14%*
RI	*Newport*	*64*	*27*	*1.55%*	*0.65%*
NJ	*Barnegat Light/Long Beach*	*57*	*34*	*1.38%*	*0.82%*
NJ	*Belford/Middletown*	*43*	*34*	*1.04%*	*0.82%*
NJ	Point Pleasant/Point Pleasant Beach	38	8	0.92%	0.19%
NY	Hampton Bays/Shinnecock	37	16	0.89%	0.39%
MA	Provincetown	32	19	0.77%	0.46%
RI	*Point Judith/Narragansett*	*18*	*54*	*0.43%*	*1.30%*
CT	Stonington	15	9	0.36%	0.22%
RI	Tiverton	14	12	0.34%	0.29%
VA	Hampton	13	14	0.31%	0.34%
NJ	Sea Isle City	12	2	0.29%	0.05%
MD	Ocean City/West Ocean City	11	2	0.27%	0.05%
RI	Little Compton	7	18	0.17%	0.43%
MA	Fall River	3	4	0.07%	0.10%

7.5 GLOSSARY OF TERMS AND ACRONYMS

ABC – "Acceptable biological catch" means a level of a stock or stock complex's annual catch that accunts for the scientific uncertainty in the estimate of OFL.

ACL – "Annual catch limit" is the level of annual catch of a stock or stock complex that serves as the basis for invoking accountability measures (AMs).

ACT – "Annual catch target" is an amount of annual catch of a stock or stock complex that is the management target of the fishery.

Adult stage – One of several marked phases or periods in the development and growth of many animals. In vertebrates, the life history stage where the animal is capable of reproducing, as opposed to the juvenile stage.

Adverse effect – Any impact that reduces quality and/or quantity of EFH. May include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality and or quantity of EFH. Adverse effects to EFH may result from actions occurring within EFH or outside of EFH and may include sites-specific of habitat wide impacts, including individual, cumulative, or synergistic consequences of actions.

Aggregation – A group of animals or plants occurring together in a particular location or region.

AMs – "Accountability measures" are management controls that prevents ACLs or sector ACLs from being exceeded, where possible, and correct or mitigate overages if they occur.

Amendment – a formal change to a fishery management plan (FMP). The Council prepares amendments and submits them to the Secretary of Commerce for review and approval. The Council may also change FMPs through a "framework adjustment procedure".

Availability – refers to the distribution of fish of different ages or sizes relative to that taken in the fishery.

Benthic community – Benthic means the bottom habitat of the ocean, and can mean anything as shallow as a salt marsh or the intertidal zone, to areas of the bottom that are several miles deep in the ocean. Benthic community refers to those organisms that live in and on the bottom.

Biological Reference Points – specific values for the variables that describe the state of a fishery system which are used to evaluate its status. Reference points are most often specified in terms of fishing mortality rate and/or spawning stock biomass.

Biomass – The total mass of living matter in a given unit area or the weight of a fish stock or portion thereof. Biomass can be listed for beginning of year (Jan-1), Mid-Year, or mean (average during the entire year). In addition, biomass can be listed by age group (numbers at age * average weight at age) or summarized by groupings (e.g., age 1+, ages 4+ 5, etc). See also spawning stock biomass, exploitable biomass, and mean biomass.

Biota – All the plant and animal life of a particular region.

Bivalve – A class of mollusks having a soft body with platelike gills enclosed within two shells hinged together; e.g., clams, mussels.

Bottom tending mobile gear – All fishing gear that operates on or near the ocean bottom that is actively worked in order to capture fish or other marine species. Some examples of bottom tending mobile gear are otter trawls and dredges.

Bottom tending static gear – All fishing gear that operates on or near the ocean bottom that is not actively worked; instead, the effectiveness of this gear depends on species moving to the gear which is set in a particular manner by a vessel, and later retrieved. Some examples of bottom tending static gear are gillnets, traps, and pots.

B_{MSY} – the stock biomass that would produce maximum sustainable yield (MSY) when fished at a level equal to F_{MSY}. For most stocks, B_{MSY} is about ½ of the carrying capacity.

B_{target} – A desirable biomass to maintain fishery stocks. This is usually synonymous with BMSY or its proxy, and was set in the original Monkfish FMP as the median of the 3-yr. running average of the 1965-1981 autumn trawl survey biomass index.

$B_{threshold}$ – 1) A limit reference point for biomass that defines an unacceptably low biomass i.e., puts a stock at high risk (recruitment failure, depensation, collapse, reduced long term yields, etc). 2) A biomass threshold that the SFA requires for defining when a stock is overfished. A stock is overfished if its biomass is below Bthreshold. A determination of overfished triggers the SFA requirement for a rebuilding plan to achieve Btarget as soon as possible, usually not to exceed 10 years except certain requirements are met. For monkfish, Bthreshold was specified in Framework 2 as 1/2BTarget (see below).

Bycatch – (v.) the capture of nontarget species in directed fisheries which occurs because fishing gear and methods are not selective enough to catch only target species; (n.) fish which are harvested in a fishery but are not sold or kept for personal use, including economic discards and regulatory discards but not fish released alive under a recreational catch and release fishery management program.

Capacity – the level of output a fishing fleet is able to produce given specified conditions and constraints. Maximum fishing capacity results when all fishing capital is applied over the maximum amount of available (or permitted) fishing time, assuming that all variable inputs are utilized efficiently.

Catch – The sum total of fish killed in a fishery in a given period. Catch is given in either weight or number of fish and may include landings, unreported landings, discards, and incidental deaths.

Coarse sediment – Sediment generally of the sand and gravel classes; not sediment composed primarily of mud; but the meaning depends on the context, e.g. within the mud class, silt is coarser than clay.

Continental shelf waters – The waters overlying the continental shelf, which extends seaward from the shoreline and deepens gradually to the point where the sea floor begins a slightly steeper descent to the deep ocean floor; the depth of the shelf edge varies, but is approximately 200 meters in many regions.

Council – New England Fishery Management Council (NEFMC).

CPUE – Catch per unit effort. This measure includes landings and discards (live and dead), often expressed per hour of fishing time, per day fished, or per day-at-sea.

DAS – A day-at-sea is an allocation of time that a vessel may be at-sea on a fishing trip. For vessels with VMS equipment, it is the cumulative time that a vessel is seaward of the VMS demarcation line. For vessels without VMS equipment, it is the cumulative time between when a fisherman calls in to leave port to the time that the fisherman calls in to report that the vessel has returned to port.

Days absent – an estimate by port agents of trip length. This data was collected as part of the NMFS weighout system prior to May 1, 1994.

Demersal species – Most often refers to fish that live on or near the ocean bottom. They are often called benthic fish, groundfish, or bottom fish.

Discards – animals returned to sea after being caught; see Bycatch (n.)

Environmental Impact Statement (EIS) – an analysis of the expected impacts of a fishery management plan (or some other proposed federal action) on the environment and on people, initially prepared as a "Draft" (DEIS) for public comment. The Final EIS is referred to as the Final Environmental Impact Statement (FEIS).

Essential Fish Habitat (EFH) – Those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. The EFH designation for most managed species in this region is based on a legal text definition and geographical area that are described in the Habitat Omnibus Amendment (1998).

Exclusive Economic Zone (EEZ) – for the purposes of the Magnuson-Stevens Fishery Conservation and Management Act, the area from the seaward boundary of each of the coastal states to 200 nautical miles from the baseline.

Exempted fisheries – Any fishery determined by the Regional Director to have less than 5 percent regulated species as a bycatch (by weight) of total catch according to 50 CFR 648.80(a)(7).

Exploitation Rate – the percentage of catchable fish killed by fishing every year. If a fish stock has 1,000,000 fish large enough to be caught by fishing gear and 550,000 are killed by fishing during the year, the annual exploitation rate is 55%.

Fathom – A measure of length, containing six feet; the space to which a man can extend his arms; used chiefly in measuring cables, cordage, and the depth of navigable water by soundings.

Fishing effort – the amount of time and fishing power used to harvest fish. Fishing power is a function of gear size, boat size and horsepower.

Fishing Mortality (F) – (see also exploitation rate) a measurement of the rate of removal of fish from a population by fishing. F is that rate at which fish are harvested at any given point in time. ("Exploitation rate" is an annual rate of removal, "F" is an instantaneous rate.)

$F_{0.1}$ – F at which the increase in yield-per-recruit in weight for an increase in a unit-of effort is only 10% of that produced in an unexploited stock; usually considered a conservative target fishing mortality rate.

F_{MSY} – a fishing mortality rate that would produce the maximum sustainable yield from a stock when the stock biomass is at a level capable of producing MSY on a continuing basis.

F_{MAX} – the fishing mortality rate that produces the maximum level of yield per recruit. This is the point beyond which growth overfishing begins.

F_{target} – the fishing mortality that management measures are designed to achieve.

FMP (Fishery Management Plan) – a document that describes a fishery and establishes measures to manage it. This document forms the basis for federal regulations for fisheries managed under the regional Fishery Management Councils. The New England Fishery Management Council prepares FMPs and submits them to the Secretary of Commerce for approval and implementation.

Framework adjustments: adjustments within a range of measures previously specified in a fishery management plan (FMP). A change usually can be made more quickly and easily by a framework adjustment than through an amendment. For plans developed by the New England Council, the procedure requires at least two Council meetings including at least one public hearing and an evaluation of environmental impacts not already analyzed as part of the FMP.

$F_{threshold}$ – 1) The maximum fishing mortality rate allowed on a stock and used to define overfishing for status determination. 2) The maximum fishing mortality rate allowed for a given biomass as defined by a control rule.

Growth Overfishing – the situation existing when the rate of fishing mortality is above F_{MAX} and then the loss in fish weight due to mortality exceeds the gain in fish weight due to growth.

ICL – Interim catch limit is the maximum amount of skate catch, including landings and dead discards, that has been chosen to promote skate rebuilding. This limit has been calculated as the product of the median catch/biomass index for the time series and the latest 3 year moving average of the applicable survey biomass (spring survey for little skate; fall survey for all other managed skates).

Individual Fishing Quota (IFQ) – A Federal permit under a limited access system to harvest a quantity of fish, expressed by a unit or units representing a percentage of the total allowable catch of a fishery that may be received or held for exclusive use by an individual person or entity

Landings – The portion of the catch that is harvested for personal use or sold.

Larvae (or Larval) stage – One of several marked phases or periods in the development and growth of many animals. The first stage of development after hatching from the egg for many fish and invertebrates. This life stage looks fundamentally different than the juvenile and adult stages, and is incapable of reproduction; it must undergo metamorphosis into the juvenile or adult shape or form.

Limited Access – a management system that limits the number of participants in a fishery. Usually, qualification for this system is based on historic participation, and the participants remain constant over time (with the exception of attrition).

Limited-access permit – A permit issued to vessels that met certain qualification criteria by a specified date (the "control date").

LPUE – Landings per unit effort. This measure is the same as CPUE, but excludes discards.

Maximum Sustainable Yield (MSY) – the largest average catch that can be taken from a stock under existing environmental conditions.

Mesh selectivity (ogive) – A mathematical model used to describe the selectivity of a mesh size (proportion of fish at a specific length retained by mesh) for the entire population. L25 is the length where 25% of the fish encountered are retained by the mesh. L50 is the length where 50% of the fish encountered are retained by the mesh.

Meter – A measure of length, equal to 39.37 English inches, the standard of linear measure in the metric system of weights and measures. It was intended to be, and is very nearly, the ten millionth part of the distance from the equator to the north pole, as ascertained by actual measurement of an arc of a meridian.

Metric ton – A unit of weight equal to a thousand kilograms (1kgs = 2.2 lbs.). A metric ton is equivalent to 2,204.6 lbs. A thousand metric tons is equivalent to 2.204 million lbs.

Minimum Biomass Level – the minimum stock size (or biomass) below which there is a significantly lower chance that the stock will produce enough new fish to sustain itself over the long-term.

Mortality – Noun, either referring to fishing mortality (F) or total mortality (Z).

Multispecies – the group of species managed under the Northeast Multispecies Fishery Management Plan. This group includes whiting, red hake and ocean pout plus the regulated species (cod, haddock, pollock, yellowtail flounder, winter flounder, witch flounder, American plaice, windowpane flounder, white hake and redfish).

Natural Mortality (M) – a measurement of the rate of fish deaths from all causes other than fishing such as predation, cannibalism, disease, starvation, and pollution; the rate of natural mortality may vary from species to species

Northeast Shelf Ecosystem – The Northeast U.S. Shelf Ecosystem has been described as including the area from the Gulf of Maine south to Cape Hatteras, extending from the coast seaward to the edge of the continental shelf, including the slope sea offshore to the Gulf Stream.

Observer – Any person required or authorized to be carried on a vessel for conservation and management purposes by regulations or permits under this Act

OFL – "Overfishing limit" means the annual amount of catch that corresponds to the estimate of the maximum fishing mortality threshold applied to a stock or stock complex's abundance and is expressed in terms of numbers or weight of fish.

Open access – Describes a fishery or permit for which there is no qualification criteria to participate. Open-access permits may be issued with restrictions on fishing (for example, the type of gear that may be used or the amount of fish that may be caught).

Optimum Yield (OY) – the amount of fish which-
(a) will provide the greatest overall benefit to the Nation, particularly with respect to food production and recreational opportunities, and taking into account the protection of marine ecosystems;
(b) is prescribed as such on the basis of the maximum sustainable yield from the fishery, as reduced by any relevant economic, social, or ecological factor; and
(c) in the case of an overfished fishery, provides for rebuilding to a level consistent with producing the maximum sustainable yield in such fishery.

Overfished – A conditioned defined when stock biomass is below minimum biomass threshold and the probability of successful spawning production is low.

Overfishing – A level or rate of fishing mortality that jeopardizes the long-term capacity of a stock or stock complex to produce MSY on a continuing basis.

PDT (Plan Development Team) – a group of technical experts responsible for developing and analyzing management measures under the direction of the Council; the Council has a Skate PDT that meets to discuss the development of this FMP.

Proposed Rule – a federal regulation is often published in the Federal Register as a proposed rule with a time period for public comment. After the comment period closes, the proposed regulation may be changed or withdrawn before it is published as a final rule, along with its date of implementation and response to comments.

Rebuilding Plan – a plan designed to increase stock biomass to the B_{MSY} level within no more than ten years (or 10 years plus one mean generation period) when a stock has been declared overfished.

Recruitment overfishing – fishing at an exploitation rate that reduces the population biomass to a point where recruitment is substantially reduced.

Recruitment – the amount of fish added to the fishery each year due to growth and/or migration into the fishing area. For example, the number of fish that grow to become vulnerable to fishing gear in one year would be the recruitment to the fishery. "Recruitment" also refers to new year classes entering the population (prior to recruiting to the fishery).

Regulated groundfish species – cod, haddock, pollock, yellowtail flounder, winter flounder, witch flounder, American plaice, windowpane flounder, white hake and redfish. These species are usually targeted with large-mesh net gear.

Relative exploitation – an index of exploitation derived by dividing landings by trawl survey biomass. This variable does not provide an estimate of the proportion of removals from the stock due to fishing, but allows for general statements about trends in exploitation.

Sediment – Material deposited by water, wind, or glaciers.

Spawning stock biomass (SSB) – the total weight of fish in a stock that sexually mature, i.e., are old enough to reproduce.

Status Determination Criteria – objective and measurable criteria used to determine if overfishing is occurring or if a stock is in an overfished condition according to the National Standard Guidelines.

Stock assessment – An analysis for determining the number (abundance/biomass) and status (life-history characteristics, including age distribution, natural mortality rate, age at maturity, fecundity as a function of age) of individuals in a stock

Stock – A grouping of fish usually based on genetic relationship, geographic distribution and movement patterns. A region may have more than one stock of a species (for example, Gulf of Maine cod and Georges Bank cod). A species, subspecies, geographical grouping, or other category of fish capable of management as a unit.

Surplus production models – A family of analytical models used to describe stock dynamics based on catch in weight and CPUE time series (fishery dependent or survey) to construct stock biomass history. These models do not require catch at age information. Model outputs may include trends in stock biomass, biomass weighted fishing mortality rates, MSY, FMSY, BMSY, K, (maximum population biomass where stock growth and natural deaths are balanced) and r (intrinsic rate of increase).

Surplus production – Production of new stock biomass defined by recruitment plus somatic growth minus biomass loss due to natural deaths. The rate of surplus production is directly proportional to stock biomass and its relative distance from the maximum stock size at carrying capacity (K). BMSY is often defined as the biomass that maximizes surplus production rate.

Survival rate (S) – Rate of survival expressed as the fraction of a cohort surviving the a period compared to number alive at the beginning of the period (# survivors at the end of the year / numbers alive at the beginning of the year). Pessimists convert survival rates into annual total mortality rate using the relationship A=1-S.

Survival ratio (R/SSB) – an index of the survivability from egg to age-of-recruitment. Declining ratios suggest that the survival rate from egg to age-of-recruitment is declining.

TAC – Total allowable catch is equivalent to the ICL.

TAL – Total allowable landings, which for skate management is equivalent to 75% of the TAC minus the dead discard rate.

Ten-minute- "squares" of latitude and longitude (TMS) – A measure of geographic space. The actual size of a ten-minute-square varies depending on where it is on the surface of the earth, but in general each square is approximately 70-80 square nautical miles at 40° of latitude. This is the spatial area that EFH designations, biomass data, and some of the effort data have been classified or grouped for analysis.

TL – Total length of a fish, measured from the tip of the 'nose' to the most posterior point of the tail, often recorded in centimeters (cm).

Total mortality – The rate of mortality from all sources (fishing, natural, pollution) Total mortality can be expressed as an instantaneous rate (called Z and equal to F + M) or Annual rate (called A and calculated as the ratio of total deaths in a year divided by number alive at the beginning of the year)

Yearclass (or cohort) – Fish that were spawned in the same year. By convention, the "birth date" is set to January 1st and a fish must experience a summer before turning 1. For example, winter flounder that were spawned in February-April 1997 are all part of the 1997 cohort (or year-class). They would be considered age 0 in 1997, age 1 in 1998, etc. A summer flounder spawned in October 1997 would have its birth date set to the following January 1 and would be considered age 0 in 1998, age 1 in 1999, etc.

Yield-per-recruit (YPR) – the expected yield (weight) of individual fish calculated for a given fishing mortality rate and exploitation pattern and incorporating the growth characteristics and natural mortality.

7.6 SAFE REPORT/AFFECTED ENVIRONMENT REFERENCES

Abernathy, A., ed. 1989. Description of the Mid-Atlantic environment. U.S. Dep. Interior, Minerals Manage. Ser., Herndon, VA. 167 p. + appendices.

Almeida, F., L. Arlen, P. Auster, J. Cross, J. Lindholm, J. Link, D. Packer, A, Paulson, R. Reid, and P. Valentine. 2000. The effects of marine protected areas on fish and benthic fauna: the Georges Bank closed area II example. Poster presented at Am. Fish. Soc. 130th Ann. Meet. St. Louis, MO, August 20-24, 2000.

Anonymous. 2005. COSEWIC Assessment Summary.

Backus, R.H. 1987. Georges Bank. Massachusetts Inst. Tech. Press, Cambridge, MA. 593 p.

Beardsley, R.C., B. Butman, W.R. Geyer, and P. Smith. 1996. Physical oceanography of the Gulf of Maine: an update. In G.T Wallace and E.F. Braasch, eds. Proceedings of the Gulf of Maine ecosystem dynamics scientific symposium and workshop. p. 39-52. Reg. Assn. for Res. on the Gulf of Maine (RARGOM), Rep. 97-1.

Benoit. 2006. Estimated discards of winter skate (*Leucoraja ocellata*) in the southern Gulf of St. Lawrence, 1971-2004. Research Document 2006/002.

Best, P.B., J. L. Bannister, R.L. Brownell, Jr., and G.P. Donovan (eds.). 2001. Right whales: worldwide status. J. Cetacean Res. Manage. (Special Issue) 2. 309pp.

Beverton, R.J.H. and S.J. Holt. 1956. A review of methods for estimating mortality rates in fish populations, with special reference to sources of bias in catch sampling. Rapp. P.v. Reun. Cons. Int. Explor. Mer 140: 67-83.

Bigelow and Schroeder.1953. Fishes of the Gulf of Maine.

Boesch, D.F. 1979. Benthic ecological studies: macrobenthos. Chapter 6 in Middle Atlantic outer continental shelf environmental studies. Conducted by Virginia Inst. Mar. Stud. under contract AA550-CT6062 with U.S. Dep. Interior, Bur. Land Manage. 301 p.

Braun-McNeill, J., and S.P. Epperly. 2004. Spatial and temporal distribution of sea turtles in the western North Atlantic and the U.S. Gulf of Mexico from Marine Recreational Fishery Statistics Survey (MRFSS). Mar. Fish. Rev. 64(4):50-56.

Brooks, D.A. 1996. Physical oceanography of the shelf and slope seas from Cape Hatteras to Georges Bank: A brief overview. In K. Sherman, N.A. Jaworski, and T.J. Smayda, eds. The northeast shelf ecosystem – assessment, sustainability, and management. p. 47-75. Blackwell Science, Cambridge, MA. 564 p.

Brown, M.W., O.C. Nichols, M.K. Marx, and J.N. Ciano. 2002. Surveillance of North Atlantic right whales in Cape Cod Bay and adjacent waters—2002. Final Report to the Division of Marine Fisheries, Commonwealth of Massachusetts. 29pp.

Butman, V., M. Noble and J. Moody. 1982. Observations of near-bottom currents at the shelf break near Wilmington Canyon in the Mid-Atlantic outer continental shelf area: results of 1978-1979 field seasons. U.S. Geol. Surv. Final Rep. to U.S. Dep. Interior, Bur. Land Manage: 3-1-3-58.

Casey, Jill M., & Ransom A. Myers. 1998. Near extinction of a large, widely distributed fish. Science. **281**(5377): 690-- 692.

Clapham, P.J., S.B. Young, and R.L. Brownell. 1999. Baleen whales: Conservation issues and the status of the most endangered populations. Mammal Rev. 29(1):35-60

Colvocoresses, J.A. and J.A. Musick. 1984. Species associations and community composition of Middle Atlantic Bight continental shelf demersal fishes. Fish. Bull. (U.S.) 82: 295-313.

Cook, S.K. 1988. Physical oceanography of the Middle Atlantic Bight. In A.L. Pacheco, ed. Characterization of the middle Atlantic water management unit of the northeast regional action plan. p. 1-50. NOAA Tech. Mem. NMFS-F/NEC-56. 322 p.

Cooper, R.A., P.C. Valentine, J.R. Uzmann, and R.A. Slater. 1987. Submarine canyons. In R.H. Backus and D.W. Bourne, eds. Georges Bank. p. 52-63. MIT Press, Cambridge, MA.

DFO, 1999. *Updates on Selected Scotian Shelf Groundfish Stocks in 1999.* DFO Sci. Stock Status Report A3-35 (1999).

Dorsey, E.M. 1998. Geological overview of the sea floor of New England. In E.M. Dorsey and J. Pederson, eds. Effects of fishing gear on the sea floor of New England. p. 8-14. MIT Sea Grant Pub. 98-4.

Dulvy, Nicholas, Metcalfe, J.D., Glanville, Jamie, Pawson, M.G., and John D. Reynolds. 2000. *Fishery Stability, Local Extinctions, and Shifts in Community Structure in Skates*. Conservation Biology. 14 (1): 283-293

Frisk, Michael G., & Thomas J. Miller. 2006. Age, growth and latitudinal patterns of two rajidae species in the northwestern Atlantic: Little skate (*Leucoraja erinacea*) and winter skate (*Leucoraja ocellata*). Canadian Journal of Fisheries and Aquatic Sciences. **63**: 1078 – 1091.

Frisk, Michael G., Thomas J. Miller, and Michael J. Fogarty. 2001. Estimation and analysis of biological parameters in elasmobranch fishes: A comparative life history study. Canadian Journal of Fisheries and Aquatic Sciences. **58**: 969-- 981.

Gabriel, W. 1992. Persistence of demersal fish assemblages between Cape Hatteras and Nova Scotia, northwest Atlantic. J. Northwest Atl. Fish. Sci. 14: 29-46.

Gedamke, T. and J.M. Hoenig. 2006. Estimating mortality from mean length data in non-equilibrium situations, with application to the assessment of goosefish. Trans. Amer. Fish. Soc. 135: 476-487.

Gedamke, Todd, John M. Hoenig, John A. Musick, William D. DuPaul and Samuel H. Gruber. 2007. Using demographic models to determine intrinsic rate of increase and sustainable fishing for elasmobranchs: Pitfalls, advances, and applications. North American Journal of Fisheries Management. **27**: 605 - 618.

Gedamke, Todd, William D. DuPaul, & John A. Musick. 2005. Observations on the life history of the barndoor skate, *Dipturus* laevis, on Georges bank (western north Atlantic). Journal of Northwest Atlantic Fishery Science. **35**: 67 - 78.

Gelsleichter, JJ. 1998. Vertebral Cartilage of the Clearnose Skate, *Raja eglanteria*: Development, Structure, Ageing, and Hormonal Regulation of Growth. Dissertation. College of William and Mary.

Hecker, B. 1990. Variation in megafaunal assemblages on the continental margin south of New England. Deep-Sea Res. 37: 37-57.

Hecker, B. 2001. Polygons BH1–4 (Veatch, Hydrographer, Oceanographer and Lydonia Canyons). In S. Azimi, ed. Priority ocean areas for protection in the Mid-Atlantic. p. 32-36. Natural Resources Defense Council, Washington, DC. 59 p.

Hecker, B. and G. Blechschmidt. 1979. Epifauna of the northeastern U.S. continental margin. In B. Hecker, G. Blechschmidt, and P. Gibson, eds. Epifaunal zonation and community structure in three mid- and North Atlantic canyons. Appendix A. Final Rep. Canyon Assess. Stud. in the Mid- and North Atlantic Areas of the U.S. Outer Continental Shelf. U.S. Dep. Interior, Bur. Land Manage., Washington, DC, January 11, 1980.

Hecker, B., D.T. Logan, F.E. Gandarillas, and P.R. Gibson. 1983. Megafaunal assemblages in canyon and slope habitats. Vol. III: Chapter I. Canyon and slope processes study. Final Rep. prepared for U.S. Dep. Interior, Minerals Manage. Ser., Washington, D.C.

Hirth, H.F. 1997. Synopsis of the biological data of the green turtle, *Chelonia mydas* (Linnaeus 1758). USFWS Biological Report 97(1). 120pp.

Hoenig, J.M. 1987. Estimation of growth and mortality parameters for use in length-structured stock production models, p. 121-128. In D. Pauly and G.R. Morgan (eds.) Length-based methods in fisheries research. ICLARM Conference Proceedings 13, 468 p. International Center for Living Aquatic Resources Management, Manila, Philippines, and Kuwait Institute for Scientific Research, Safat, Kuwait.

ICES International Council for the Exploration of the Sea. 2000. Report of the ICES Advisory Committee on the Marine Environment (ACME) 2000. Cooperative Research Report No. 241, 27 pp.

James, M.C., R.A. Myers, and C.A. Ottenmeyer. 2005a. Behavior of leatherback sea turtles, *Dermochelys coriacea*, during the migratory cycle. Proc. R. Soc. B, 272: 1547-1555.

Johnson GF (1979) The biology of the little skate, Raja erinacea, in Block Island Sound, Rhode Island. MA thesis, University of Rhode Island, Kingston, R.I., USA.

Johnson, A., G. Salvador, J. Kenney, J. Robbins, S. Kraus, S. Landry, and P. Clapham. 2005. Fishing gear involved in entanglements of right and humpback whales. Mar. Mamm. Sci. 21(4): 635-645.

Katona, S.K., V. Rough, and D.T. Richardson. 1993. A field guide to whales, porpoises, and seals from Cape Cod to Newfoundland. Smithsonian Institution Press, Washington, D.C. 316pp.

Keinath, J.A., J.A. Musick, and R.A. Byles. 1987. Aspects of the biology of Virginias sea turtles: 1979-1986. Virginia J. Sci. 38(4): 329-336.

Kelley, J.T. 1998. Mapping the surficial geology of the western Gulf of Maine. In E.M. Dorsey and J. Pederson, eds. Effects of fishing gear on the sea floor of New England. p. 15-19. MIT Sea Grant Pub. 98-4.

Kenney, R.D. 2002. North Atlantic, North Pacific, and Southern hemisphere right whales. In: W.F.Perrin, B. Wursig, and J.G.M. Thewissen (eds.), Encyclopedia of Marine Mammals. Academic Press, CA. pp. 806-813.

Kneebone, Jeff, Darren E. Ferguson, James A. Sulikowski, & Paul C. W. Tsang. 2007. Endocrinological investigation into the reproductive cycles of two sympatric skate species, M*alacoraja senta* and A*mblyraja radiata*, in the western Gulf of Maine. Environmental Biology of Fishes. **80**: 257 - 265.

Kulka, D. W. and C. M. Miri 2003. The status of Thorny skate (*Amblyraja radiata* Donovan, 1808) in NAFO Divisions 3L, 3N, 3O, and Subdivision 3Ps. NAFO SCR Doc. 03/57, Ser. No. N4875. 100p.

Kulka, D.W., and C.M. Miri. 2007. Update on the status of thorny skate (*Amblyraja radiata*, Donovan 1808) in NAFO Divisions 3L, 3N, 3O, and Subdivision 3Ps. NAFO SCR Doc. 07/33.

Kulka, D.W., D. Swain, M.R. Simpson, C.M. Miri, J. Simon, J. Gauthier, R. McPhie, J. Sulikowski, and L. Hamilton. 2006b. Distribution, abundance, and life history of *Malacoraja senta* (smooth skate) in Canadian Atlantic waters with reference to its global distribution. DFO Research Document. 2006/093.

Kulka, D.W., M.R. Simpson, and C.M. Miri. 2006a. An assessment of thorny skate (*Amblyraja radiata* Donovan, 1808) on the Grand Banks of Newfoundland. NAFO SCR Doc. 06/44.

Lindeboom, H.J., and S.J. de Groot. 1998. Impact II. The effects of different types of fisheries on the North Sea and Irish Sea benthic ecosystems. NIOZ Rapport 1998-1. 404 p.

Link, Jason A., and Katherine Sosebee. 2008. Estimates and Implications of Skate Consumption in the Northeast U.S. Continental Shelf Ecosystem. North American Journal of Fisheries Management 28:649–662, 2008.

Mahon, R., S.K. Brown, K.C.T. Zwanenburg, D.B. Atkinson, K.R. Buja, L. Claflin, G.D. Howell, M.E. Monaco, R.N. O'Boyle, and M. Sinclair. 1998. Assemblages and biogeography of demersal fishes of the east coast of North America. Can. J. Fish. Aquat. Sci. 55: 1704-1738.

McPhie, R. 2006. Proceedings of the review of DFO science information for smooth skate (*Malacoraja senta*) relevant to status assessment by COSEWIC. DFO Proceedings Series. 2006/030.

Morgan, L.E. and R. Chuenpagdee. 2003. Shifting gears: assessing the collateral impacts of fishing methods in U.S. waters. Pew Science Series on Conservation and the Environment, 42 p.

Morreale, S.J. and E.A. Standora. 1998. Early life stage ecology of sea turtles in northeastern U.S. waters. U.S. Dep. Commer. NOAA Tech. Mem. NMFS-SEFSC-413, 49 pp.

Morreale, S.J. and E.A. Standora. 2005. Western North Atlantic waters: Crucial developmental habitat for Kemp's ridley and loggerhead sea turtles. Chel. Conserv. Biol. 4(4):872-882.

Mountain, D.G., R.W. Langton, and L. Watling. 1994. Oceanic processes and benthic substrates: influences on demersal fish habitats and benthic communities. In R.W. Langton, J.B. Pearce, and J.A. Gibson, eds. Selected living resources, habitat conditions, and human perturbations of the Gulf of Maine: environmental and ecological considerations for fishery management. p. 20-25. NOAA Tech. Mem. NMFS-NE-106. 70 p.

Musick, J.A. and C.J. Limpus. 1997. Habitat utilization and migration in juvenile sea turtles. Pp. 137-164 In: Lutz, P.L., and J.A. Musick, eds., The Biology of Sea Turtles. CRC Press, New York. 432 pp.

Natanson, L.J. 1993. Effect of temperature on band deposition in the little skate, raja erinacea. Copeia. **1**: 199 - 206.

Natanson, Lisa J., James A. Sulikowski, Jeff R. Kneebone, & Paul C. Tsang. 2007. Age and growth estimates for the smooth skate, M*alacoraja senta*, in the Gulf of Maine. Environmental Biology of Fishes. **80**: 293 - 308.

NEFMC New England Fishery Management Council. 1998. Final Amendment #11 to the Northeast Multispecies Fishery Management Plan, #9 to the Atlantic Sea Scallop Fishery Management Plan, Amendment #1 to the Monkfish Fishery Management Plan, Amendment #1 to the Atlantic Salmon Fishery Management Plan, and components of the proposed Atlantic Herring Fishery Management Plan for Essential Fish Habitat, incorporating the environmental assessment. October 7, 1998.

NEFMC New England Fishery Management Council. 2003. Amendment 13 to the Northeast Multispecies Fishery Management Plan, including a Final Supplemental Environmental Impact Statement and an Initial Regulatory Flexibility Analysis. Vols I and II, submitted Dec 1 2003.

NEFSC Northeast Fisheries Science Center. 2002. Workshop on the effects of fishing gear on marine habitats off the northeastern United States, October 23-25, 2001, Boston, Massachusetts. U.S. Natl. Mar. Fish. Serv. Northeast Fish. Cent. Woods Hole Lab. Ref. Doc. 02-01. 86 p.

NMFS and U.S. Fish and Wildlife Service (USFWS). 1991a. Recovery plan for U.S. population of loggerhead turtle. National Marine Fisheries Service, Washington, D.C. 64 pp.

NMFS and USFWS. 1991b. Recovery plan for U.S. population of Atlantic green turtle. National Marine Fisheries Service, Washington, D.C. 58 pp.

NMFS and USFWS. 1992. Recovery plan for leatherback turtles in the U.S. Caribbean, Atlantic, and Gulf of Mexico. National Marine Fisheries Service, Washington, D.C. 65 pp.

NMFS and USFWS. 1995. Status reviews for sea turtles listed under the Endangered Species Act of 1973. National Marine Fisheries Service, Silver Spring, MD. 139 pp.

NMFS. 1998. Recovery Plan for the blue whale (*Balaenoptera musculus*). Prepared by R.R. Reeves, P.J. Clapham, R.L. Brownell, Jr., and G.K. Silber for the National Marine Fisheries Service, Silver Spring, MD. 42pp.

NMFS. 2005. Recovery Plan for the North Atlantic right whale (*Eubalaena glacialis*). National Marine Fisheries Service, Silver Spring, MD. 137pp.

NMFS. 1991. Final recovery plan for the humpback whale (*Megaptera novaeangliae*). Prepared by the Humpback Whale Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland. 105 pp.

NOAA/NMFS. 1975. *The Market in Western Europe for Dogfish, Squid, Mussels, Skate, Monkfish and Whiting*. Prepared as part of the New England Fisheries Development Program.

Northeast Fisheries Center (NEFC). 1991. Report of the 12th Stock Assessment Workshop (12th SAW), Spring 1991. Woods Hole, MA: NOAA/NMFS/NEFC. NEFC Ref. Doc.91-03.

Northeast Fisheries Science Center (NEFSC). 2000. 30th Northeast Regional Stock Assessment Workshop (30th SAW) Stock Assessment Review Committee (SARC) Consensus Summary of Assessments. NEFSC Ref. Doc. 00-03, 477 p.

Northeast Fisheries Science Center (NEFSC). 2007. 44th Northeast Regional Stock Assessment Workshop (44th SAW): 44th SAW assessment report. US Dept. Commerce, Northeast Fish Sci. Cent. Ref. Doc. 07-10; 661 p. Also available at http://www.nefsc.noaa.gov/nefsc/publications/crd/crd0710/.

NRC National Research Council. 2002. Effects of trawling and dredging on seafloor habitat. Ocean Studies Board, Division on Earth and Life Studies, National Research Council. National Academy Press, Washington, D.C. 126 p.

Overholtz, W.J. and A.V. Tyler. 1985. Long-term responses of the demersal fish assemblages of Georges Bank. Fish. Bull. (U.S.) 83: 507-520.

Packer DB, Zetlin CA, Vitaliano JJ. 2003a. Essential fish habitat source document: barndoor skate, *Dipturus laevis*, life history and habitat characteristics. NOAA Technical Memorandum NMFS-NE-173.

Packer DB, Zetlin CA, Vitaliano JJ. 2003b. Essential fish habitat source document: clearnose skate, *Raja eglanteria*, life history and habitat characteristics. NOAA Technical Memorandum NMFS-NE-174.

Packer DB, Zetlin CA, Vitaliano JJ. 2003c. Essential fish habitat source document: little skate, *Leucoraja erinacea*, life history and habitat characteristics. NOAA Technical Memorandum NMFS-NE-175.

Parent, Serge, Serge Pepin, Jean-Pierre Genet, Laurent Misserey, and Salvador Rojas. 2008. Captive Breeding of the Barndoor Skate (*Dipturus laevis*) at the Montreal Biodome, With Comparison Notes on Two Other Captive-Bred Skate Species. Zoo Biology 27:145–153.

Perry, S.L., D.P. DeMaster, and G.K. Silber. 1999. The great whales: History and status of six species listed as endangered under the U.S. Endangered Species Act of 1973. Mar. Fish. Rev. Special Edition. 61(1): 59-74.

Poppe, L.J., J.S. Schlee, B. Butman, and C.M. Lane. 1989a. Map showing distribution of surficial sediment, Gulf of Maine and Georges Bank. U.S. Dep. Interior, U.S. Geol. Sur. Misc. Invest. Ser., Map I-1986-A, scale 1:1,000,000.

Poppe, L.J., J.S. Schlee,. Knebel H.J. 1989b. Map showing distribution of surficial sediment on the mid-Atlantic continental margin, Cape Cod to Albemarle sound. U.S. Dep. Interior, U.S. Geol. Sur. Misc. Invest. Ser., Map I-1987-D, scale 1:1,000,000.

Pratt, S. 1973. Benthic fauna. In Coastal and offshore environmental inventory, Cape Hatteras to Nantucket Shoals. p. 5-1 to 5-70. Univ. Rhode Island, Mar. Pub. Ser. No. 2. Kingston, RI.

Reid, R.N. and F.W. Steimle, Jr. 1988. Benthic macrofauna of the middle Atlantic continental shelf. In A.L. Pacheco, ed. Characterization of the middle Atlantic water management unit of the northeast regional action plan. p. 125-160. NOAA Tech. Mem. NMFS-F/NEC-56. 322 p.

Richards SW, Merriman D, Calhoun LH (1963) Studies in the marine resources of southern New England. IX. The biology of the little skate Raja erinacea, Mitchill. Bull Bingham Oceanogr Collect Yale Univ 18:311–407.

Schmitz, W.J., W.R. Wright, and N.G. Hogg. 1987. Physical oceanography. In J.D. Milliman and W.R. Wright, eds. The marine environment of the U.S. Atlantic continental slope and rise. p. 27-56. Jones and Bartlett Publishers Inc., Boston, MA.

Shepard, F.P., N.F. Marshall, P.A. McLonghlin, and F.G. Sullivan. 1979. Currents in submarine canyons and other sea valleys. Am. Assn. Petrol. Geol., Studies in Geol. No. 8.

Sherman, K., N.A. Jaworski, T.J. Smayda, eds. 1996. The northeast shelf ecosystem – assessment, sustainability, and management. Blackwell Science, Cambridge, MA. 564 p.

Shoop, C.R. and R.D. Kenney. 1992. Seasonal distributions and abundance of loggerhead and leatherback sea turtles in waters of the northeastern United States. Herpetol. Monogr. 6: 43-67.

Simon, J. E. and K. T. Frank. November 1998. *Assessment of the Winter Skate Fishery in Division 4VsW*. DFO Canadian Stock Assessment Secretariat Research Document 98/145.

Simon, James E., Lei H. Harris and Terry L. Johnston. 2003. Distribution and abundance of winter skate, *Leucoraja ocellatta*, in the Canadian Atlantic. DFO Research Document. 2003/028.

Sissenwine, M.P. and E.W. Bowman. 1978. An analysis of some factors affecting the catchability of fish by bottom trawls. ICNAF Res Bull. 13: 81-87.

Sosebee, K.A. 2005. Maturity of skates in northeast United States waters. E-Journal of Northwest Atlantic Fishery Science. **35**(9).

Steimle, F.W. and C. Zetlin. 2000. Reef habitats in the middle Atlantic bight: abundance, distribution, associated biological communities, and fishery resource use. Mar. Fish. Rev. 62: 24-42.

Steimle, F.W., C.A. Zetlin, P.L. Berrien, D.L. Johnson and S. Chang. 1999. Essential fish habitat source document: tilefish, Lopholatilus chamaeleonticeps, life history and habitat characteristics. NOAA Tech. Mem. NMFS-NE-152. 30 p.

Stevenson, D., L. Chiarella, D. Stephan, R. Reid, K. Wilhelm, J. McCarthy, and M. Pentony. 2004. Characterization of the fishing practices and marine benthic ecosystems of the northeast U.S. shelf, and an evaluation of the potential effects of fishing on essential fish habitat. NOAA Tech. Memo. NMFS-NE-181. 179 p.

Stumpf, R.P. and R.B. Biggs. 1988. Surficial morphology and sediments of the continental shelf of the middle Atlantic bight. In A.L. Pacheco, ed. Characterization of the middle Atlantic water management unit of the northeast regional action plan. p. 51-72. NOAA Tech. Mem. NMFS-F/NEC-56. 322 p.

Sulikowski, J. A., J. Kneebone, S. Elzey, J. Jurek, W. H. Howell, & P. C. W. Tsang. 2006. Using the composite variables of reproductive morphology, histology and steroid hormones to determine age and size at sexual maturity for the thorny skate *Amblyraja radiata* in the western Gulf of Maine. Journal of Fish Biology. **69**: 1449 - 1465.

Sulikowski, J.A., P. C. W. Tsang, & W. Huntting Howell. 2004. An annual cycle of steroid hormone concentrations and gonad development in the winter skate, Leucoraja ocellata, from the western Gulf of Maine. Marine Biology. **144**: 845 - 853.

Sulikowski, James A., Jeff Kneebone, Scott Elzey, Joe Jurek, Patrick D. Danley, W. Huntting Howell, and Paul C.W. Tsang. 2005a. Age and growth estimates of the thorny skate (*Amblyraja radiata*) in the western gulf of Maine. Fishery Bulletin. **103**: 161 - 168.

Sulikowski, James A., Michael D. Morin, Seung H. Suk, and W. Huntting Howell. 2003. Age and growth estimates of the winter skate (*Leucoraja ocellata*) in the western gulf of Maine. Fishery Bulletin. **101**: 405 - 413.

Sulikowski, James A., Paul C.W. Tsang & W. Huntting Howell. 2005b. Age and size at sexual maturity for the winter skate, *Leucoraja ocellata*, in the western Gulf of Maine based on morphological, histological and steroid hormone analyses. Environmental Biology of Fishes. **72**: 429 - 441.

Sulikowski, James A., Scott Elzey, Jeff Kneebone, Joe Jurek, W. Huntting Howell and Paul C. W. Tsang.

2007. The reproductive cycle of the smooth skate, *Malacoraja senta*, in the Gulf of Maine. Marine and Freshwater Research. **58**, 98–103

Swingle, W.M., S.G. Barco, T.D. Pitchford, W.A. McLellan, and D.A. Pabst. 1993. Appearance of juvenile humpback whales feeding in the nearshore waters of Virginia. Mar. Mamm. Sci. 9: 309-315.

Templeman, W. 1984. Migrations of thorny skate, *Raja radiata*, tagged in the Newfoundland area. Journal of Northwest Atlantic Fishery Science. **5**(1): 55 - 63.

Theroux, R.B. and M.D. Grosslein. 1987. Benthic fauna. In R.H. Backus and D.W. Bourne, eds. Georges Bank. p. 283-295. MIT Press, Cambridge, MA.

Theroux, R.B. and R.L. Wigley. 1998. Quantitative composition and distribution of the macrobenthic invertebrate fauna of the continental shelf ecosystems of the northeastern United States. NOAA Tech. Rep. NMFS 140. 240 p.

Townsend, D.W. 1992. An overview of the oceanography and biological productivity of the Gulf of Maine. In D.W. Townsend and P.F. Larsen, eds. The Gulf of Maine. p. 5-26. NOAA Coast. Ocean Prog. Reg. Synthesis Ser. No. 1. Silver Spring, MD. 135 p.

Tucholke, B.E. 1987. Submarine geology. In J.D. Milliman and W.R. Wright, eds. The marine environment of the U.S. Atlantic continental slope and rise. p. 56-113. Jones and Bartlett Publishers Inc., Boston, MA.

Turtle Expert Working Group (TEWG). 1998. An assessment of the Kemp's ridley (*Lepidochelys kempii*) and loggerhead (*Caretta caretta*) sea turtle populations in the Western North Atlantic. NOAA Technical Memorandum NMFS-SEFSC-409. 96 pp.

Turtle Expert Working Group (TEWG). 2000. Assessment update for the Kemp's ridley and loggerhead sea turtle populations in the western North Atlantic. U.S. Dep. Commer. NOAA Tech. Mem. NMFS-SEFSC-444, 115 pp.

USFWS and NMFS. 1992. Recovery plan for the Kemp's ridley sea turtle (*Lepidochelys kempii*). NMFS, St. Petersburg, Florida.

USFWS. 1997. Synopsis of the biological data on the green turtle, *Chelonia mydas* (Linnaeus 1758). Biological Report 97(1). U.S. Fish and Wildlife Service, Washington, D.C. 120 pp.

Valentine, P.C. and R.G. Lough. 1991. The sea floor environment and the fishery of eastern Georges bank. U.S. Dep. Interior, U.S. Geol. Sur. Open File Rep. 91-439. 25 p.

Valentine, P.C., E.W. Strom, R.G. Lough, and C.L. Brown. 1993. Maps showing the sedimentary environment of eastern Georges bank. U.S. Dep. Interior, U.S. Geol. Sur. Misc. Invest. Ser., Map I-2279-B, scale 1:250,000.

Waring, G.T. 1984. Age, growth and mortality of the little skate off the northeast coast of the United States. Transactions of the American Fisheries Society. **113**: 314 - 321.

Waring, G.T., D.L. Palka, P.J. Clapham, S. Swartz, M. Rossman, T. Cole, L.J. Hansen, K.D. Bisack, K. Mullin, R.S. Wells, D.K. Odell, and N.B. Barros. 1999. U.S. Atlantic and Gulf of Mexico marine mammal stock assessments - 1999. NOAA Technical Memorandum NMFS-NE-153.

Waring, G.T., E. Josephson, C.P. Fairfield, and K. Maze-Foley, Editors. 2006. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments-2005. NOAA Tech. Memo. NMFS-NE-194, 352pp.

Waring, G.T., E. Josephson, C.P. Fairfield, and K. Maze-Foley, Editors. 2007. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments-2006. NOAA Tech. Memo. NMFS-NE-201, 378 pp.

Waring, G.T., R.M. Pace, J.M. Quintal, C. P. Fairfield, K. Maze-Foley (eds). 2003. U.S. Atlantic and Gulf of Mexico marine mammal stock assessments - 2003 . NOAA Technical Memorandum NMFS-NE-182. 287 p.

Watling, L. 1998. Benthic fauna of soft substrates in the Gulf of Maine. In E.M. Dorsey and J. Pederson, eds. Effects of fishing gear on the sea floor of New England. p. 20-29. MIT Sea Grant Pub. 98-4.

Wiebe, P.H., E.H. Backus, R.H. Backus, D.A. Caron, P.M. Glibert, J.F. Grassle, K. Powers, and J.B. Waterbury. 1987. Biological oceanography. In J.D. Milliman and W.R. Wright, eds. The marine environment of the U.S. Atlantic continental slope and rise. p. 140-201. Jones and Bartlett Publishers Inc., Boston, MA.

Wigley, R.L. and R.B. Theroux. 1981. Atlantic continental shelf and slope of the United States – macrobenthic invertebrate fauna of the middle Atlantic bight region – faunal composition and quantitative distribution. Geol. Surv. Prof. Pap. 529-N. 198 p.

Wiley, D.N., R.A. Asmutis, T.D. Pitchford, and D.P. Gannon. 1995. Stranding and mortality of humpback whales, *Megaptera novaengliae*, in the mid-Atlantic and southeast United States, 1985-1992. Fish. Bull., U.S. 93:196-205.

Worthington, L.V. 1976. On the North Atlantic circulation. Johns Hopkins Ocean. Stud. No. 6. Johns Hopkins Univ. Press, Baltimore, MD. 110 p.

Wright, W.R. and L.V. Worthington. 1970. The water masses of the North Atlantic Ocean: a volumetric census of temperature and salinity. Ser. Atlas Mar. Environ., Am. Geol. Soc. Folio No. 19.

Wynne, K. and M. Schwartz. 1999. Guide to marine mammals and turtles of the U.S. Atlantic and Gulf of Mexico. Rhode Island Sea Grant, Narragansett. 115pp.